MEASURING THE QUALITY OF CONTRACTORS' CO-ORDINATION ACTIVITIES DURING THE CONSTRUCTION PROCESS

by

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THESIS

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ABSTRACT

Abstract of thesis entitled

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Construction co-ordination is a management function that has received a smallest amount of quality improvement attention than many others. The objective of the thesis is to study the important function of construction co-ordination, in particular to see if the quality of co-ordination can be measured in some way. Without the ability to measure, it is difficult to confidently improve the quality of the co-ordination function. Possibly the industry practitioners have found it difficult to align construction co-ordination function with the 'classic' quality improvement models of Total Quality because of its process characteristics of Informality, Intangibility, Customers' participation in the processes (Co-production), Low repetition, Customers not soliciting the service (Unsolicited Service) and Problem solving content involved. To understand how this type of process can be improved the present research described in this thes is tested the two hypotheses:

H1: Attributes based quality measurement tools are not applicable to the construction co-ordination processes.

H2: The Critical Incident Technique (CIT) is a practical method for measuring the quality of construction co-ordination processes.

The bulk of the formal research activity consisted of four experiments.

Experiment 1 was conducted to understand the recent construction industry experiences of using the two multi-attribute quality measurement systems, ‘Performance Assessment Scoring System’ (PASS) and ‘Construction Quality Assessment System’ (CONQUAS), in Hong Kong and Singapore respectively. A study was conducted by a questionnaire survey followed by a series of in-depth interviews with a selected number of the respondents where it was investigated whether the two systems are successfully contributing towards achieving improved customer satisfaction and continuous improvement of products and processes. Results showed that the usefulness of PASS and CONQUAS as quality improvement tools are flawed because of *the mandatory enforcement involved, they are not administered by people involved in the processes, they are used for judgemental purposes, they are unable to furnish statistical evidence of quality, they cannot systematically identify customer expectations, they focus only on the outputs and are based on conformance to specifications instead of customer satisfaction*. Based on these lessons learnt, it was decided that these two measurement models are not suitable to be used for testing H1 and H2.

A literature review revealed that there is no formal understanding of how day-to-day co-ordination is achieved on a construction project. A study (Experiment 2) was therefore directed at identifying what activities are performed to achieve co-ordination and which among those are the most important and more time consuming for the construction co-ordinator. Texts on the duties and responsibilities of project managers were reviewed to develop an array of 64 issues relevant to achieving co-ordination. A questionnaire was developed to present these issues to construction project managers and senior co-ordinators so that they could indicate on a 3-point scale against each, the relative importance and the relative time consumed. The 33 responses received from Hong Kong and Singapore indicated that '*identifying strategic activities and potential delays'* and '*ensuring the timeliness of all work carried out'* are the most important co-ordination activities. '*Conducting regular meetings and project reviews'* and '*analysing the project performance, detecting variances and dealing with their effects'* appear to be the most time consuming activities.

Based on the results of the latter experiment, the testing of Hypothesis H1 was focused on the three co-ordination processes: (1) Identifying strategic activities and potential delays, (2) Ensuring the timeliness of all work carried out and (3) Liaison with the client and consultants. The hypothesis was tested (Experiment 3) by interviewing and soliciting from industry practitioners, in-depth knowledge and understanding relating to the application of a multi-attribute measurement model (that require identification of attributes of the process and ranking their quality and importance) to each of these three processes. The survey revealed how the characteristics of all three processes of informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work caused great difficulties in applying the eight steps of the multi-attribute quality measurement model. On the strength of these arguments, Hypothesis H1 was accepted.

Hypothesis H2 was tested (Experiment 4) by collecting critical (highly satisfying or dissatisfying) incidents experienced by a variety of customers and other stakeholders of co-ordination processes and analysing them. Analysis of the 23 incidents collected demonstrated that the Critical Incident Technique could enable identification of the implicit, explicit and latent expectations of customers and other stakeholders, evaluation of the quality of co-ordination processes and outputs and a comprehension of information useful for quality improvement. Therefore, Hypothesis H2 was accepted.

Hitherto, there are no records of the application of the Critical Incident Technique in the construction industry. It is envisaged however, that in-depth knowledge gathered through its consistent application, could be used to develop a management maturity grid that would provide guidance to future project managers on how various aspects of the co-ordination function could be improved in incremental steps.

The thesis concludes that the Critical Incident Technique is a practical method for measuring the quality of construction co-ordination processes while multi-attribute quality measurement tools are not applicable to these processes.

Keywords: Construction, Co-ordination, Multi-attribute Quality Measurement, Critical Incident Technique, Hong Kong, Singapore.

STATEMENT OF SOURCES

To the best of my knowledge and belief, the work presented in this thesis is original unless otherwise acknowledged in the text. The material, either in whole or in part, has not been submitted for a degree in this or any other University.

Don Darshi De Saram

To

my wife

Kushmi Vorajini

and the two sons

Keshika Migara

and

Nadeeka Narada

who underwent many untold hardships while supporting me in this endeavour

THE STRUCTURE OF THE THESIS

Because of the length of this thesis it was considered necessary to provide an introduction to its structure at this point. It consists of nine chapters and the structure is graphically depicted by the flowchart in Figure i. Therein both solid and dashed arrows indicate the flow of the research processes and the sequence in which a reader may proceed to read.

Chapters 1 to 3 are introductory chapters. After Chapter 3 the reader may either read Chapters 4, 5, 6 and 7 (Chapters 4 and 6 present initial learning processes pertaining to this branch of the research process) on testing the suitability of the attributes based models for measuring the quality of construction co-ordination or read Chapter 8 on testing the suitability of the Critical Incident Technique (CIT) for that purpose. The contents of each chapter can be briefly described as follows. Proceeding in the numerical order of the chapters, the three introductory chapters are described first.

Chapter 1 – Introduction to the Study

The reader is introduced to this study by first presenting the historical background and the present context of construction co-ordination. Then the significance of this study is discussed followed by the objectives and the scope. Finally an overview of the research methodology used is presented.

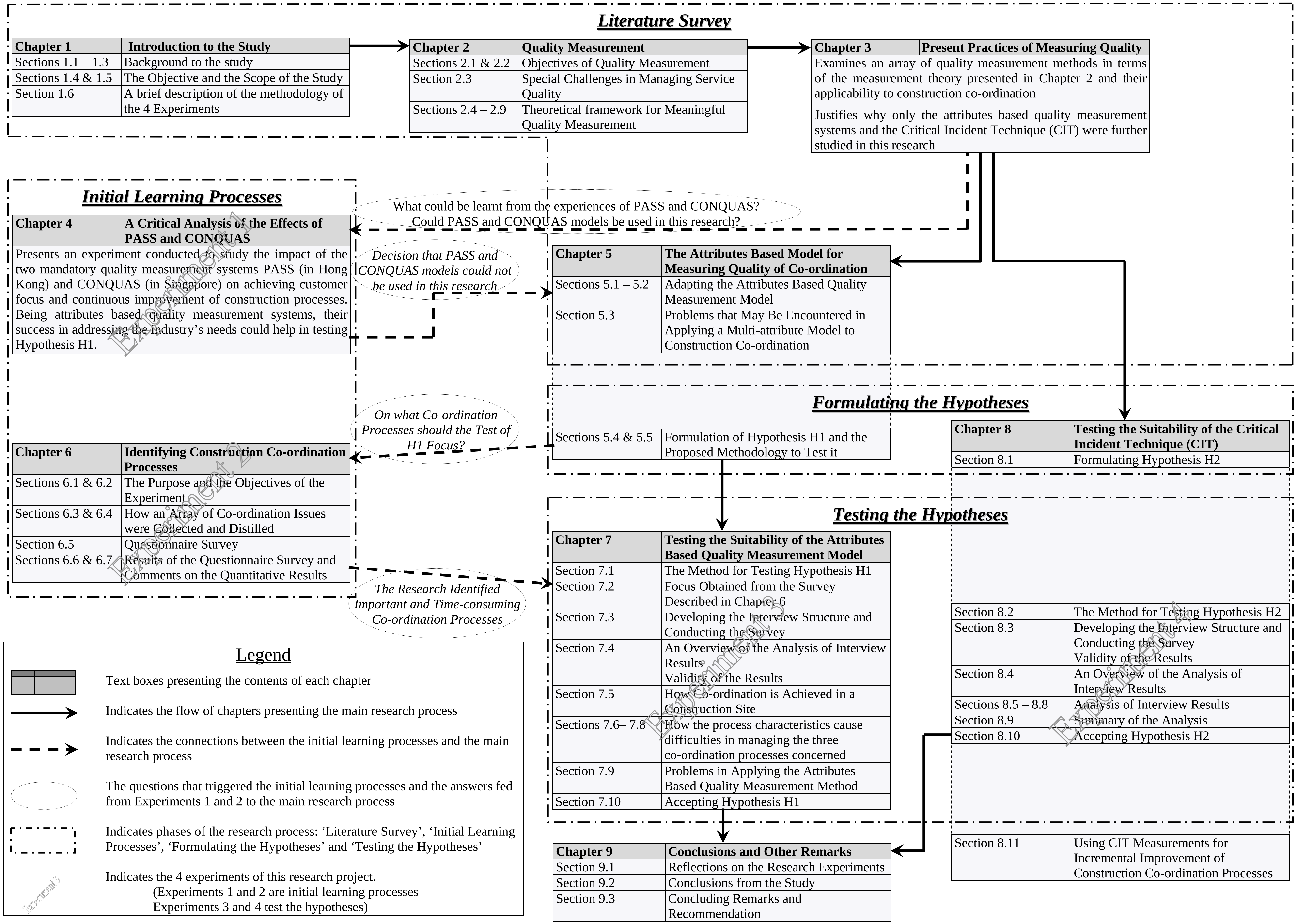

Figure i: The Research Process and the Structure of the Thesis

Chapter 2 – **Quality Measurement**

Presented in Chapter 2 is a discussion of the challenges in measuring service quality and the essential features of a quality measurement system geared at improving service processes. This discussion presents the theory required for applying measurement models to service processes. Further it reveals the fact that measuring the quality of non- manufacturing processes is more complex and challenging than measuring the quality of manufacturing processes.

Chapter 3 – **Present Practices of Measuring Quality**

Chapter 3 is devoted to examining an array of popular quality measurement methods in terms of the theory presented in Chapter 2 and their possible application in efforts to improve construction co-ordination processes. This discussion will serve to justify why only the attributes based quality measurement systems and the Critical Incident Technique (CIT) were further studied in this research.

At this point the research branched into two sets of experiments; one set to test the suitability of the multi-attribute methods and the other to test the suitability of the Critical Incident Technique (CIT). Chapters 4 to 7 on testing the suitability of the multi-attribute methods are presented next.

Chapter 4 – **A Critical Analysis of the effects of PASS and CONQUAS**

In the construction industries of Hong Kong and Singapore, there are two quality measurement systems, namely Performance Assessment Scoring System (PASS) and Construction Quality Assessment System (CONQUAS), implemented by the respective Governmental clients. Chapter 4 presents an experiment (Experiment 1) conducted to study their impact on achieving customer focus and continuous improvement of construction processes. Being attributes based quality measurement systems, their success in addressing the industry's needs could help in testing Hypothesis H1 on applicability of attributes based quality measurement tools to construction co-ordination. However, this experiment revealed that PASS and CONQUAS models could not be used in this research thus a generic multi-attribute quality measurement model was adapted to construction co-ordination context as presented in Chapter 5.

Chapter 5 – **The Attributes Based Model for Measuring Quality of Co-ordination**

Chapter 5 presents an attributes based quality measurement model and describes how this model could be further adapted to suit the construction co-ordination context and the present study. Possible challenges in applying such a model to measure the quality of construction co-ordination processes are then discussed thus formulating Hypothesis H1, which is to the effect that attributes based quality measurement tools are not applicable to construction co-ordination. Methodology adopted to test this hypothesis is also briefly discussed.

A questionnaire on all quality aspects of the entire co-ordination function will be well beyond the practical size for a survey on the industry. The survey described in Chapter 6 was necessary to decide on which co-ordination processes should the application of the multi-attribute quality measurement model and the rest of the research process be focused.

Chapter 6 – Identifying Construction Co-ordination Processes

Chapter 6 is devoted to present an experiment where a questionnaire survey was conducted to identify what are construction co-ordination processes and of these what are considered important and time consuming. This chapter first describes the reasons for conducting this experiment and the objectives of the experiment. Next it is discussed how an array of construction co-ordination issues were collected and distilled to a manageable size that can be presented in a questionnaire. The questionnaires thus developed and the surveys that were conducted are then described. Finally the quantitative results thus obtained are analysed to identify *what are construction co-ordination processes* and of these *what are considered important and time consuming*.

Chapter 7 – Testing the Suitability of the Attributes Based Quality Measurement Model

In Chapter 7 the methodology of Experiment 3, for testing Hypothesis H1, is discussed first. Then it is described how the interview structures were developed, improved and the surveys were conducted. In analysing the survey results, the first step was to develop an understanding of how co-ordination is achieved in construction sites. Next the analysis was directed at generating an understanding of the nature of co-ordination processes. Armed with such knowledge, the applicability of the multi-attribute models for measuring quality of these processes is finally argued. This argument eventually leads to the conclusion that Hypothesis H1 should be accepted.

With that conclusion ends the series of experiments conducted to test the suitability of the multi-attribute models for measuring quality of construction co-ordination processes. In the following chapter the experiment conducted to test the suitability of the Critical Incident Technique (CIT) is described. Then in Chapter 9 the findings of both experiments are summarised and recommendations are made.

***Chapter 8* – Testing the Suitability of the Critical Incident Technique (CIT)**

In Chapter 8, Hypothesis H2, i.e., that the Critical Incident Technique (CIT) is a practical method to measure the quality of construction co-ordination, is formulated based on certain properties of the Critical Incident Technique (CIT) and the construction co-ordination processes. Then the methodology of Experiment 4, to test the hypothesis is discussed and the interview structures and questionnaires developed and the surveys conducted are described. The data collected in the surveys are analysed to evaluate the suitability of the Critical Incident Technique (CIT) to measure the quality of construction co-ordination process. Based on the argument developed in this discussion Hypothesis H2 is accepted.

***Chapter 9* – Conclusions and Recommendations**

Chapter 9 presents the conclusions of this study and recommendations on how the findings can be applied to continuously improve the quality of co-ordination process.

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ABBREVIATIONS

BD	Buildings Department, Hong Kong
CIDB	Construction Industry Development Board, Singapore (now it is called Building and Construction Authority (BCA))
CII	Construction Industry Institute, Austin, Texas, USA
CIT	Critical Incident Technique
CONQUAS	Construction Quality Assessment System
DLP	Defects Liability Period
ECI	European Construction Institute
EFQM	European Foundation for Quality Management
HK$	Hong Kong Dollar (US$ 1 ≈ HK$ 7.78 at the time of this study)
HKHA	Hong Kong Housing Authority
HKQAA	Hong Kong Quality Assurance Agency
JUSE	The Union of Japanese Scientists and Engineers
LD	Liquidated Damages
OR	Operations Research
PASS	Performance Assessment Scoring System
PE	Professional Engineer
PR	Public Relations
RC	Reinforced Concrete
S$	Singapore Dollar (US$ 1 ≈ S$ 1.6 at the time of this study)
TQM	Total Quality Management

Every attempt has been made to avoid the use of male gender words such as he, him and his. Instead the following abbreviations have been used that may refer to both the male and female genders.

S/he	He or she	His/er	His or her
Him/er	Him or her		

However, male gender words were left unchanged wherever they occurred in the quotations from interview transcripts or other texts.

Harvard system of giving references is used throughout this thesis. The numbers with the prefix "Qt" in Chapter 7 refer to quotations from interview transcripts given in Appendix I.

Punctuations:

…	The 'Ellipsis' symbol has been used in the quotations from interview transcripts or other texts wherever some irrelevant text has been deleted in the midst.
–	The 'Long Hyphen' has been used in the quotations from interview transcripts wherever the respondent has made some discontinuation in his/er speech, e.g., changed what s/he wanted to say in the middle of the sentence or added another idea without finishing the sentence.

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Chapter 1

INTRODUCTION TO THE STUDY

1.1 Historical Background of Construction Co-ordination

"The building industry had a guild type of structure through the middle ages right into the seventeenth century" (Higgin and Jessop 1965). Guilds were initial fraternities formed among craftsmen of the same trade that later developed into more organised "unions" (Lerner 1995) or "monopolistic craft and trade organisations" (Juran 1995). Through these the craftsmen sought to look after their own interests, protect themselves from or stand-up to competition, share the knowledge, discuss problems, develop techniques, provide apprenticeship to the younger generation; in short, they looked for stability in life (Lerner 1995 and Deleforge 1995). Lerner (1995) further explains that, beyond providing for the well being of a capable, honest craftsman, the guilds performed the functions to protect the customers and themselves from deception by unscrupulous workers even by imposing punishments. Deleforge (1995) quotes the following from 'Regius' text (an English text written in 1390) which appears to be the oldest equivalent of a charter codifying guilds of builders:

> Spare no effort: good work is its own reward and brings its author happiness.

According to Juran (1995) craftsmen's guilds were capable of managing for quality until commercialisation and industrialisation reduced their influence. Higgin and Jessop (1965) state that the fire of London in the middle of the seventeenth century created an enormous rebuilding requirement that occasioned the first big change in the structure of the building industry. This rebuilding challenge was met by a development in line with the developing bourgeois economic culture of the time, the building craftsman as entrepreneur. With it came concern with "getting the job done and realising on an investment of capital or labour in the quickest and most profitable way than previous concern with the workmanship or the "delight" of the result. This new approach had obvious advantages in the situation of crisis that the rebuilding of London created" (Higgin and Jessop 1965). New commercial builder units developed centred around enterprising master craftsmen from the old guilds. Small enterprises undertaking bricklaying, carpentry, plumbing, etc., sprang up, each controlled by a man from the appropriate guild background. "In order to co-ordinate these economically separated competing units, working at a rather higher register than previously, some form of co-ordination was required. Under the guild system, with its slower tempo, the design function was barely separated from the construction function. The master artisans worked it out among themselves and with the client as they went along" (Higgin and Jessop 1965).

They further explain that the central problem of co-ordination arises from the fact that the basic relationship between the parties to a construction project has the character of an "interdependent autonomy". There is a lack of match between the "technical interdependence" of the work and the "organisational independence" of those who control the work. "For [more than] three centuries the construction industry has been struggling to reconcile this technical interdependence and organisational independence" (Higgin and Jessop 1965).

1.2 Present Context of Co-ordinating Construction Works

Although the above was observed during the studies sponsored by the Tavistock Institute in the UK over 35 years ago, in recent times, Shamma-Toma *et al.* (1998) confirm that a frequent observation by respondents was that there was poor, little or inadequate co-ordination/communication within the entire construction process. They continue to state, “Social order and co-ordination [in a construction project] is a day-to-day accomplishment of project participants. We have little systematic knowledge of how this informal system relates to the various formal systems – contractual, technical, directive and so on – since attention [of research] is directed almost exclusively at the formal systems. The direction signalled by Tavistock studies has not been followed”.

Crichton (1966) however was impressed by the fact that these problems have not caused jobs to lag as much as would be expected according to formal management systems. “The reason of course is that informal (and, within one definition, unscientific) management practises [seen to be employed in construction projects], calling for almost hour-to-hour redeployment by an experienced site manager, have kept the job going without undue delay or the generation of unacceptable cost. This informal management has disadvantages – it reduces the programming time scale to a week or a day, so that long-term programming is often overlooked and it produces a climate of endemic crisis which becomes self-perpetuating. The type of man who can best handle this situation tends to have a crisis type of personality” (Crichton 1966).

Poon (1999) describes how it is inevitable that construction personnel make decisions onsite. He further states that much research work had been carried out in developing or improving the techniques of decision-making, yet characteristics of decisions made by site staff remain largely unknown. His survey does show that such decisions were mainly concerned with technical, engineering and financial aspects. From time to time, decisions are required to be made onsite because of such reasons as incomplete planning, client's variations, imperfect site conditions, limited resources, nature of works, et cetera. The said survey revealed that many decisions had to be made either within one hour or on the same day and that experience was the most important contributing factor in making the decisions.

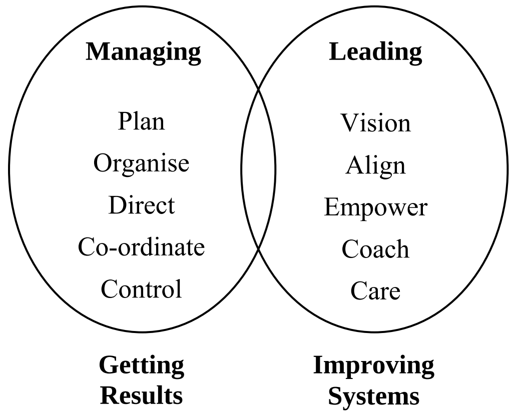

Figure 1.1: Leading vs. Managing

Source: Tenner and DeToro (1992)

"Perhaps the most influential of all classical theorists of management was Henri Fayol (1841–1925), the French industrialist" (Bounds *et al.* 1995). In 1916 he identified co-ordination as an important managerial activity (Fayol 1949). The importance he had attached to this activity can be gauged by his statement "The best liaison officer would be the General Manager visiting all departmental heads in turn". Nevertheless Tenner and DeToro (1992) point out that, when implementing Total Quality all participants to a project will be aligned and focused towards the same mission, goals and objectives. As illustrated in Figure 1.1, old management roles of planning, organising, directing, co-ordinating, and controlling should diminish and their place should be taken up by vision, alignment, empowerment, coaching and empathy instilled by "leaders" as opposed to "managers". Chitkara (1998) also agrees that co-ordination will not be required "If the situation variables are measurable, the policies and the procedures are well defined and communication flows smoothly in all directions, then *espirit de corps* prevails, every one is interested in his task and all work collectively to achieve the ultimate project objectives in a fast changing project environment". However, such an ideal environment is rarely met in construction projects where it is usual to have many disparate and economically independent parties participating. Walker (1996) states "It is clearly the case that success of the construction process depends to a large extent upon the way in which the architect, engineer, quantity surveyor, contractors and others work together. It depends upon them perceiving the same objectives for the project and recognising that what each of them achieves depends upon what the others do. With this view they should be able to stand above the particular interests of their own contribution and see the problem posed by the project as a whole. The advent of the project manager has, to a large degree, come about as a result of the inability of the contributors to consistently achieve this and in response to the consequent need for someone to concentrate solely upon integrating the various contributors in the interest of the client". Crichton (1966) has described the reality in a construction site as a social system in which "a group of people are systematically sharing control of a common process, where the relationships among the group are based on mutual independence and contributions to the common task are based on sequential finality". He further states that this system "does not seem suited to effectively control a process characterised by interdependence of operations, fraught with uncertainty, requiring carefully phased decisions and continuous application of all control functions". In such a context, "co-ordination is essential both within and among the various departments to fill up the voids created by changing situations in the systems, procedures and policies … co-ordination is one of the most sensitive functions of the management" (Chitkara 1998).

Higgin and Jessop (1965) state: "Looking at the building process, we can distinguish three main functions. Two are obvious: design and construction. The third is co-ordination". It is not so obvious due to the very low tangibility of both the co-ordination processes and their products/results. It may be due to this intangibility that many authors of textbooks on construction project management, for example Clough and Sears (1991), Shtub *et al.* (1994), Sengupta and Guha (1995) and Halpin and Woodhead (1998), have not discussed this vital topic. Although authors such as Chitkara (1998), Forsberg *et al.* (1996), Walker (1996), Kerzner (1994), Ritz (1994), Lavender (1996), Fisk (1997), Barrie and Paulson (1992) and Gould (1997) discuss co-ordination, they fall short of comprehensively identifying those activities a construction project co-ordinator needs to perform to achieve good co-ordination.

Another possible reason for the lack of discussion on co-ordination is mentioned in the Tavistock studies. Co-ordination in the building industry is carried out quite informally (Crichton 1966). "These [informal] forms of control are drawn from direct observation of the building team at work and from talks with them about what they were doing. Most of their [site personnel's] forms of behaviour are undertaken quite consciously and their existence is known to all members of the building team. They are, nevertheless, informal in that they are not spoken of on the record; nor would they appear in the handbooks or formal reports and literature of the industry – except as procedures to be avoided" (Crichton 1966). Walker (1996) state "Informal structures exist alongside formal organisational structures because people cannot be treated as machines. Their behavioural responses to their position within a formal organisation cannot be expected to subscribe to the predetermined manner in which they are expected to perform. Hence an informal structure will arise. How different this structure is from the 'official' structure will depend on many factors not least of which will be how well the formal organisation has been constructed".

In 1988 Thomas W. Malone developed a 'co-ordination theory'. A number of subsequent studies, for example, Malone and Crowston (1994), Yu (1996) and Malone *et al.* (1999) have studied the possibility of applying this theory in various contexts other than in construction projects. However, this 'co-ordination theory' and the subsequent studies focus entirely on the formal forms of control and do not consider the importance of the informal forms of control that seem to be momentous in dynamic environments such as found in construction sites. Further, they define co-ordination as "managing dependencies between activities". Nonetheless, the experiment described in Chapter 6 (Experiment 2) has established that the definition of construction project co-ordination has to be broader. The results have shown that proactively finding out potential problems to be solved is a very important part of construction co-ordination. Hence it is a function that requires cognitive competencies (such as problem solving, critical thinking, question formulation, relevant information searching, making informal judgements, efficient use of information and so on (Segers *et al.* 1999)) and social competencies.

The general experience of the Author during collection of data for this research was that construction project managers could not specifically identify the co-ordination activities they carried out. It was claimed that the activities are so numerous and miscellaneous in nature. They neither could identify specific customers nor specific inputs/outputs of their processes and claimed that the customers of a construction project manager are so numerous because s/he has to work with every participant of the project and every outsider connected with the project, each having unique needs. It may be that Informality, Intangibility, Co-production by Customers (described in Section 2.3), Low Repetition, Unsolicited Service (described in Section 5.3.5) and Problem Solving Work of construction co-ordination processes have made it very difficult for practitioners to align this most important function with the 'classic' quality improvement models of Total Quality.

1.3 The Significance of this Study

The above discussion displays the importance of the co-ordination function and possible difficulties that led to it not being studied in depth. Nevertheless, it is very important that industry practitioners be helped on how this type of process can be improved.

Crosby (1993) states that, present day use of customer satisfaction measurement information is more widespread in an organisation and much more closely linked to management of overall operations. In some highly customer-driven firms, it serves as the primary means for aligning the entire organisation with customer's total needs. Hence, customer satisfaction measurement is a management tool. Further, quality measurement is an integral part of the Shewhart and Deming Cycle (please see Figure 2.1) for continuous improvement. Hence it is an important and a necessary activity in the Total Quality Process; to assess the development and to justify the effort put into the quality improvement programme.

In this context, present research focused on studying possible methods to measure the quality of construction co-ordination processes. The Researcher hopes that the knowledge thus imparted will eventually help construction industry practitioners to better understand what are the good practises in co-ordination, benchmark the co-ordination processes and continuously improve them. Considering the lack of research and discussion on construction co-ordination, it is expected that this research will provoke further studies on this complex, intangible and informal function.

Measurements in the construction environment have always remained a difficult problem. Choi & Ibbs (1994) state, "When it comes to measuring work process, the construction industry does not enjoy a good reputation. The problem, however, can be attributed to the nature of the industry, which lacks solid data gathering and the exceptional fluctuation in productivity. Data collected in a construction project usually lacks consistency in structure and compilation". This is further evident from the results of the experiment described in Chapter 4 (Experiment 1) by the Author. Worldwide, perhaps because of these reasons, there are not many records of attempts to measure the quality of construction.

The research described in this thesis tests the applicability to construction co-ordination, of two methods of measuring quality. First, is an attributes based method that has gained popularity in many industries, especially in the services industry. Second, is the Critical Incident Technique (CIT), which has seldom been applied anywhere or at least there are no records of its use in the construction industry. Stauss (1993) compares these two methods for measuring service quality as follows. "In multi-attribute methods, lists of relevant quality attributes are always established [by the service provider] and respondents [customers] are asked in interviews to evaluate and weight the attributes of a particular service". On the other hand "the Critical Incident Technique (CIT) is essentially a means of collecting and classifying stories of "critical incidents" by employing content analysis" (Stauss 1993). He further elaborates "Services require the participation of customers in the service production process. That is why services are perceived as processes and are kept in mind, to a large extent, as episodes. Hence, the dominating mode of experience within service processes is "episodic" and not attribute-based. Further, services are basically intangible. Therefore, the transformation of concrete incident-based experiences into abstract attribute-based evaluations is more difficult with services than for goods. Multi-attribute methods are not able to take the episodic nature of service experiences into consideration. In the Critical Incident Technique (CIT) it is not abstract discussions of service attributes that are the subject of the data collecting interviews, but special incidents. These little stories are easy to talk about and attractive because of their authenticity. During an interview, customers are not forced into any given framework; they are simply asked to recall specific events. The respondents can use their own terms and familiar language. The result is 'pure' customer data. CIT allows service providers to see how customers think" (Stauss 1993).

Nevertheless, there are no records of this powerful tool being used in the construction industry. Therefore, it is expected that the results of this research will instigate construction industry practitioners to view quality measurement from another perspective.

1.4 The Objective of the Study

The objectives of this research are to test the two hypotheses:

H1: Attributes based quality measurement tools are not applicable to the construction co-ordination processes.

H2: The Critical Incident Technique (CIT) is a practical method for measuring the quality of construction co-ordination processes.

The formulation of these Hypotheses and the arguments behind them are described in detail in Chapters 5 and 8.

1.5 The Scope of the Study

The scope of construction co-ordination varies greatly between stages of the lifecycle of a project. Also, because a construction project has many participant organisations, e.g., client, consultant, main contractor, subcontractors, the scope of co-ordination will differ from one such participant to another and will also depend on the type of contract (e.g., traditional bid and build, design and build, construction management, management) that exists between them. Further, the scope of co-ordination depends on the level of hierarchy in the management of each such organisation. The nature and complexity of co-ordination work will also vary with the type of the project, e.g., civil engineering construction, building construction, mechanical or electrical service installation et cetera. Therefore, the present research was focused on:

1. The construction stage of building projects with a traditional bid and build contract.

2. The perspective of the Project Manager of the Main Contractor in co-ordinating the day-to-day site operations.

Reasons for focusing on construction stage of building projects was that it is common experience that building projects have more co-ordination problems than civil engineering construction projects possibly due to greater number of parties (e.g., specialist consultants, specialist contractors) involved in the project and due to greater number and variety of activities involved. Often, co-ordination problems in the design stage can get conveniently buried until they surface in the construction stage as buildability problems, clashes in the works of different trades and so on. Therefore, this study focusing on the construction stage will eventually help industry practitioners to better identify imminent co-ordination problems in the design stage.

Reason for focusing on the perspective of the Project Manager of the Main Contractor was that it is the Main Contractor who is chiefly responsible for project wide co-ordination. Any living being co-ordinates its movements and actions in the day-to-day life. Every workman/woman in a construction site co-ordinates his/er movements to perform the work, handle the material and use the tools and equipment. In every gang of workmen, in every small sub-subcontractor, in every subcontractor, there is at least one senior and experienced person who will co-ordinate the work of the rest. The difference in the co-ordination work carried out by such parties and those carried out by the main contractor's project manager (and his team of co-ordinators) is, the complexity of the requirement to co-ordinate disparate parties who may never have worked together before.

Surveys of Construction Project Managers conducted under this research focused on building contractors in Hong Kong and Singapore as follows:

- All the contractors in the NW2 tender list (unlimited contract sum) and in the NW1 tender list (contract sum up to 300 Million Hong Kong Dollars) of the Hong Kong Housing Authority.

- All contractors in the Hong Kong Government Works Branch tender list Group C (any contract sum exceeding 50 Million Hong Kong Dollars) in the Category for Buildings.

- All contractors in the G8 (unlimited contract sum) and G7 (contract sum up to 50 Million Singapore Dollars) tender lists of Construction Industry Development Board, Singapore.

The questionnaire surveys were mailed to all construction companies thus attempting to obtain the opinion of all of them. Although "Building Project Managers" would have been a more appropriate sampling unit than "Building Contractors", it was not possible to get a comprehensive list of the former. The response rate was of the order of 20%, which is very good especially for the Hong Kong construction industry. However, the responses are entirely from volunteers and not from a random sample of the industries in Hong Kong and Singapore. It is possible that the responses are from personnel who are more organised in their work, thus could find some time to help a research project such as this.

Finding industry personnel willing to participate in the interview surveys was a major difficulty encountered in this research. Therefore, it was again not possible to access a random sample. Eventually, the interviewees were some of the respondents to earlier questionnaire surveys and a few other Project Managers contacted through known sources. Nevertheless, Mason (1996) proposes "you sample until you know that you have a picture of what is going on and can generate appropriate picture of it. This point is reached when your data begin to stop telling you anything new about the social process under scrutiny". Further, the survey on Critical Incident Technique (CIT) was directed at all construction personnel other than Main Contractors' Project Managers. Again it was difficult to identify an exact population of such personnel or approach a sample. Justifications for the validity of the interview results are further discussed in Chapters 7 and 8.

There could be varying levels of interest in achieving co-ordination (at times even vested* interests in not achieving co-ordination) among different project participants depending on the type of contract and the method of payment (e.g., lump sum, measure and pay, cost reimbursable). As this research focused on measuring the quality of co-ordination, attempts were made to study how in measurement results the bias due to a vested* interest in not achieving co-ordination could be eliminated but no attempt was made to identify different biases that could exist due to type of contract or payment method.

Although focus was maintained on Building Projects, data was also collected from project managers and other project participants in civil engineering and services disciplines. Reasons were as follows:

1. Some pilot tests of the interview structures were made on managers of civil works projects in order to avoid possible burnout of available respondents from the building discipline.

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* Vested interests in not achieving construction co-ordination among different project participants and possible reasons for that are described in detail in Section 5.3.5.

2. A few managers of civil works projects who were known to the Author as very knowledgeable and experienced were interviewed merely to compare with the results from the building discipline.

3. When questionnaires or requests for interviews were mailed to construction companies, at times project managers or other participants from disciplines other than building had volunteered to respond.

However, it was interesting to find that the responses from these project managers and other personnel of disciplines other than building were not actually different to the responses from their building counterparts. Therefore, the Author feels that the results of this study could be generalised industry wide. Therefore, the title of this thesis is given as 'Measuring the Quality of Contractors' Co-ordination Activities During the Construction Process', and not building process.

1.6 Overview of the Research Methodology

The bulk of the formal research activity consisted of the following four experiments, which form a part of the overall methodology which is described below in this section.

***Experiment 1*:** Finding whether the Performance Assessment Scoring System (PASS) in Hong Kong and the Construction Quality Assessment System (CONQUAS) in Singapore, both being attributes based quality measurement systems, have contributed to better customer focus and continuous improvement of construction processes and products.

***Experiment 2*:** Identifying what constitutes the construction co-ordination function and what are the more important and time consuming of these.

***Experiment 3*:** Testing the suitability of a generic multi-attribute quality measurement model to measure quality of construction co-ordination.

***Experiment 4*:** Testing the suitability of the "Critical Incident Technique" (CIT) to measure quality of construction co-ordination.

The methodologies for these experiments are given in detail in the relevant Chapters in this thesis. It is considered necessary at this point to give an overview of the entire methodology employed. The entire research process is graphically depicted by the flowchart in Figure i (page viii). The first two experiments were part of the initial learning process. The third and the fourth were the main experiments of this study.

Obvious initial step was to review literature on construction co-ordination and quality measurement as presented in Sections 1.1 and 1.2 and in Chapters 2 and 3. This led to the formulation of Hypotheses H1 and H2.

1.6.1 Analysis of the Effects of PASS and CONQUAS (Experiment 1)

As discussed above, there is a lack of application of quality measurement in the construction industry worldwide. Nevertheless there are two systems namely PASS and CONQUAS applied in the construction industries respectively in Hong

Kong and Singapore on a mandatory basis. Hence, their impact on achieving customer focus and continuous improvement was studied in Experiment 1. Relevance of this exercise to this research is that both PASS and CONQUAS are attributes based quality measurement systems. Their success in addressing the industry's needs depend on their ability to achieve customer focus and continuous improvement – two of the fundamental tenets of Total Quality. This will help in testing Hypothesis H1 on applicability of attributes based quality measurement tools to construction co-ordination by answering the following two questions:

1. What could be learnt from the quality measurement experiences of PASS and CONQUAS?

2. Could PASS and CONQUAS models be used in some way in this research to test Hypothesis H1?

This was a part of the initial learning process carried out before testing H1.

Initially, a pilot study was carried out in Hong Kong during which four personnel from construction contractors were interviewed. Open-ended questions were asked on their experiences of PASS. Based on the results of this survey, a questionnaire was developed to solicit wider opinion from the construction industries of Hong Kong and Singapore. The only differences between the version of the questionnaire mailed to Hong Kong and Singapore was that the words "CONQUAS" and "Client" respectively replaced the words "PASS" and "HKHA" (Hong Kong Housing Authority). The details of the survey are given in Chapter 4. In Hong Kong, 51 questionnaires were mailed to the Quality Managers of contractors on the NW1 and NW2 tendering lists of the Hong Kong

Housing Authority. In Singapore, the Construction Industry Development Board (CIDB) had 120 building contractors listed in their G7 and G8 lists and questionnaires were mailed to the Quality Managers of all of them.

There were 10 responses from Hong Kong and 26 from Singapore, of the order of 20% return rate in both cases. Responses indicated that the respondents had very much mixed feelings about the usefulness of PASS and CONQUAS as quality management tools. Therefore, rather than interpret merely from the quantitative data, follow-up interviews were conducted with 5 respondents from Hong Kong and 15 from Singapore. Further, personnel of the PASS Control Unit of HKHA were interviewed to gather information on how this client of great initiative is proposing to solve the shortcomings of PASS in the future.

However, as discussed in detail in Chapter 4, the results indicated that PASS and CONQUAS have failed to improve the industry’s focus on the customer needs and to instigate continuous improvement of the construction processes. Hence, they had failed to become useful quality management tools for the construction industry. Such lessons learnt from this experiment further vindicated the existing theories of making meaningful quality measurements and contributed towards designing Experiments 3 and 4. More importantly, the results showed that there was no point in further considering the applicability of PASS and CONQUAS measurement models to construction co-ordination. Therefore, it was decided to test the applicability of another generic multi-attribute quality measurement model (presented in Chapter 5) to construction co-ordination, thus test Hypothesis H1.

1.6.2 Identifying Important Co-ordination Processes (Experiment 2)

For the reasons given in the preceding paragraph, a generic multi-attribute model for measuring quality from Tenner and DeToro (1992) (discussed in detail in Chapter 5) was adapted to test Hypothesis H1. Construction co-ordination includes a vast scope of activities and for practical reasons described in Section 6.1, it was necessary to test the model on a limited range of co-ordination processes; preferably on those processes considered most important by industry practitioners.

As stated above, the author found very little research and discussion on construction co-ordination. One of the major implications for this research is that no ready definition exists of what is construction co-ordination and how it is achieved. That made it not possible to readily identify important co-ordination processes on which to test the attributes based quality measurement model. In this context, the Author performed Experiment 2 to identify what constitutes the construction co-ordination function, what are the more important activities and what are the more time consuming.

In the absence of previous literature, texts on the duties and responsibilities of project managers, co-ordinators, clerks of works, construction engineers, etc., were reviewed from the contractor's project manager's perspective during the building phase and an array of issues pertaining to achieving co-ordination were identified. The array of issues was distilled as described in Section 6.4 to arrive at a list of 64 activities that may be undertaken to achieve co-ordination in a construction project. A questionnaire was then developed to present the array to construction project managers and co-ordinators to enable them to identify activities of “High”, “Mid” or “Low” importance and “N/A” those considered not applicable. Sufficient space was also provided enabling respondents to add any activities not listed. The questionnaire also solicited whether the time consumed by the each activity in the array was “High”, “Mid” or “Low”. The questionnaire was distributed among building contractors in Hong Kong and Singapore as described in Section 6.5. The attributes based quality measurement model was tried out on the co-ordination activities indicated as more important by the practitioners.

1.6.3 Testing the Suitability of an Attributes Based Quality Measurement Model for Measuring Quality of Co-ordination (Experiment 3)

The previous two experiments were initial learning processes. This (Experiment 3) was the first of the main experiments of this study. (Please see the flowchart in Figure i, page viii).

For the purpose of this experiment (Experiment 3), a generic multi-attribute model for measurement of quality presented by Tenner and DeToro (1992) was adapted to construction co-ordination context. All procedures followed and considerations made during this process of adaptation are given in Chapter 5. Hypothesis H1 was tested by applying this model on the construction co-ordination processes considered important (as indicated by results of Experiment 2) by the industry practitioners.

Quality measurement systems should be developed with the involvement of those who will be measured (Davidow and Uttal, 1989). The resulting ownership of the quality measurement system among the process participants is vital for acceptance of its results and its eventual success. The results of the experiment described in Chapter 4 (Experiment 1) which illustrate the problems due to mandatory implementation of PASS and CONQUAS, further confirm this opinion. One method for testing the attributes based model might be to select a construction site willing to participate and to try it out there. However, this would be pointless because the process participants would have no sense of belonging towards the measurement system. This would create both lack of co-operation to furnish information and lack of confidence to supply authentic information. Nevertheless, the objective of the present attempt to try out the above model on construction co-ordination processes was only to propose or demonstrate to industry practitioners the suitability of such measurement model being applied in that context. Hence, it was decided to collect data by in-depth interviews of industry practitioners who would willingly contribute to the research and to use such data to demonstrate how a measurement system for co-ordination processes could be performed. The resulting data would not represent any particular construction site, but can be used to demonstrate the applicability of the measurement method in the construction co-ordination context.

Adapting the latter method, 8 interviews were conducted in Hong Kong and 9 in Singapore. The survey results and eventual acceptance of Hypothesis H1 is described in Chapter 7.

1.6.4 Testing the Suitability of the Critical Incident Technique (CIT) for Measuring Quality of Co-ordination (Experiment 4)

This was the other main experiment (Experiment 4) of this study. (Please see the flowchart in Figure i, page viii).

The Critical Incident Technique (CIT) is a quality measurement system that offers much flexibility both in gathering data and in administering it (Stauss 1993). Hypothesis H2 was tested by trying out this technique in the construction co-ordination context. For the reasons explained in Section 1.6.3, this experiment too was conducted with industry practitioners who would willingly contribute to the research, instead of attempting to focus it on a selected construction site.

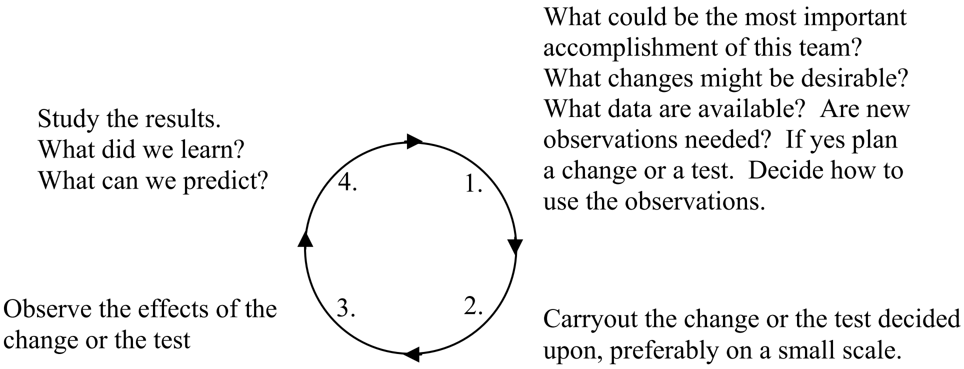
The methodology employed is described in detail in Chapter 8. The very simple questionnaire required was developed based on Stauss (1993) and Bitner *et al.* (1990). Where possible, the questions were asked by interviewing the respondents. The questions that needed to be asked were so simple that it was possible to be administered as a mailed questionnaire when an interview was not possible, although many recipients of the questionnaires were not happy to write the descriptive answers. The respondents were made to feel comfortable by allowing the critical incidents described to be unattributable.

21 Responses on critical incidents were received by way of responses to interviews and in response to requests sent par mail, fax and e-mail. The survey

results, their analysis and eventual acceptance of Hypothesis H2 are described in Chapter 8.

Chapter 2

QUALITY MEASUREMENT



Step 5. Repeat Step 1, with knowledge accumulated.
Step 6. Repeat Step 2 and onward.

Figure 2.1: Shewhart and Deming Cycle

Source: Deming (1986)

2.1 Quality Measurement is a Management Tool

Figure 2.1 shows the well-known cycle for continuous improvement originally proposed by Dr. Walter A. Shewhart and introduced to Japan by Dr. William Edwards Deming as the 'Shewhart Cycle'. Today it is known in Japan as the 'Deming Cycle' (Deming 1986). It was proposed by these pioneers of Total Quality as a procedure for an organisation to continuously improve by making decisions based on facts. It is a procedure to understand the present situation, make an incremental change, observe the effects, study the results and continue to improve using the knowledge accumulated. "Measurement is both the last and the first step in producing superior service. … First step towards better service is difficult without some measurement of current service performance" (Davidow and Uttal 1989). Commenting on the customer satisfaction measurement Crosby (1993) states, "In some highly customer-driven firms, customer satisfaction measurement serves as the primary means for aligning the entire organization (mission/vision, strategies, culture, structure, systems, management approaches, etc.) with the customer's total needs. Thus, in theory and in practice, customer satisfaction measurement is not so much a research activity as it is a management tool".

2.2 Objectives of Measuring Quality

Deming (1986) presents a philosophy of managing for quality, known as 'Total Quality', that emphasised on the need for continuous improvement, training, leadership, teamwork and so on. He also expresses how slogans, exhortations, targets, numerical quotas or goals and performance merit ratings rob people of pride of workmanship causing both quality and productivity to suffer. To quote some of Dr. Deming's words, "A quota is a fortress against improvement of quality and productivity. I have yet to see a quota that includes any trace of a system by which to help anyone to do a better job. A quota is totally incompatible with never-ending improvement. There are better ways. … Eliminate work standards, rates and piecework, to put in their place intelligent supervision … knowledgeable and intelligent leadership. … Management by numerical goals is an attempt to manage without knowledge of what to do and in fact is usually management by fear. … Unfortunately, people that are measured by counting are deprived of pride of workmanship". Deming (1986) further elaborates that evaluation of performance, merit rating, annual review, management by objectives and management by numbers "nourishes short-term performance, annihilates long-term planning, builds fear, demolishes teamwork, nourishes rivalry and politics. … Basically what is wrong is that, performance appraisal or merit rating focuses on the end product and not on leadership to help people [carrying out the process]". In this context, the objectives of quality measurement should be solely for the purposes of process improvement and not to evaluate the individuals involved in the processes against targets, quotas or goals. "The 80 American Nobel prize winners all had tenure, security. They were answerable only to themselves" (Deming 1986). It is noteworthy in the Shewhart and Deming Cycle (please see Figure 2.1) the questions asked in Step 1 are based on the process and the team:

- What could be the most important accomplishment of this team?
- What changes might be desirable?

In Step 4, the questions asked are:

- What did we learn?
- What can we predict?

Shewhart and Deming Cycle is a procedure to understand the present status of the process, make an incremental change, observe the effects, study the results comparing with the original status and continue to improve using the knowledge accumulated. Thus as reiterated by Deming (1986), the purpose of quality measurement in a Total Quality environment is to manage by facts and not by arbitrarily enforced objectives. In this context, the challenges of measuring service quality and the essential features for meaningful quality measurement geared at improving service processes will be discussed in the rest of this chapter.

2.3 Special Challenges in Managing Service Quality

As it would be apparent from the following discussion, construction co-ordination is a "service process" whereby the Project Manager and the team of co-ordinators provide a service to the "production personnel" (customers of the co-ordination service) building the facility being constructed. Hence it needs to be managed (also measured) as a service. Tenner and DeToro (1992) point out that process improvement techniques have been designed typically for manufacturing processes and the inherent differences between manufacturing and service processes make it more challenging to apply such techniques to the latter. Table 2.1 presents some characteristics that distinguish services from goods.

Table 2.1 : Distinguishing Characteristics of Services

Source: Davidow and Uttal (1989)

- In contrast to goods, services are intangible – they cannot be stored and they cannot be inspected at some time after they are produced.
- Services are delivered to the customer at the same time they are produced, so it is hard for workers to inspect their work before it is shipped. If the clerk at the ticket counter does not smile when producing a service, there is no way to add the smile later on.
- The customer usually plays a role in the production process, which means that controlling service quality entails controlling customer behaviour, a thorny job at best. Incompetent customers can doom service to be incompetent, as banking customers do if they make no effort to understand banking procedures.
- The production of customer service usually relies more heavily on the worker's behaviour than on any system of machinery. Since a person's behaviour can vary radically depending on how he or she feels, you cannot control service production just by imposing standards. You have to get employees to internalise a set of norms that allow them to respond flexibly and effectively to customers, which is why outstanding service companies have such strong cultures.

Table 2.2 presents a comparison of some typical process attributes between manufacturing and services. It could be appreciated that construction co-ordination processes very much match all the differences stated in Table 2.1 and in third column of Table 2.2, thus the deviation from the characteristics of manufacturing processes is very great. Hence, the task of measuring its quality requires much adaptation of techniques.

Table 2.2 : Comparing Typical Process Attributes

Source: Tenner and DeToro (1992)

Attribute	**Manufacturing**	**Nonmanufacturing**
Output properties	Tangible	Intangible or tangible
Production and delivery	Separate	Integrated
Customer interface	Focused: sales and marketing	Spread across line employees
Feedback	Through process	Through customer
Organisational focus	Process efficiency	Customer relations
Process ownership	Clearly defined	Multiple
Process boundaries	Defined	Unclear
Process definition	Documented	Unclear
Control points	Defined	None
Quality measures	Established and objective	Subjective
Corrective action	Preventive	Reactive

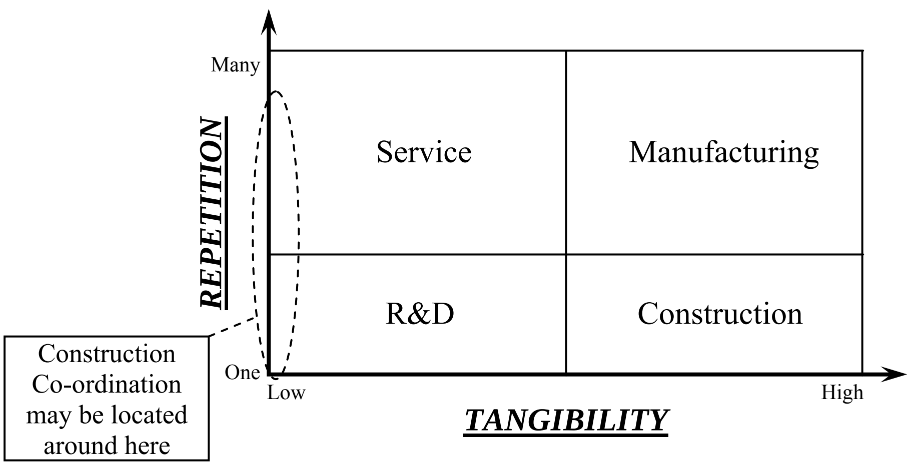


Figure 2.2: Repetition and Tangibility of Processes

Source: Adapted from Kidd (1989)

It is common experience that compared to other service processes, co-ordination processes are low in both tangibility and repetition (please see Figure 2.2). This makes construction co-ordination a most challenging service to manage. Additionally, construction co-ordination processes feature a very high level of co-production by customers. Co-production is customer participation in the production of the output (two examples pertaining to construction co-ordination will follow). Found in most non-manufacturing functions this is a key characteristic that distinguishes them from manufacturing processes (Tenner and DeToro 1992). Responses by industry practitioners to this research have confirmed the statement by Crichton (1966) that construction co-ordination is often achieved by almost hour-to-hour redeployment by an experienced site manager. A co-ordinator is chartered, as a representative of the Project Manager who proactively ensures future events will occur as planned (Forsberg *et al.* 1996). Hence a construction co-ordinator's job is highly interactive with his customers. Most important co-ordination activity as stated by the respondents to a survey in this research was "identifying strategic activities and potential delays". This highlights the importance for co-ordinator to identify such situations and then co-ordinate to avoid any adverse effects on the project. In other words, co-ordination requirements or problems need to be identified by the Project Manager and solved rather than his/er customers bringing such needs to him/er. Hence, it is a process that requires continuously maintaining good communication with the entire project team on all aspects of the work and keep observing the work of all parties to the project. As one respondent to an interview survey under this research commented:

> Credibility of a co-ordinator depends highly on production personnel co-operating with him.

Tenner and DeToro (1992) state "The feature of co-production brings the customer directly into the service process. As a result, the service itself represents an experience of vital interest, importance and value to the customers. In fact, co-production influences the basic design of service processes".

Table 2.3 : Simplifying Ten Service Characteristics to Three Key Differences

Source: Alberecht and Zemke (1985) and Tenner and DeToro (1992)

	Ten Characteristics of Service Identified	**Key Differences***		
1.	Service is produced at the instant of delivery and cannot be created in advance and stored in inventory.	C	T	R
2.	Service cannot be centrally produced, inspected or stockpiled.	C	T	R
3.	Service cannot be demonstrated, nor can a sample be sent in advance for approval.	C	T	
4.	In the absence of a tangible product, customers value the service on the basis of their own personnel experience.		T	
5.	The service experience cannot be resold or passed on to a third party.	C	T	
6.	Faulty service cannot be recalled.	C		
7.	Quality assurance is required before production.	C		
8.	Delivery of service usually requires human interactions.	C		
9.	Customers' assessments of service quality are subjective and strongly influenced by expectations.		T	R
10.	Customers' assessments of service quality tend to decrease in proportion to the number of employees they encounter during the delivery process.	C		

* Key: C = Co-production by customer; T = Tangibility (lack of); R = Repetition (lack of).

Table 2.3 presents 10 characteristics of service processes identified by Alberecht and Zemke (1985). The right-hand column "Key Differences" presents a simplification made by Tenner and DeToro (1992) in terms of Co-production by customer, Tangibility (lack of) and Repetition (lack of) discussed above. It further endorses that construction co-ordination severely deviates from manufacturing process characteristics. This deviation requires much adaptation of classical quality improvement techniques before they could be successfully applied to improve construction co-ordination processes. "Measurement of performance also becomes more difficult as process characteristics deviate in this manner. Such measures become more subjective and less clearly defined" Tenner and DeToro (1992). They further elaborate that these obstacles can be overcome by taking advantage of measurement at the three levels of Process, Output and Outcome (defined in the next section). "In cases where outputs are intangible, successful application requires the identification of appropriate measures, either subjective or objective. In cases where the outputs are unique or in which customers are co-producers, successful application requires clarification of the underlying work processes that are repeated" Tenner and DeToro (1992). Therefore, the rest of this chapter is devoted to discuss requirements for meaningful quality measurement.

2.4 Three Levels of Measurement: Process, Output and Outcome

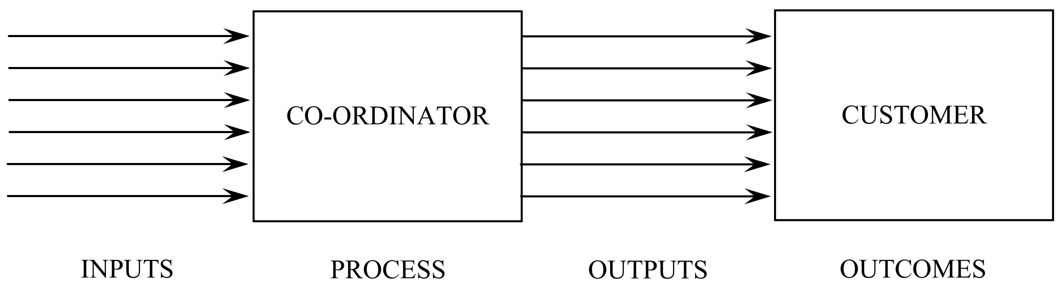


Figure 2.3: Inputs, Process, Outputs and Outcomes

"Despite the serious difficulties [discussed above] of measuring and controlling the quality of customer service, service leaders have figured out ways of doing it. Generally, they use three different metrics: *process* measures, *product* measures, and *satisfaction* measures" (Davidow and Uttal 1989). Tenner and DeToro (1992) preferred to call these three levels as "Process, Output and Outcome", which the Author prefers.

Process measures - "The most primitive measures focus on controlling the process of creating service" (Davidow and Uttal 1989). Tenner and DeToro (1992) describe them as defining and measuring activities, variables and operations of the work process itself. Includes services and products supplied by the suppliers and parameters that directly control the integration of people, materials, methods, machines and the environment within the work process.

Output measures - Defining and measuring specific features, values, characteristics and attributes of each product or service (Tenner and DeToro 1992). In doing so, it is assumed that the said features, values, characteristics and attributes contribute to customer satisfaction (Davidow and Uttal 1989). Therefore, it is important to compare voice of the process (what the process is capable of delivering) with voice of the customer (customers' expectations).

Outcome measures - Defining and measuring ultimate impact of the process on the customer (Tenner and DeToro 1992); what use (outcome) the customer makes out of the process and how the customers' satisfaction is affected. Davidow and Uttal (1989) state, "Service quality ultimately is whatever the customer says it is and not just whatever the service supplier can measure. Satisfaction surveys give companies the most meaningful picture of how good their perceived service quality is, and they are a crucial check on the relevance of product measures [output measures]".

However, regarding such elaborate measuring systems Davidow and Uttal (1989) warn, “Managers who are obsessed with the quality of customer service normally keep discovering new measures and adding them onto the existing ones. Over time, the number and variety of quality measures tend to mushroom close to the point of unmanageability. That is natural. Customer service quality is so elusive that you can only measure it by successive approximations”. Hence, “all serious systems for measuring service quality run the risk of not being taken seriously. Front-line employees and supervisors have a lot on their minds besides filling out endless reports” (Davidow and Uttal 1989). In this context, they stress the importance of:

1. Measurement programs having strong support from top management
2. When developing measures of quality, service leaders seeking the help of the employees who will be measured.
3. Developing measurement systems that depend on the information that employees and managers need to do their jobs

Fourthly, Davidow and Uttal (1989) stress the importance of linking part of workers’ and managers’ compensation to their achievement of quality standards. However, this contradicts the philosophy presented in Deming (1986). It could nourish short-term performance, rivalry and politics while building fear and annihilating long-term planning and teamwork.

Davidow and Uttal (1989) suggest that “Deepest trap [in measuring quality] is suboptimisation – the tendency to perform to whatever measures you pick at the expense of the larger reasons for measuring. … Employees tend to do exactly what the measures tell them to do or what they are rewarded for doing, ignoring the purpose of the measures", often to the detriment of customer satisfaction. "Process standards are especially vulnerable to suboptimisation because they are so narrow, so specific and so visible. Managers find it easy to push hard on process standards, and employees find it easy to concentrate on nothing else. The more elaborate the process standards and the more managers push them, the greater the likelihood of gross suboptimisation and grossly poor service" (Davidow and Uttal 1989). They further elaborate, using examples from service industry, how some companies had developed "elaborate, three-inch-thick policy manuals that specified literally hundreds of process measures supervisors would use to measure work group performance. The companies had very rigid standards of quality, but they were based on management's perceptions of quality. The target of the prescribed levels was internal efficiency. However, company managers gradually realised that getting employees to go by the book made them terrible at serving customers. … Customers were told the 'rules' rather than granted the exception". Further, "all measures are imperfect representations of customer expectations because they do not get inside the customer's head. Even reasonably close representations eventually drift out of alignment with expectations because those expectations keep changing. A system for measuring the quality of customer service that does not include large doses of feedback from customers is not an effective system. To minimise suboptimisation, companies that produce great service counterbalance process measures with a wealth of product and satisfaction measures that keep employees' eyes fixed on the customer. They strive to ensure that the measures they use for process and product are not self-defeating, poorly structured, or unrelated to customer needs and expectations" (Davidow and Uttal 1989).

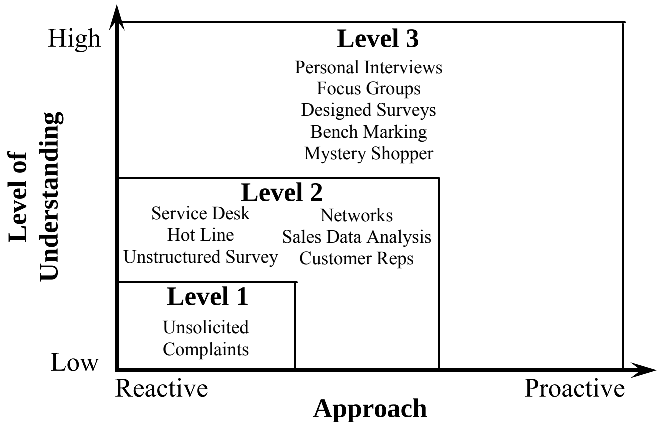


Figure 2.4: Three Levels of Mechanisms for Understanding Customers

Source: Adapted from Tenner and DeToro (1992)

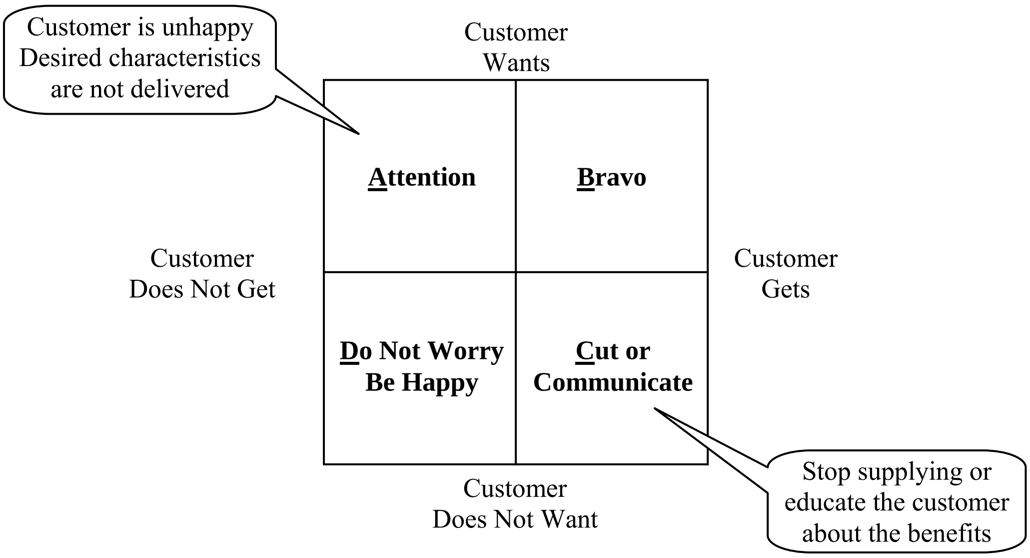


Figure 2.5: Customer Window

Source: Saunders and Caplette (1990)

In such a context, Figure 2.4 illustrates three levels of activities that can be carried out to listen to the voice of the customer. Lowest level (Level 1) being relying on unsolicited complaints, which is merely a reactive approach. To obtain an in-depth understanding of customer expectations, one has to resort to more proactive Level 3 approaches as shown. Such in-depth understanding will enable the service provider/supplier to get a very clear view of quality characteristics sought and not sought by the customer. Such could be mapped in a customer window (Figure 2.5) to get an understanding of customer needs (voice of the customer) vs. capabilities of the present operation (voice of the process) to better focus the process/product improvement efforts. Quality measurements should then be accordingly carried out to support such efforts.

2.5 Three Levels of Customer Expectations: Implicit, Explicit and Latent

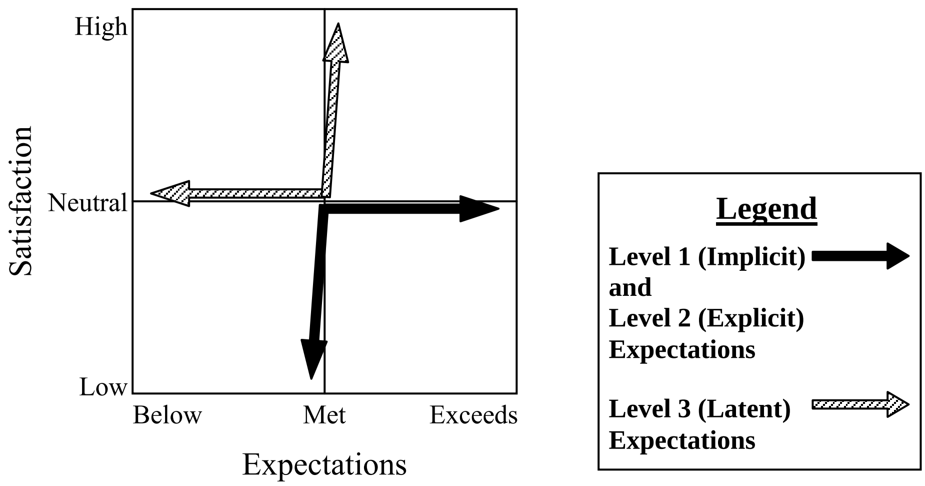


Figure 2.6: Satisfaction and Dissatisfaction of Customers

Source: Adapted from Tenner and DeToro (1992)

It is noteworthy that customer satisfaction and dissatisfaction are not on the same scale. As depicted in Figure 2.6 and discussed below, customer satisfaction or dissatisfaction depends on achieving or not achieving three different levels of expectations. These three levels of expectations are illustrated in Figure 2.7. At the end of this section a fourth level of expectations of customers for recovery of defects will be discussed. Methods of measuring quality should be able to recognise all these levels and evaluate the service accordingly.

Level 1 expectations are the base expectations, taken for granted by the customer that s/he will receive. They may be important characteristics and may have once been higher expectations. However at present, they have diminished in priority due to customers being generally satisfied with those aspects of the service. There is a possibility that such expectations will not be even mentioned when asked from the customer what features are required in the service (an example will follow). To the customer, it is implied that such features will be included in the service (Tenner and DeToro 1992).

Level 3	*(Latent)*	Value added characteristics and features not expected by customers but delighted if given
Level 2	*(Explicit)*	Features, characteristics, options and trade-offs specifically requested by customers
Level 1	*(Implicit)*	Minimum performance levels always assumed present and taken for granted by customers

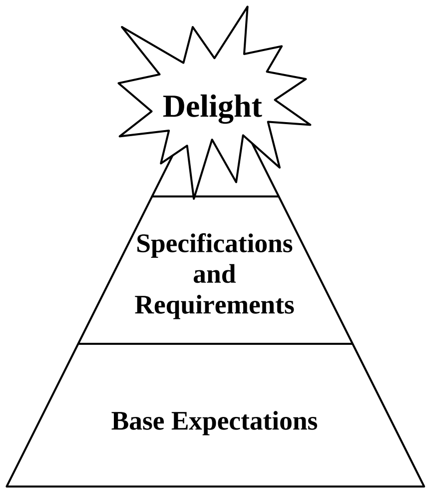


Figure 2.7: Three Levels of Customer Expectations

Source: Tenner and DeToro (1992)

Level 2 expectations are those currently being demanded by the customers. However, asked to rank them in the order of priority, the customers may rank them in the order of their expectations rather than actual importance for their purpose (Tenner and DeToro 1992).

For example Tenner and DeToro (1992) explain that, when selecting an airline to travel, safety might be the only important feature to be considered. However, that has today become an implicit (Level 1) expectation and customers select an airline based on other conveniences.

Level 3 expectations are what customers will not expect or not be aware of the availability. They will be delighted when provided. These requirements are real but not visible or obvious to the customer. However, when level 3 expectations are regularly met, they will over the time migrate down to levels 2 and 1 (Tenner and DeToro 1992).

Meeting Level 1 expectations (implicit expectations) and Level 2 expectations (explicit expectations) of a customer does not create satisfaction. Instead it merely creates a neutral customer (Tenner and DeToro 1992). However, failing to meet Levels 1 and 2 of expectations will rapidly make a customer unhappy and dissatisfied. It should be appreciated that meeting these two levels of expectations cannot create a delighted customer. This level of performance where only the Levels 1 and 2 expectations are targeted is only a defensive level of operating where the service provider at best can avoid a dissatisfied customer (Tenner and DeToro 1992). Figure 2.6 graphically illustrates this phenomenon.

Meeting Level 3 expectations (latent expectations) of a customer will make him/er feel delighted (Tenner and DeToro 1992, Bitner *et al.* 1990). Failing to meet them will not cause dissatisfaction. Please see the illustration in Figure 2.6. Having met Levels 1 and 2 expectations, targeting Level 3 expectations will provide continuous improvement to the operation.

There is another level of expectation, which is "hidden and only discovered after unhappy customers bring problems back to the supplier" (Tenner and DeToro 1992), or in the context of construction co-ordination when a failed co-ordination issue comes to light. The service provider's ability to recover the problem effectively will neutralise the original feeling of dissatisfaction or create satisfaction among customers. If the corrective action does not meet the customer's expectations, the original feeling will be exacerbated (Tenner and DeToro 1992).

2.6 Service Quality Characteristics

A service will have many features, values, attributes and characteristics that are attractive or preferable to customers. Such are the quality characteristics or the quality attributes. However, "In the absence of a tangible product, customers value the service on the basis of their own personnel experience" (Alberecht and Zemke 1985). Hence, a customers' definition of a quality service can be very complex. Therefore, Garvin (1987) said, "must breakdown the word quality into manageable parts". Today, there are many models and frameworks developed to clarify how customers define quality or value. Some of the most popular are:

- Faster, better and cheaper – the well known triangular model
- Eight dimensions of service quality (please see Table 2.4) proposed by Garvin (1987)
- Ten determinants of service quality (please see Table 2.5) identified by Parasuraman *et al.* (1985) based on their focus group interviews

- 'SERVQUAL' model (or the "RATER" criteria) by Parasuraman *et al.* (1986) given in Table 2.6. This is a result of the said authors further purifying their earlier ten determinants of service quality to give a more concise model with good reliability and validity.

Table 2.4 : Eight Dimensions of Service Quality

Source: Garvin (1991)

1	*Performance:* The product's primary operating characteristic. For example, performance of an automobile includes traits such as acceleration, handling, cruising speed, and comfort; performance of an airline includes on-time arrival.
2	*Features:* Secondary aspects of performance. These are the "bells and whistles" that supplement the basic functions. Examples include free drinks on planes and sunroofs on cars. The line separating primary performance characteristics from secondary features is often difficult to draw. Further, customers define value in terms of flexibility and their ability to select among available features, as well as the quality of those features.
3	*Reliability:* Probability of successfully performing a specified function for a specified period of time under specified conditions. Reliability of durable goods is often measured as the mean time to first failure or mean time between failures. These measures, however, require a product to be in use for a specified period of time and are not relevant in the case of products and services that are consumed instantly.
4	*Conformance:* Degree to which a product's design and operating characteristics meet established standards. Although this is sometimes defined as "conformance to requirements," a sounder analysis will be obtained by examining each characteristic's divergence from its target value. This more robust measure of conformance is built on the teachings of a prize-winning Japanese statistician, Genichi Taguchi.
5	*Durability:* A measure of product life. Durability can be defined as the amount of use obtained from a product before it deteriorates to the point that replacement is preferred over repair. Durability is closely linked to both reliability and serviceability. Consumers weigh the expected costs of future repairs against the investment in and operating expenses of a newer, more reliable model.
6	*Serviceability:* The speed, courtesy, competence, and ease of repair. The cost of repairs includes more than the simple out-of-pocket costs. Serviceability covers this full dimension by recognising the loss and inconvenience due to downtime of equipment, the nature of dealings with service personnel, and the frequency with which repairs fail to correct the outstanding problems.
7	*Aesthetics:* How a product looks, feels, sounds, tastes, or smells. Aesthetics is largely a matter of personal judgment and a reflection of individual preference; it is a highly subjective dimension.
8	*Perceived quality:* Reputation Consumers do not always have complete information about a product's or service's attributes; indirect measures or perceived quality may be their only basis for comparing brands.

Table 2.5 : Ten Determinants of Service Quality

Source: Parasuraman *et al.* (1985)

1. ***Reliability*** involves consistency of performance and dependability. It means that the firm performs the service right the first time. It also means that the firm honours its promises. Specifically, it involves: - accuracy in billing; - keeping records correctly; - performing the service at the designated time.
2. ***Responsiveness*** concerns the willingness or readiness of employees to provide service. It involves timeliness of service: - mailing a transaction slip immediately; - calling the customer back quickly; - giving prompt service.
3. ***Competence*** means possession of the required skills and knowledge to perform the service. It involves: - knowledge and skill of the contact personnel; - knowledge and skill of operational support personnel; - research capability of the organization.
4. ***Access*** involves approachability and ease of contact. It means: - the service is easily accessible by telephone (lines are not busy and they don't put you on hold); - waiting time to receive service is not extensive; - hours of operation are convenient; - location of service facility is convenient.
5. ***Courtesy*** involves politeness, respect, consideration, and friendliness of contact personnel (including receptionists, telephone operators, and so forth). It includes: - consideration for the consumer's property; - clean and neat appearance of public contact personnel.
6. ***Communication*** means keeping customers informed in language they can understand. It also means listening to customers. It may mean that the company has to adjust its language for different consumers increasing the level of sophistication with a well-educated customer and speaking simply and plainly with a novice. It involves: - explaining the service itself; - explaining how much the service will cost; - assuring the consumer that a problem will be handled.
7. ***Credibility*** involves trustworthiness, believability and honesty. It involves having the customer's best interests at heart. Contributing to credibility are: - company name; - company reputation; - personal characteristics of the contact personnel; - the degree of hard sell involved in interactions with the customer.
8. ***Security*** is the freedom from danger, risk, or doubt. It involves: - physical safety (will I get mugged at the automatic teller machine?); - financial security (does the company know where my stock certificate is?); - confidentiality (are my dealings with the company private?).
9. ***Understanding*** *the customer* involves making the effort to understand the customer's needs. It involves: - learning the customer's specific requirements; - providing individualised attention; - recognising the regular customer.
10. ***Tangibles*** include the physical evidence of the service: - physical facilities; - appearance of personnel; - tools or equipment used to provide the service; - physical representations of the service, such as a plastic credit card or a bank statement; - other customers in the service facility.

Table 2.6 : 'SERVQUAL' Model (or the Five "RATER" Criteria)

Source: Parasuraman *et al.* (1986)

1. Tangibles:	Physical facilities, equipment, and appearance of personnel.
2. Reliability:	Ability to perform the promised service dependably and accurately.
3. Responsiveness:	Willingness to help customers and provide prompt service.
4. Assurance:	Knowledge and courtesy of employees and their ability to convey trust and confidence.
5. Empathy:	Caring, individualised attention the firm provides its customers.

Considering the complex dimension of service quality, Tenner and DeToro (1992) find it useful to divide the quality characteristics into two major sets:

1. **Deliverables** – Tangible attributes that are retained by the customer even after the service has been delivered.

2. **Interactions** – Characteristics observed or experienced by the customer during the transaction.

Based on these two divisions and by synthesising the above four popular quality models, Tenner and DeToro (1992) propose the (possibly more comprehensive) model for understanding service quality characteristics given in Table 2.7. This model was utilised in the rest of this research with further adaptations to the construction co-ordination context as given in Chapter 5 (please see Table 5.2).

Table 2.7 : A More Comprehensive Model for Understanding Service Quality

Source: Tenner and DeToro (1992)

	Deliverables	**Interactions**
Faster	Availability Convenience	Responsiveness Accessibility
Better	Performance Features Reliability Conformance Serviceability Aesthetics Perceived quality	Reliability Security Competence Credibility Empathy Communications Style
Cheaper	Price	

2.7 Relative Importance of Quality Characteristics

Relative importance of each quality characteristic or attribute of a service will vary in relation to specific expectations of the customer at any particular time. No universal prescription has been developed and it is not wise to prioritise them on a global basis (Tenner and DeToro 1992). Hence, the relative ratings of importance of performance characteristics should be determined with customers for each product and service and then updated frequently because customers change the priorities very quickly due to changing situations. Tenner and DeToro (1992) state that, building of understanding of how customers rank relative importance of quality characteristics is not a simple task. It can be confounded by the three levels of expectations and complacence resulting from their present level of satisfaction with quality characteristics as described before.

2.8 Four Dimensions of Quality Measurement

Goetsch and Davis (1994) define Total Quality as "an approach to doing business that attempts to maximise the competitiveness of an organisation through continual improvement of the quality of its products, services, people, processes and the environments". Tenner and DeToro (1992) point out that "In addition to the output actually delivered to the end customer and the resultant outcome, each process generates by-products and outcomes for other "customers" [or stakeholders]. One is financial return for the shareholders. Another is job satisfaction for the employees. The third by-product is the social impact on the community". Therefore, a quality measurement system has to measure in terms of the following four dimensions:

- End User
- Shareholders
- Employees
- Community

Tenner and DeToro (1992) further elaborate that "The three levels of measures [Process, Output and Outcome (described above)] with respect to the actual output also apply to each by-product. Satisfaction and desired characteristics of these by-products are defined by their respective "customers". These, in turn, represent three additional sets of specifications against which process performance can be measured". According to Tenner and DeToro (1992) these specifications and their measurement parameters should be defined and managed as follows:

"Process: These parameters will be defined by the employees to control, improve and optimise the performance of their work processes consistent with all desired output characteristics. These measures will not be used to assess the performance of the employees and need not be reported to managers, shareholders, customers, or the community except to the extent that these people can offer ideas and help in identifying which parameters to measure, how to collect and analyse the data, or how to improve the process.

Output: These parameters are defined by the respective customers (end users, shareholders, employees, or community) and characterise the product/service required and expected. The focus of an organization's attention can be adjusted in relation to how much visibility, reward, and attention is devoted to output measures in each dimension. Output measures will be tested continuously against outcomes to assure that they remain consistent with customers' ever-changing expectations.

Outcome: These parameters determine the ultimate success or failure of the organization. Everyone should understand how his or her process and output measures relate to outcomes, and selected key measures should be displayed conspicuously. Since outcomes are beyond the control of individual employees, it may be unfair to base individual compensation and reward on these measures. Instead, these measures might more appropriately be tied to whole teams or organizations. Customer satisfaction often represents the key outcome measure" Tenner and DeToro (1992).

<u>2.9 Criteria for Meaningful Quality Measurement</u>

Presented above in this chapter is a discussion on the challenges of measuring service quality and the essential features of a meaningful quality measurement model for improving service processes. They could be summarised as:

a) Measure at the three levels: process, output and outcome

b) Apply to customers as well as other stakeholders: owner/shareholders, employees and society

c) Identify the implicit, explicit and latent expectations of customers/stakeholders and evaluate the satisfaction

d) Generate measurement results that can be utilised to improve the processes

Whether the multi-attribute quality measurement method and the Critical Incident Technique (CIT) have the capability of satisfying the above essential features, despite the difficulties due to construction co-ordination process characteristics:

- Informality
- Intangibility
- High Co-production
- Low Repetition
- Unsolicited Service
- Problem solving content involved

was used as the criterion to test Hypotheses H1 and H2 later in this study.

It may be clear to the reader that measuring quality of non-manufacturing processes is more complex and challenging than measuring quality of manufacturing processes. In this context, some popular quality measurement methods and their possibilities of finding application in construction co-ordination context will be briefly discussed in Chapter 3.

Chapter 3

PRESENT PRACTICES OF MEASURING QUALITY

3.1 Present Knowledge in Measuring Quality

Today there are numerous practises used for measuring quality. However, as discussed in Chapter 1, so far their application in the construction industry has been limited. Even in industries and businesses where quality measurements are more popularly used, seldom are they applied intelligently and in a meaningful way; often measurement systems are incorrectly applied, to the detriment of the organisation (Rosenberg 1996, Miller 1998). Davidow and Uttal (1989) state, "People tend to do what they are told to do and what they're rewarded for doing. Unfortunately, they tend to do those things to the exclusion of everything else. Unless you pick individual measures very carefully and design a system that balances process, product, and satisfaction measures, suboptimization is a certainty". In this context, this chapter is devoted to examining an array of quality measurement methods in terms of the theory presented in Chapter 2 (summarised in Section 2.9) and their applicability to improvement efforts of construction co-ordination processes. This discussion will serve to justify why only the attributes based quality measurement systems and the Critical Incident Technique (CIT) were further studied in this research eventually formulating Hypotheses H1 and H2.

3.2 Attributes Based Quality Measurement Systems

"The best-known and most widely used methods for measuring perceived quality involve quantitative multi-attribute measurements" (Stauss 1993). Within this approach, "lists of relevant quality attributes are always established [by the service provider] and respondents [customers] are asked in interviews to evaluate and weight the attributes of a particular service" (Stauss 1993). Tenner and DeToro (1992) better describe this measurement procedure by presenting as follows a multi-attribute performance measurement paradigm based on the measurement theories given in Chapter 2:

1. "Every product and service can be characterised by a set of performance measures.
2. Your job begins by understanding your customers and identifying the set of characteristics that fully define their needs.
3. You must next translate these customer-driven characteristics into process measures and learn the performance level that your process is capable of delivering for each characteristic.
4. You should then determine how satisfied customers are with performance at the current level, and the relative importance customers place on changing the level of each characteristic" (Tenner and DeToro 1992).

Miller (1998) state, "There is no question that the popularity of surveys [based on multi-attribute methods] is on the rise". The Author sees this as a sign of the usefulness of these surveys realised by the Industry. The multi-attribute methods could be used to measure at the levels of Process, Output and Outcome as required by the quality measurement theory presented in Chapter 2. Although easily measurable attributes at all these three levels are difficult to be found, especially when tangibility is low and co-production by customer is high, Tenner and DeToro (1992) propose as follows: "In cases where outputs are intangible, successful application requires the identification of appropriate measures, either subjective or objective. In cases where the outputs are unique or in which customers are co-producers, successful application requires clarification of the underlying work processes that are repeated". This was possible because multi-attribute methods could breakdown a complex service delivery process into more comprehendible attributes that could be evaluated individually. Relative importance of these attributes could also be identified by requesting respondents to indicate weightings. Further, this method could accommodate the three levels of customer expectations, Implicit, Explicit and Latent, by asking appropriate questions. It could also solicit customer opinion on recovery after a defect or an error was detected. Further, multi-attribute methods can measure in the four dimensions representing all stakeholders, viz. End User, Shareholder, Employees and Community by surveying representative samples of all these four parties.

However, Miller (1998) and Rosenberg (1996) state that these quantitative surveys are often poorly administered. Considering the disadvantages of this measurement method Stauss (1993) write, "First, it is quite possible that the quality attributes of the questionnaire reflect much more the company's perspective [of the service requirements] than the customer's view. Second, the data collected by these methods cannot grasp the customer's quality perception completely. A comprehensive listing of all quality aspects would result in a questionnaire that would exceed by far the normal customer's willingness to answer. So it is highly likely that a multitude of problems and positive service contact experiences will not be listed at all, particularly those that do not address the core service and that management deems to be of secondary importance". "The end result is a survey to determine how satisfied customers are with a number of factors that the organisation believes customers think are important" (Miller 1998). Stauss (1993) further elaborates "This defect becomes even worse because multi-attribute methods are not able to take the episodic nature of service experiences into consideration. Services require the participation of customers in the service production process. That is why services are perceived as processes and are kept in mind, to a large extent, as episodes, too. Multi-attribute methods can record only to what extent these episodes are translated into attitude or satisfaction scores, not the stored episodes themselves". Therefore, when customer is expressing his "stored" experiences in terms of the multi-attribute framework presented in the questionnaire, certain simplification and distortion inevitably occurs. Many important aspects of the service will be lost during the simplification and misrepresented due to distortion.

It is common experience that construction co-ordination involves lots of problem solving work. The results of the experiment described in Chapter 6 (Experiment 2) serves to confirm this. Such problem solving work require cognitive competencies "such as problem solving, critical thinking, question formulation, relevant information searching, making informal judgements, efficient use of information, etc." (Segers *et al.* 1999). These competencies are less visible and less obvious to the customers of the service. Hence, they will not be able to easily identify them and assign a score when requested in an attributes based measurement questionnaire.

Additionally, this measurement method can have many problems that are typical of quantitative surveys. "Perhaps because [by quantitative surveys] customer satisfaction is typically presented numerically (usually as survey results), people become seduced by numbers and assume that they represent an objective reality in the same way that production numbers or stock prices do" (Rosenberg 1996). Miller (1998) further points out that a high rating on a multi-attribute quantitative survey tend the organisation to attach the causality that the customer is satisfied while actual situation may be that s/he is unhappy over matters not listed in the survey. Also he states "Customer satisfaction equals customer loyalty" is a wrong assumption. Hence, an organisation can even loose business while surveys continue to indicate high customer satisfaction. Miller (1998) also elaborate how quantitative questionnaires could get answered by the wrong people within the customer (where the customer is an organisation or a family), i.e., not by the person who makes the decision to purchase or not by the person who will really use the service.

"Attribute-based quality and satisfaction surveys seem to be incomplete and not sufficiently differentiated with respect to the information needs of quality management" (Stauss 1993). Miller (1998) states "for example, if 85% respondents answer questions 3, 4 and 5 as dissatisfied, what could you do? The natural approach is to improve these factors. But what if those factors are not important to the customers? What if they are not important at all?" Often a multi-attribute methods fail to identify what exactly made the customer feel satisfied or dissatisfied. Even if they do by leaving space for the customer to write his/er own opinion at the end of the questionnaire, the attributes already listed in the questionnaire might influence the comment to be similar to the framework that was in the mind of the persons who prepared the questionnaire.

However as described earlier, multi-attribute quantitative methods have the potential of reasonably measuring the quality of a service. Most of shortcomings identified above could be potentially overcome by carefully applying good practises of surveying and analysing the results. Nonetheless, they are popularly used in many service industries and business sectors. Therefore, this research further considered the applicability of multi-attribute methods to construction co-ordination context as described in Chapter 5. These further considerations led to formulating Hypothesis H1, which is tested as described in Chapter 7.

While multi-attribute methods for measuring quality are voluntarily applied in many industries and business sectors, there are two mandatory measurement systems imposed on construction contractors in Hong Kong and Singapore. Named ‘Performance Assessment Scoring System’ (PASS) and ‘Construction Quality Assessment System’ (CONQUAS) respectively, the two systems have developed into complex measurement methods to evaluate, based on attributes, the quality capability of contractors working for the Hong Kong Housing Authority and the Singapore Government. Please find a detailed study of these two systems presented in Chapter 4.

3.3 Quality Management Maturity Grids

Another method for measuring quality is the use of a "Quality Management Maturity Grid" as proposed by Crosby (1979). A similar grid is used for Malcolm Baldrige National Quality Award, USA (ASQ1998). The grids used in these cases are given in Tables 3.1 and 3.2 as two examples. Crosby (1979) states, "Using the Quality Management Maturity Grid, even the manager who is not professionally trained in quality business can determine where the operation in question stands from a quality stand point". These grids are more suited for assessing the "status" (as termed by Crosby 1979) of quality management of a company, a division or an operation. By applying these methods, it will be possible to evaluate the entire approach by the management and overall results of the operation.

As would be evident from the discussion below, this method of measurement will not indicate details of the processes and products that need attention. Application of a maturity grid will show whether the management is in a position capable of carrying out process improvement and how the deployment of the management could be improved.

Table 3.1: Quality Management Maturity Grid

Source: Crosby (1979)

Measurement Categories	***Stage I: Uncertainty***	***Stage II: Awakening***	***Stage III: Enlightenment***	***Stage IV: Wisdom***	***Stage V: Certainty***
Management understanding and attitude	No comprehension of quality as a management tool. Tend to blame quality department for "quality problems."	Recognizing that quality management may be of value but not willing to provide money or time to make it all happen.	While going through quality improvement program learn more about quality management, becoming supportive and helpful.	Participating. Understand absolutes of quality management. Recognise their personal role in continuing emphasis.	Consider quality management an essential part of company system.
Quality organisation status	Quality is hidden in manufacturing or engineering departments. Inspection probably not part of organization. Emphasis on appraisal and sorting.	A stronger quality leader is appointed but main emphasis is still on appraisal and moving the product. Still part of manufacturing or other.	Quality department reports to top management, all appraisal is incorporated and manager has role in management of company.	Quality manager is an officer of company; effective status reporting and preventive action. Involved with con-sumer affairs and special assignment.	Quality manager on board of directors. Prevention is main concern. Quality is a thought leader.
Problem handling	Problems are fought as they occur; no resolution; inadequate definition; lots of yelling and accusations.	Teams are set up to attack major problems. Long-range solutions are not solicited.	Corrective action communication established. Problems are faced openly and resolved in an orderly way.	Problems are identified early in their development All functions are open to suggestion and improvement.	Except in the most unusual cases problems are prevented.
Cost of quality as % of sales	Reported: unknown Actual: 20%	Reported: 3% Actual: 18%	Reported: 8% Actual: 12%	Reported: 6.5% Actual: 8%	Reported: 2.5% Actual: 2.5%
Quality improvement actions	No organized activities. No understanding of such activities.	Trying obvious "motivational" short-range efforts.	Implementation of the 14-step program with thorough understanding and establishment of each step.	Continuing the14-step program and starting Make Certain.	Quality improvement is a normal and continued activity.
Summation of company quality posture	"We don't know why we have problems with quality."	"Is It absolutely necessary to always have problems with quality"	"Through management commitment and quality improvement we are identifying and re solving our problems."	"Defect prevention is a routine part of our operation."	"We know why we do not have problems with quality."

Table 3.2: Malcolm Baldrige Award – Scoring Guidelines

Source: ASQ (1998)

Score	Approach/Deployment
0%	• no systematic approach evident; anecdotal information
10% to 30%	• beginning of a systematic approach to the primary purposes of the Item • early stages of a transition from reacting to problems to a general improvement orientation • major gaps exist in deployment that would inhibit progress in achieving the primary purposes of the Item
40% to 60%	• a sound, systematic approach, responsive to the primary purposes of the Item • a fact-based improvement process in place in key areas; more emphasis is placed on improvement than on reaction to problems • no major gaps in deployment, though some areas or work units may be in very early stages of deployment
70% to 90%	• a sound, systematic approach, responsive to the overall purposes of the Item • a fact-based improvement process and organizational learning/sharing are key management tools; clear evidence of refinement and improved integration as a result of improvement cycles and analysis • approach is well-deployed, with no major gaps; deployment may vary in some areas or work units
100%	• a sound, systematic approach, fully responsive to all the requirements of the Item • a very strong, fact-based improvement process and extensive organizational learning/sharing are key management tools; strong refinement and integration - backed by excellent analysis • approach is fully deployed without any significant weaknesses or gaps in any areas or work units

Score	Results
0%	• no results or poor results in areas reported
10% to 30%	• early stages of developing trends; some improvements *and/or* early good performance levels in a few areas • results not reported for many to most areas of importance to the applicant's key business requirements
40% to 60%	• improvement trends *and/or* good performance levels reported for many to most areas of importance to the applicant's key business requirements • no pattern of adverse trends *and/or* poor performance levels in areas of importance to the applicant's key business requirements • some trends and/or current performance levels – evaluated against relevant comparisons *and/or* benchmarks – show areas of strength *and/or* good to very good relative performance levels
70% to 90%	• current performance is good to excellent in most areas of importance to the applicant's key business requirements • most improvement trends *and/or* performance levels are sustained • many to most trends *and/or* current performance levels – evaluated against relevant comparisons and/or benchmarks – show areas of leadership and very good relative performance levels
100%	• current performance is excellent in most areas of importance to the applicant's key business requirements • excellent improvement trends *and/or* sustained excellent performance levels in most areas • strong evidence of industry and benchmark leadership demonstrated in many areas

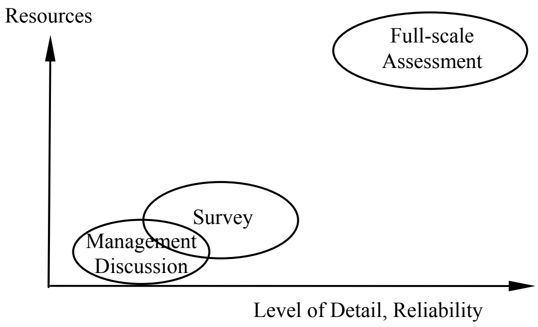


Figure 3.1: Three Levels of Applying Maturity Grids

Source: Hart and Bogan (1992)

Using quality management maturity grids, three levels of assessment may be conducted on an organisation as shown in Figure 3.1 (Hart and Bogan 1992). The lower levels of assessment are based on management discussions or brainstorming sessions and simple surveys within the companies (Hart and Bogan 1992, Blazey 1998). Advantages and drawbacks of these are illustrated in Table 3.3.

Table 3.3: Drawbacks and Advantages of Lower Levels of Assessment

Source: Hart and Bogan (1992)

Advantages	**Drawbacks**
• Easy to Repeat	• Subjective
• Triggers Useful Discussions	• Dependency on the Internal Culture
• Points Out Targets for Development	• Focus on Matters Considered Important Only

The full-scale assessment as carried out in the case of Malcolm Baldrige National Quality Award involves:

- a very detailed self-assessment

- being evaluated by external examiners, who will:
  - put in many hours to study and evaluate your self assessment
  - make a site visit

The major advantage the Author sees in the Baldrige system is that by the laborious self-assessment it obtains a large amount of data on the true context of the organisation. The judges put in a large amount of time in evaluating the self-assessment thus applying a rigorous interpretative analysis. The organisation will certainly benefit by the many critical questions that may be asked by the judges and any suggestions made based on their professional knowledge in quality management. "A survey of 1996 Baldrige Award applicants showed that over 80 percent of respondents found the feedback report to be relevant and important in helping their organizations' continuous improvement efforts. More than any other thing, applying for the Baldrige Award encourages a process of corporate introspection. The process provides an unparalleled opportunity to better understand your customers, people, procedures and corporate culture" (Selzer 1999).

Quality measurement models developed by Norwegian Building Research Institute and European Construction Institute are also in the forms of maturity grids (Sjøholt and Lakka, 1994 and ECI 1996). They are mainly designed to be used in the lower levels of assessment illustrated above. Norwegian Building Research Institute had in fact followed the Malcolm Baldrige criteria where as European Construction Institute has developed a matrix of its own. ECI (1996) states, "The matrix is intended to provide organisations, projects, sites or sections with a tool for determining their progress towards the achievement of Total

Quality". Similarly, measurement models by European Foundation for Quality Management (EFQM) and the Union of Japanese Scientists and Engineers (JUSE) are designed to determine the quality status of organisations. EFQM (2000) states, "Regardless of sector, size, structure or maturity, to be successful, organisations need to establish an appropriate management system. The EFQM Excellence Model is a practical tool to help organisations do this by measuring where they are on the path to Excellence; helping them understand the gaps; and then stimulating solutions". On the objectives of the Deming prize in Japan, Deming (1986) states "...the Union of Japanese Scientists and Engineers (JUSE) instituted the annual Deming Prize(s) for contributions to quality and dependability of product". However, it is noteworthy that these models do comprehensively achieve their stated objectives for measuring the quality status of organisations as judged from the popularity and the respect these awards command in the respective countries/regions. DeCarlo and Sterett (1990) have commented, "In the first two years the award [Malcolm Baldrige Award] programme exceeded the expectations of those who worked to establish and implement it. The Malcolm Baldrige National Quality Award is more than an annual presentation by the president. It is the driving force of a national quality movement, the hub around which the wheel of quality improvement in America turns". Further many authors, for example Bemowski (1996b) and Berquist and Ramsing (1999), have commented very positively on Malcolm Baldrige National Quality Award after it has been in operation for a period of ten years. "Baldrige Index has once again outperformed the Standard & Poor's 500-this year [1999] by 4.8 to 1, one of the highest returns since the Commerce Department's National Institute of Standards and Technology started doing the study in 1995. Baldrige Award winning organizations build excellence into every aspect of the way they do business and this study shows that is good for business. Customers are delighted, employees are enthusiastic and empowered, and it shows in the bottom line and in all other aspects of their business" Kosko (2000).

A problem with applying maturity grids is that it does not reflect the opinion of the customer. The personnel involved in the processes may become so internally focused and be happy in a measuring environment that does not reflect the needs and problems of the customers. Although the maturity grids used by the quality awards such as Deming Prize, Malcolm Baldrige National Quality Award and European Quality Award measure effects on the organisation/business results of the organisation (JUSE 1997, ASQ 1998 and EFQM 1999), the evaluations are unlikely to reflect the particular improvements required in the production processes and product outputs to meet the customer expectations.

The grid may not be able to capture measures at the three levels of Process, Output and Outcome because the measures are not identifying the features of the processes and the products but emphasise on the management deployment. For the same reason they will not recognise the three levels of customer expectations; Implicit, Explicit and Latent; nor will it be possible to understand the expectations of customers on "Recovery" after a defect/error has been found. Further, we cannot identify the relative importance that customers assign to different quality characteristics. The foregoing will be true with regard to all four quality dimensions representing all stakeholders, viz. End User, Shareholder, Employees and Community.

Therefore, based on the theory for measuring quality discussed in Chapter 2, we could conclude that quality management maturity grids are not suitable for measuring the quality of production/service processes and their product/service outputs. These grids are more suited for assessing the "status" (as termed by Crosby 1979) of quality management of a company, a division or an operation. Hence, the possibility of using a quality management maturity grid as a measurement tool for the construction co-ordination processes was not further considered in this research.

3.4 Phillip B. Crosby's Method

Crosby (1979) argues that effective measurement methods can be obtained from the personnel involved in the process itself and their supervisors: ask "How do you know who is doing the best work, whom to keep and whom to replace, whom to reward and whom to penalise?"

Main problem with this type of measure is that it does not include the voice of the customer. The personnel involved in the process may become so internally focused that their opinion may be far from the expectations of the customers. As a result, this method will not recognise implicit, explicit and latent expectations of the customers. The measures identified could only focus on the process and to a certain extent on the outputs. It is unlikely that they will represent the customers' perspective of the outputs and the eventual outcomes to the customers.

The subsequent surveys conducted under this research asked from construction project managers and co-ordinators questions such as:

- What are the features of a good job of co-ordination as opposed to bad co-ordination? *(Please see in supplementary question Q 6 in Appendix H).*

- How do you differentiate a good job of liaison from bad liaison? *(Please see in supplementary question Q 8 in Appendix H).*

The responses were so general (as evident from the examples given below) that the information yielded would be of little use in improving construction co-ordination processes. Although all project participants may intuitively know what is good co-ordination, it may be that Informality, Intangibility, Co-production by Customers (described in Section 2.3), Low Repetition, Unsolicited Service (described in Section 5.3.5) and Problem Solving Work of construction co-ordination processes have made it very difficult for them to give very specific answers to the above questions.

> The whole purpose of co-ordination is to ensure that Projects are completed on time. That is the whole purpose of co-ordination. Of course at the same time it is also important to have good co-ordination to minimise double handling and also to minimise potential disputes within the main contractor and/or his subcontracts. These are more or less the reason why co-ordination is important. … I would look at the end result of co-ordination to say whether it is good or bad co-ordination. Good co-ordination will result in a project with minimum disputes, with minimum double handling, minimum abortive work and with minimum delay. That is good co-ordination. So, bad co-ordination is the other way around.

> Good co-ordination is where work is completed on time. … Proper co-ordination will of course ensure that work is completed on time and within the budget.

> Good co-ordination is basically proactive co-ordination. Bad co-ordination is basically no co-ordination. There is no in-between. Either you co-ordinate or you don't.

> I would say good co-ordination is, if your job is 100% satisfactory. No major problem surfaced, that means the problem has been solved earlier, before it surface. Bad co-ordination is every now and then a problem surfaces and you were unable to detect it and solve beforehand.
>
> Bad co-ordination is waiting for things to happen and then go and say that these are all wrong. Because you have to be proactive. If you are being reactive, you are reacting all the time to the problems that have taken place. If you are proactive, you are doing it earlier and you are driving it and you are in control of the job.
>
> Liaison with the Client and Consultants is just get on well with everybody and become one nice big happy family.
>
> Liaison with the clients and consultants, of course the main objective is to ensure that a good job is done. As a contractor of course we are profit oriented and we must maximise the profits. Any mistake, any discrepancy that is not found out will ultimately cause additional cost to the client or us.
>
> How do you differentiate a good job of liaison from bad liaison? You can tell from your results.
>
> How do you differentiate between a good job of liaison and a bad job? I can deliver a switchboard that consultant will reject after some time saying this is not what I want. But, no I have complied with the contract. Yes, but this is not what I wanted. So you should know exactly what he wanted and supply that.

Because of the problems identified above, the applicability of this measurement method to construction co-ordination processes was not further considered in this research.

3.5 Simple Metrics

The author also considered the possibility of making use of simple metrics as discussed in Sections 3.5.1 to 3.5.3 below. Their merits and demerits are discussed in Section 3.5.4.

3.5.1 Value/Price Ratio or Value/Cost Ratio

A possibility is to consider the Value/Price Ratio or Value/Cost Ratio. As the customers of construction co-ordinators are more often parties internal to the project and because the outputs of the co-ordination processes are not directly sold, one way of employing this type of metric is to consider the ratio of:

$$\frac{\text{Value of savings made due to good co-ordination}}{\text{Cost of achieving co-ordination}}$$

The problem in applying the above ratio is to identify items of value to calculate

1. what was saved due to good co-ordination and
2. what percentage of the time of project manager and other staff was spent on co-ordination

Hence, it may be more suitable to consider the ratio of:

$$\frac{\text{Extra cost due to failures of co-ordination}}{\text{Project sum}}$$

or

$$\frac{\text{Extra cost due to failures of co-ordination}}{\text{Value of work done}}$$

This ratio may be more practical to calculate provided sufficient and accurate data is collected on failures in co-ordination. The project sum denominator could be used for comparison between projects whereas the value of work done could be applied when it is required to make comparisons between different periods of the same project. Project co-ordinators should strive to achieve as a low value of this ratio as possible. Further, if the contractor's management has a vested interest in not achieving co-ordination (to make claims for extra payment or extension of time – please see Section 5.3.5 where it is discussed how and why construction contractors could have vested interests in co-ordination), this measure can allow for such interest as well. This is because such items of value where they have a vested interest could be excluded from the calculation. Therefore, it is a good and practical measure for the contractor's management. Further, if the company is keen on comparing with the cost of co-ordination, they could consider the ratio of:

$$\frac{\text{Extra cost due to failures of co-ordination}}{\text{Cost of achieving co-ordination}}$$

However, a major difficulty in applying this metric is the collection of cost data. This would at times require online data capture which is very difficult in construction projects. Choi & Ibbs (1994) state, "When it comes to measuring work process, the construction industry does not enjoy a good reputation. The problem, however, can be attributed to the nature of the industry, which lacks solid data gathering and the exceptional fluctuation in productivity. Data collected in a construction project usually lacks consistency in structure and compilation". Especially it is doubtful whether there would be much enthusiasm within the main contractor's project team to collect data on "Extra cost due to failures of co-ordination".

3.5.2 Error Free Performance

Error Free Performance is another concept that could be used for measurement. For example, the number of co-ordination failures in each month of project duration can be considered. Again, this system can avoid counting the situations where contractor's management has a vested interest in not achieving co-ordination (to make claims for extra payment or extension of time – please see Section 5.3.5 where it is discussed how and why construction contractors could have vested interests in co-ordination). However, collection of data for this metric will be difficult especially in large projects. It might require online data capture which is not an easy task in construction projects especially when the data is on negative aspects of the construction process (number of co-ordination failures) thus providing no incentive for the project participants to co-operate.

3.5.3 Usage of Co-ordination Facility

Measuring the usage of co-ordination facility, i.e., how much do the project participants come to the project manager and the co-ordinators, will indicate how useful is their service to the project participants. There could be arguments against this, such as:

1. If good co-ordination is achieved everything will flow smoothly and there is no need for anyone to contact the co-ordinators;

2. Co-ordinators are supposed to proactively find out potential problems and co-ordinate. Therefore, rather than other project participants coming to them, they must go to the others.

3. Vested interests in not achieving site co-ordination (to make claims for extra payment or extension of time – please see Section 5.3.5 where it is discussed how and why construction contractors could have vested interests in co-ordination) will confound the apparent use of the avenues for co-ordination available onsite.

Therefore, this method may not be very applicable to construction co-ordination and may not be used.

3.5.4 Merits and Demerits of Simple Metrics

Out of the three simple metrics described in Sections 3.5.1 to 3.5.3 it was seen that Value/Cost Ratio and Error Free Performance could be used in the construction co-ordination context. They will be rather simple and easy to comprehend and compare.

However, the problem is that they are just calculated metrics and do not contribute to understanding the point of view, needs and expectations of the project participants. They may give some indication of how well or how efficiently the process is running but they cannot identify implicit, explicit and latent expectations of the customers and evaluate the process performance against them. At best, these types of metrics are process measures and cannot lead to appreciation of the outputs and outcomes. Further, they do not provide useful data that could be readily applied to improve the co-ordination processes. In using such metrics the greatest danger is the possible reduction to managing by numbers or managing by objectives. As Deming (1986) warned this could nourish short-term performance at the expense of the project objectives. It is appropriate to again recall what Davidow and Uttal (1989) state, "Service quality ultimately is whatever the customer says it is and not just whatever the service supplier can measure. … Employees tend to do exactly what the measures tell them to do or what they are rewarded for doing, ignoring the purpose of the measures".

3.6 Model by Construction Industry Institute (USA)

The Construction Industry Institute, USA, has developed a model derived from best practises of quality measurement found in the industry (CII 1994 and Stevens *et al.* 1994). Many measurement examples collected from the industry are categorised under a framework based on four TQM elements: customer focus, leadership, delivery and employee empowerment. A construction organisation intending to implement quality measurement is supposed to select a few out of the many examples. However the collection looks fragmented, possibly because the examples have been collected from many companies in the industry.

Some of the measurement examples given are attributes based measurements. For example, conducting surveys where project participants are asked evaluate the Project Manager's performance by ranking attributes such as:

- Human relations skills

- Leadership skills
- Technical experience
- Administration experience

However, the measurement examples have not been compiled to encompass the features of the measurement theory discussed in Chapter 2 such as measuring at the process, the output and the outcome (please see Section 2.4), recognising implicit, explicit and latent expectations of the customers (please see Section 2.5) and so on. Therefore, the examples fail to provide guidance on how to make comprehensive quality measurements.

Some measurement examples provided resemble the simple metrics presented in the previous section. For example, achieving milestones is considered to represent the accountability of the project management and the following ratio is supposed to provide a measure of the accountability:

$$\frac{\text{Number of Milestones Achieved On Time}}{\text{Total Number of Milestones Scheduled}}$$

In another example, the quality of design management is to be measured by:

- Counting the number of design change requests
- Comparing drawing issue dates vs. scheduled dates

Although such simple metrics are easy to comprehend and compare, they have the demerits described in Section 3.5.4. The greatest danger, as warned by Deming (1986), is the possibility of being reduced to managing by numbers or managing by objectives thus nourishing short-term performance at the expense of the larger project objectives. Further these metrics only provide some indication of how well the identified numerical goals are met. Therefore they do not provide data that could be readily applied to improve the processes. Stevens *et al.* (1994) comment as follows on the measurement examples they have collected, "most companies have difficulty in using measurements for immediate improvements. Instead most measurements are being used to determine performance, forecast results at completion and obtain feedback for improvement on future jobs". Due to such problems it was not possible to consider adapting examples from this measurement model to construction co-ordination processes.

3.7 Critical Incident Technique (CIT)

Stauss (1993) states that the CIT is essentially a means of assembling and classifying stories or 'critical incidents' by employing content analysis, and that Flanagan, originally developed this method in 1954 to identify requirements for effective job performance. He defined an incident as "any observable human activity that is sufficiently complete in itself to permit inferences and predictions to be made about the person performing the act", and is called critical "if it makes a 'significant' contribution, either positively or negatively, to the general aim of the activity". Stauss further states that the CIT focuses on events that have been seen to lead to success or failure in accomplishing a task" and that, CIT "has been used extensively in diverse disciplines, including education, human resource management, and work satisfaction research, but only in the most recent years has it been applied as a quality measurement tool. The credit for recognizing and further developing the Critical Incident Technique as an instrument for measuring perceived service quality goes to Bitner, Nyquist, Booms, and Tetreault".

The methodology adopted in this technique is based on surveys, whereby "respondents are asked to describe in story like fashion memorable services encounters that materially affected their satisfaction" Crosby (1993). Stauss (1993) states, "Originally, the Critical Incident Technique was created as a means of direct observation, but in its application to the measurement of the perceived service quality, observations are practicable only in the most exceptional cases. Observations can measure only limited parts of the aggregate volume of critical incidents. They are unable to determine the intensity of the emotion experienced during the critical incident and an appropriate method of application is both difficult and expensive. Thus, as a substitute for direct observations, critical incidents are normally collected by direct, open-ended interviews, either face-to-face or by telephone. During the interviews, respondents are asked to recall a contact situation with the service provider where the experience was either especially satisfying or especially dissatisfying. This approach is suitable because it is likely that customers will keep in mind (as stories) those events they perceive as being extremely positive or negative. In the data collection process, it is important that the interviewer clarify how the incident happened, which of the involved persons acted in which ways, and which circumstances were decisive for the customer's evaluation" (Stauss 1993).

Once the data collection has been completed, the process of interpreting and understanding the service-related incidents commences. Responses that are not suitable for analysis due to reasons such as lack of clarity need to be eliminated.

The remaining incidents have to be classified under a suitable system of classification usually identified by service quality models such as Eight dimensions of service quality (Garvin 1987), Ten determinants of service quality (Parasuraman *et al.* 1985), 'SERVQUAL' model (Parasuraman *et al.* 1986), etc. or under some suitable system of classification formed by inductive interpretation (Stauss 1993). Bitner *et al.* (1990), Bejou *et al.* (1996) and Shea and Roberts (1998) provide examples of classifications formed by inductive reasoning. Such classification and presentation of data can provide a valuable insight to the quality delivered by the service provider. Additionally, "all critical incidents should be stored in a database to ensure easy access for quality management purposes"(Stauss 1993).

An important feature of the Critical Incident Technique is that at the time of collecting data we do not attempt to make the respondent fit into our definition of quality or our model of quality. The respondent is allowed to express an opinion on the quality of the service in his/er own words based on his/er expectations, perceptions and priorities. Stauss (1993) elaborates, "The Critical Incident Technique allows customers to think about services the way they normally do. During an interview, customers are not forced into any given framework, they are simply asked to recall specific events. The respondents can use their own terms and familiar language". In the case of construction co-ordination processes, the fact that the processes are characterised by Informality, Intangibility, High Co-production by Customers (described in Section 2.3), Low Repetition, Unsolicited Service (described in Section 5.3.5) and Problem Solving Work has no effect on the respondents' ability to recall critical incidents.

When describing experiences, the respondents' stories provide opportunities for the service provider to understand many tacit details of how the customers think, what is important to them, their objectives, values, expectations and so on. From descriptions of negative experiences it will be possible to identify implicit expectations and explicit expectations. Descriptions of delightful experiences will indicate latent expectations among the customers. The latter type of experience will indicate to us what aspects of the service have created loyal customers. When co-production is a characteristic, i.e., co-production by customers in the service processes, as in the construction co-ordination processes, customer descriptions of critical incidents will also contain information on aspects of the service production process in addition to that on outputs and outcomes.

The problem solving skills of a construction project manager or a co-ordinator will be required to do a good job of co-ordination. Such problem solving work require cognitive competencies "such as problem solving, critical thinking, question formulation, relevant information searching, making informal judgements, efficient use of information, etc." (Segers *et al.* 1999). These competencies are less visible and less obvious to the customers of the service. There are many methods being developed to measure cognitive skills, e.g., Verbal Protocol Technique (Roberts *et al.* 1993, Hassebrock and Prietula 1992), Observation of Overt Naturally Occurring Speech (Osborne 2000), Learning Journals (McCrindle and Christensen 1995). However they are very much in the early stages of development and have been used only under simulated, controlled conditions such as prearranged tests. They have not been used in real life situations where the services are actually provided. More often than not, because of the involvement of many independent organisations in a construction project, the project participants have commercial and technical secrets to guard. Therefore, it is not practical to use tests of cognitive competencies where the subject (construction project manager or co-ordinator) while at work is required to reveal his/er cognitive thought process, for example by "verbalising the thought process" or "thinking aloud" as described by Roberts *et al.* (1993) and Hassebrock and Prietula (1992). However when applying CIT, the stories on critical incidents related by the respondent are likely to describe certain aspects of the problem solving skills of the construction project manager or the co-ordinator. Although such findings may not be as comprehensive as the results of the tests attempted by cognitive psychologists, within the limits of practical constraints at a construction site, they have the potential of providing some valuable insights on the quality of the problem solving skills and cognitive skills of the project manager or the co-ordinator thus providing an indication of the developmental efforts required.

The Critical Incident Technique can cover all four dimensions of quality measurement. That is, it can be applied to survey the opinion of all stakeholders of the process viz. end user, shareholders, employees and the community.

For the reasons discussed in this section, the applicability of CIT to construction co-ordination processes was further studied in this research. The above considerations led to formulating Hypothesis H2 and testing it as described in Chapter 8. Hitherto, there are no records of this technique being applied in the construction industry.

Chapter 4

LESSONS FROM PASS AND CONQUAS

The Performance Assessment Scoring System (PASS) and the Construction Quality Assessment System (CONQUAS) are multi-attribute quality measurement systems applied to the work of contractors in the construction industries of Hong Kong and Singapore respectively. Descriptions of these two systems are provided in Appendix A, Sections A.2 and A.1 respectively.

4.1 The Objective and the Purpose of the Study

This chapter presents a study (Experiment 1) carried out in Hong Kong and Singapore with the objective of "evaluating the suitability and effectiveness of PASS and CONQUAS in achieving:

- better satisfied customers and
- continuous improvement of products and processes."

Quality measurement theory presented in Section 2.1 explains the importance of these two aspects to the effectiveness of a quality measurement system.

It is noteworthy that in proposing quality measurement matrices, both CII and the Nordic Construction Institute built upon the existing measurement experience available in the industry (CII 1994, Sjøholt and Lakka 1994). Similarly, before testing the applicability of quality measurement methods to construction, the Author wished to learn:

1. What could be learnt from the quality measurement experiences of PASS and CONQUAS?
2. Could PASS and CONQUAS models be used in some way in this research to test Hypothesis H1?

Further significance of such knowledge for achieving the objectives of the main research is that, it will enable the development of an understanding of the suitability of attributes based quality measurement systems (which PASS and CONQUAS are – as shown Appendix A, Section A.3) to measure construction processes. In view of the quality management philosophy imparted by Deming (1986) and the measurement theories discussed in Chapter 2, this study could illuminate lessons that could be learnt from the mandatory implementation of measurements such as is done in PASS and CONQUAS. Further, PASS includes measurement of the quality of a contractor's co-ordination (although CONQUAS does not). From this study we could also understand how PASS contributes to improving co-ordination at construction sites.

However, this experiment yielded disappointing results indicating that PASS and CONQUAS are failing to achieve better satisfied customers and continuous improvement of construction products and processes. It was also found that PASS and CONQUAS models could not be used in this research to test Hypothesis H1. Thus, the results of this experiment became incidental to the main research, discussion is included in the thesis because:

- It shows what has been learnt from the existing measurement experiences in the construction industry.

- The results significantly affected the Author's thinking when conducting Experiments 3 and 4.

To reflect the incidental nature of this section of the work, it was decided to place some of the space consuming sections pertaining to this chapter, especially the lengthy analysis of the qualitative and quantitative data, in Appendix A.

4.2 Background to Measuring Construction Quality in Hong Kong and Singapore

Many commercial organisations worldwide, either manufacturing goods or providing services, have implemented quality improvement programmes where measuring quality was a part of such programmes. According to many authors, e.g., Albercht and Zemke (1985), Band (1991), Berry *et al.* (1985), Bounds *et al.* (1995), Crosby (1993), Davidow and Uttal (1989), DeCarlo and Sterett (1990), Goetsch and Davis (1994), Tenner and DeToro (1992), Zeithaml *et al.* (1990), reasons that instigated such endeavours may be such as increased competition, loss of market share, increasingly complex and dynamic business environment and increasing customer demands, while in a few cases it has been the company's own understanding and commitment (Bemowski 1996a). However, in the construction industries of Hong Kong and Singapore, the quality movement has been led by the governmental client organisations mainly by imposing mandatory requirements (De Saram *et al.* 1998, Ahmed, Lee and De Saram 1998, Ahmed, Li and De Saram 1998 Ahmed, Tam and De Saram 1999, Kam and Tang 1997 and 1998, Kumaraswamy 1996, Lam *et al.* 1994, Lee 1994, Low 1994, Shen 1995, Tam 1996 and Tang *et al.* 1998). As a result, there are two quality measurement systems, namely the Performance Assessment Scoring System (PASS) and the Construction Quality Assessment System (CONQUAS), implemented by the respective Governmental clients. Participation in these two systems is mandatory for construction contractors who wish to tender respectively for Hong Kong public housing works and all governmental jobs in Singapore.

It is very desirable that a buyer measures the quality capability of vendors. Deming (1986) states, "… must take a clear stand that price of services has no meaning without adequate measure of quality. Without such a stand for rigorous measure of quality, business drifts to the lowest bidder, low quality and high cost being the inevitable result". He further emphasises the importance of finding a "vendor that can furnish statistical evidence of quality. We must work with vendors so that we understand the procedures that they use to achieve a reduced number of defects". Such a stand is very important for the development of the construction industry because, in Deming's words, "The policy of forever trying to drive down the price of anything purchased, with no regard to quality and service, can drive good vendors and good service out of business. He that has a rule to give his business to the lowest bidder deserves to get rooked" (Deming 1986). However, PASS and CONQUAS focus on the outputs of the construction processes rather than on statistical evidence of quality or *how* the contractors achieve a reduced number of defects. "Focus on outcome is not an effective way to improve a process or an activity" (Deming 1986). Therefore, how successful are PASS and CONQUAS in achieving their objectives of promoting better performance in construction projects?

The Author is not aware of any previous research on how PASS and CONQUAS implementation has affected the contractors. The bulk of the research on quality is on the effects of implementation of ISO 9000 standards; e.g., De Saram *et al.* (1998), Ahmed, Lee and De Saram 1998, Ahmed, Li and De Saram 1998 and Ahmed *et al.* 1999), Kam and Tang (1998), Tang et al (1998), Kumaraswamy (1996), Tam (1996), Shen (1995) Low (1994 and 1998) and Lee (1994). Actually, Kam and Tang (1997) discuss the implementation of both PASS and CONQUAS from the point of view of public sector construction clients but not the effects of these systems on the contractors. Low *et al.* (1999) studied "whether there is a relationship between certification to ISO 9000 standards and the achievement of higher construction quality standards as indicated by CONQUAS scores". According to Kumaraswamy (1996), many considered PASS inspection to be more difficult than ISO 9000 audits. This, he points out, as a demonstration that the Client (The Hong Kong Housing Authority) "expects and obtains more than mere ISO 9000 certification" from its contractors. At present there is a lack of knowledge on the consequences for construction contractor organisations that implemented PASS and CONQUAS. From a Total Quality perspective, two very valuable effects of a quality measurement system is better focus on customer needs and continuous improvement of construction processes. Has the implementation of these two quality measurement systems helped them to achieve such benefits?

4.3 Research Methodology

Initially, a pilot study was carried out in Hong Kong where four personnel (a Quality Manager, two Project Managers and a Director) from construction contractors on the HKHA tender lists were interviewed. Open-ended questions were asked on their experiences of PASS. The structure used for the interview survey is given in Appendix AB. Based on the results of this survey, the questionnaire given in Appendix AC was developed to solicit wider opinion from the construction industry. The only differences between the versions of the questionnaire mailed to Hong Kong and Singapore was that the words “CONQUAS” and “Client” respectively replaced the words “PASS” and “HKHA” (Hong Kong Housing Authority).

In Hong Kong, 51 questionnaires were mailed to Quality Managers of contractors on the NW1 (contract value up to HK$ 300 Million) and NW2 (unlimited contract sum) tendering lists of the Hong Kong Housing Authority. In Singapore, Construction Industry Development Board (CIDB) had 120 construction contractors listed in their G7 (contract value up to S$ 50 Million) and G8 (unlimited contract sum) lists and questionnaires were mailed to Quality Managers of all of them.

There were 10 responses from Hong Kong and 26 from Singapore, both in the order of a 20% response rate. The respondents were of the calibre of Quality Managers, Project Managers and Construction Managers. In one case an Assistant General Manager had responded. Responses indicated that the respondents had mixed feelings about the usefulness of PASS and CONQUAS.

Therefore, rather than interpreting purely from quantitative survey data, follow-up interviews were conducted with 5 more respondents from Hong Kong and 15 from Singapore. Further, personnel of the PASS Control Unit of HKHA were interviewed to gather information on how HKHA, being a client that has taken many initiatives towards improving construction quality management, is proposing to solve the shortcomings of PASS in the future. Both quantitative and qualitative data gathered are presented and analysed in the subsequent sections of this chapter. As mentioned above, the main objective of the data analysis is to understand whether PASS and CONQUAS have contributed to a better focus on customer needs and a continuous improvement of construction processes.

The personnel of the PASS Control Unit of HKHA, raised the question whether the respondents who made negative comments on PASS were from contractors who had been unsuccessful in getting a good score. Initially there was a difficulty in checking this aspect because PASS scores are confidential information. However, because the research was conducted at the HK Polytechnic University, i.e., an independent body and also to maximise the benefit to the research, under conditions of strict confidentiality HKHA provided to the Author the relative "league" positions of those contractors who responded to the survey together with an indication of who are above the 'Composite Target Quality Score' (the upper quartile of the league) and who are below the 'Composite Lower Score Threshold' (the lower quartile of the league). The CONQUAS scores were also confidential information and it was not possible to obtain them from the CIDB. Hence, the Author had to rely on some of the comments made by the respondents on their own scores. Such information is incorporated into the discussion at appropriate places.

4.4 Summary of the Findings

The results of this study (derived from the analysis presented in Appendix A, Section A.4) indicate that PASS and CONQUAS serve the purpose of providing a contractor merit rating and at times a financial incentive, rather than a quality improvement tool. This may be due to many reasons such as the primary purpose of these systems being to determine which contractors should get a tendering advantage or a financial incentive, mandatory enforcement on the contractors, assessment being done by personnel other than those involved in carrying out the construction processes, subjectivity of the assessments, human relations between assessors and the contractors and so on. Especially in Hong Kong and to some extent in Singapore, the contractors did not seem to have much faith in the scores delivered by these assessments and the systems were considered a burden on the contractor. It was evident that PASS and CONQUAS tests are not in “statistical control”, thus they are unable to furnish “statistical evidence of quality”. Also, a majority of respondents both from Hong Kong and Singapore did not feel that PASS and CONQUAS had succeeded in ensuring that contractors performing better in quality will get more jobs in the future.

PASS and CONQUAS were found to focus only on the outputs and not on the construction processes. Another problem was that PASS and CONQUAS focus on compliance with the standards and the contractual requirements set by the client rather than focusing on satisfaction of the customers (both internal and external). Today the construction industry’s usual focus is to comply with the specifications and the contractual requirements. Further, PASS and CONQUAS could neither measure quality against explicit, implicit and latent expectations of customers nor readily identify changes in expectations of customers. Responses indicated that even in projects with high PASS or CONQUAS score, there could be dissatisfied end users. In this context, there was very little effort to use PASS and CONQUAS scores for developmental purposes.

Initially, since their inception, PASS and CONQUAS scores had been improving. In the past few years, however, they have reached a plateau above which it seems difficult to improve. The results suggest that the initial improvement is possibly due to the removal of special causes of defects because of sheer pressure by the clients. Further control of construction workers and site staff, checking of materials and documenting to provide evidence of conformance, may not improve the quality of construction products. If the quality is to further develop common causes of defects have to be removed by adopting meaningful management practises based on the Total Quality philosophy.

Nevertheless, the main objective of PASS and CONQUAS was for the Hong Kong and Singapore Governmental bodies to identify good construction contractors. The results have shown that this objective is also not being successfully met. Deming (1986) suggests that clients should find vendors who can furnish their own statistical evidence of quality and work with them to understand the procedures they use to achieve reduced numbers of defects. As described in Chapter 2, Deming (1986) had reiterated that use of performance measures for judgemental purposes and monetary incentives would result in poor quality.

4.5 Conclusions

This study illustrates lessons from the quality measurement experience in the construction industries of Hong Kong and Singapore. It has shown how two types of factors, i.e., problems in the two systems and problems in implementation, have limited the usefulness of PASS and CONQUAS as a quality improvement tool:

Problems in the systems:

- Measures are based on conformance to specifications instead of achieving customer satisfaction
- Focus only on the outputs and not on the construction processes
- The tests are not in "statistical control", thus they are unable to furnish "statistical evidence of quality"
- Could not measure quality against explicit, implicit and latent expectations of customers
- Could not identify changes in expectations of customers

Problems in implementation:

- Mandatory enforcement on the contractors
- Measurement systems developed and administered by people other than those involved in the processes

- Scores being used for judgemental purposes

Although PASS and CONQUAS are multi-attribute methods that are presently employed to measure the quality of construction products, in view of the above shortcomings, it is concluded that these two systems cannot be considered as examples to check the applicability of multi-attribute quality measurement systems to construction co-ordination processes. Therefore another generic multi-attribute quality measurement model has been selected and adapted to the construction co-ordination context in order to test Hypothesis H1. This is described in Chapter 5.

Chapter 5

THE ATTRIBUTES BASED MODEL FOR MEASURING QUALITY OF CO-ORDINATION

5.1 Adapting the Attributes Based Quality Measurement Model

Based on measurement theory discussed in Chapter 2 and the measurement paradigm presented in Chapter 3, Tenner and DeToro (1992) have proposed a generic multi-attribute quality measurement model given in Figure 5.1 to measure service quality. Applying this model involves the eight steps, A to H, shown therein. All special terms used such as "stakeholder", "characteristic", "service quality model", are described in the measurement theory presented in Chapter 2.

The rest of this section will be devoted to further elaborating these eight steps and discussing how this generic model could be further adapted to suit the construction co-ordination context and the present study. The service quality model adapted (with minor changes to suit construction co-ordination) from Tenner and DeToro (1992) is presented in Section 5.2. Possible challenges in applying the attributes based model for measuring the quality of construction co-ordination processes will then be discussed in Section 5.3 leading to the formulation of Hypothesis H1 presented in Section 5.4. The methodology adopted to test this hypothesis is briefly discussed in Section 5.5.

Step A: Define the product/service to be improved.

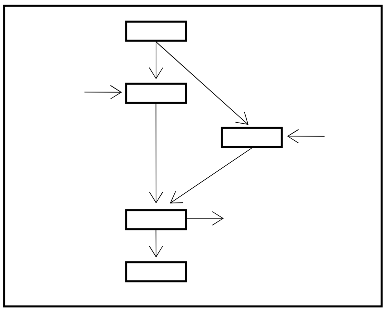
Step B: List the customers of the process.

Step C: List the other stakeholders of the process.

Step D: Identify (with the help of a service quality model) those performance characteristics of the product/service required by the customers and other stakeholders.

Step E: Translate each characteristic desired by customers and other stakeholders into corresponding specifications for the product/service and indicate their absence, presence or value in comparison to the customers'/stakeholders' expectations.

Step F: Flowchart (or document) the operation of the process.



Step G: List the measures internal to the process that control the performance of the product/service against the specifications.

Step H: Determine how satisfied customers are with performance at the current level and the relative importance customers place on changing the level of each characteristic.

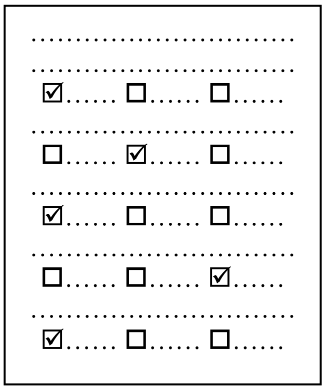


Figure 5.1: Attributes Based Quality Measurement Model

Source: Adapted from Tenner and DeToro (1992)

Step A. State the construction co-ordination process to be measured.

The first step is to explicitly state the process to be measured. This has to be done by the personnel who are carrying out construction co-ordination and are interested in improving those processes. Tenner and DeToro (1992) define a process as “the sequential of people, materials, methods and machines in an environment to produce value-added outputs for customers”.

For the purpose of this study the Author wished to focus on a few co-ordination processes considered important industry practitioners. As described in detail in Chapter 1, the currently available literature on management does not provide a ready description of what processes are carried out to achieve co-ordination on a construction site during the construction phase. Hence, the Author had to perform the survey presented in Chapter 6 to identify what are co-ordination processes and which of those are considered important and which of those are time consuming.

Step B. Identify the customers of the process.

Step C. Identify the other stakeholders of the process.

Steps B and C have to be carried out by asking the personnel who are carrying out construction co-ordination to identify their customers and all other parties they may consider as stakeholders (described in Section 2.8). Ideally, it should be carried out in a brainstorming session among a team of co-ordinators. However, this proved not be possible in this research study and in-depth interviews on very experienced construction co-ordinators were used instead.

Step D. Identify (with the help of a service quality model) those performance characteristics required by the customers and other stakeholders.

Customer requirements such as reliability, availability, convenience for each performance characteristics of co-ordination processes are established in this step with the help of a service quality model. Service quality models are described in Section 2.6. In identifying customer expectations, it is beneficial to apply a model of service quality characteristics because customers' definition of a quality service can be very complex. Therefore, as Garvin (1987) said, "must breakdown the word quality into manageable parts". The purpose of using the service quality model is to clarify how customers define quality or value. The service quality model adapted for the purposes of this research is given in Section 5.2.

At this stage, it is necessary to identify the three levels of customer and other stakeholder expectations, i.e., Implicit, Explicit and Latent (described in detail in Section 2.5) as shown in the matrix in Table 5.1.

Table 5.1: Matrix to Identify Quality Characteristics Required

Source: Adapted from Tenner and DeToro (1992)

Customers	Other Stakeholders		
	Stockholder	Employees	Community
<u>Implicit</u> 1. .... 2. .... 3.	1. .... 2. .... 3.	1. .... 2. .... 3.	1. .... 2. .... 3. ....
<u>Explicit</u> 1. .... 2. .... 3.	1. .... 2. .... 3.	1. .... 2. .... 3.	1. .... 2. .... 3. ....
<u>Latent</u> 1. .... 2. .... 3.	1. .... 2. .... 3.	1. .... 2. .... 3.	1. .... 2. .... 3. ....

Ideally, this step could be achieved through brainstorming sessions or discussions among the team of co-ordinators. The outcome of these meetings could be reinforced with inputs from a sample of customers and other stakeholders. This approach was not practical for this research and therefore Step D was achieved by first interviewing very experienced construction co-ordinators and then reinforcing the findings by further interview surveys of their customers and other stakeholders.

Step E. Translate each characteristic desired by customers and other stakeholders into corresponding specifications for the process and the outputs.

Under this, we need to identify:

- 'Voice of the customer' based on the requirements (such as performance, reliability, availability, convenience) of customers (and also other stakeholders) identified above. As elaborated in Section 2.4, it is not sufficient to merely identify the voice of the customer in terms of process outputs. Service providers need to go another step forward and identify the outcomes for the customers, i.e., what use (outcome) the customer makes out of the process and how the customers' satisfaction is affected (please see Section 2.4 for details). This step could be carried out by discussions among the team of co-ordinators, based on the information gathered in Step D above and reinforced with inputs from a sample of customers and other stakeholders. In this research it is done by the Author based on the information gathered in the interviews mentioned under Step D above.

- Requirements specified in contract documents/specifications/drawings. This is achieved by inspecting the relevant documents.

- 'Voice of the process' or what the process is capable of delivering. This is carried out by discussions among the team of co-ordinators. However, as this research is not focusing on any particular project, general opinions about co-ordination in construction projects today was collected from the respondents.

Step F. Flowchart (or otherwise document) the process.

Step G. List the measures internal to the process that control the performance of the process outputs against the requirements and specifications identified above. List the salient features of the process as practised now.

Steps F and G are performed to identify process measures (described in Section 2.4). These two steps could again be carried out by discussions among the team of co-ordinators. For the purposes of this research, information on the flow of the co-ordination process is gathered during the interviews so that the Author can make a typical flowchart. Measures internal to the process and important features of the process are then be identified by the Author.

Step H. Determine how satisfied customers are with performance at the current level and the relative importance customers place on changing the level of each characteristic.

The above Steps D to G yield a detailed study of the customer (and other stakeholder) expectations, measures that control the performance of the process outputs and other salient features of the processes. These measures of process attributes can then be listed in questionnaires that could be presented to the customers and all stakeholders. Therein, the respondents will be asked to rank on a Likert scale of three points:

a) How important is the service attribute?

b) How well does the present process satisfy the expectations of this attribute?

As explained in Section 2.7, it is not sufficient to just ask how well the customer's expectation on a particular attribute is satisfied; it is equally important to know the level of importance the customer attaches to that attribute. The results of the above survey on the importance of service attributes and customer satisfaction can be plotted on a 'Customer Window' shown in Figure 2.5. The process development efforts can then be focused on the attributes in quadrant 'A' that the customer *wants but does not get*; filtering out those in quadrant 'D' that the customer *does not want and does not get*. Similarly the attributes in quadrants 'B' and 'C' can be identified for further action. The attributes in quadrant 'B' may soon slide into quadrant 'A' due to continuously rising customer expectations and hence may need continued attention. The service provider could either stop supplying the attributes in quadrant 'C' or educate the customer about their benefits.

5.2 Proposed Service Quality Model to be Used in this Study

As presented in Section 2.6, by synthesising four popular service quality models, Tenner and DeToro (1992) have proposed a more comprehensive model of service quality characteristics. Therein, elements of all other models are categorised into the three elements of the conventional model Faster, Better and Cheaper. Also, they were categorised as quality characteristics that are deliverables of the service and quality characteristics of interactions that customers experience during the service. To be used in Step D above, for the purposes of this research, the Author adapted this model to the construction co-ordination context with minor changes. The version thus used in the research is given in Table 5.2.

Table 5.2: Service Quality Model

3 Macro Dimensions of Value	**Deliverables of the Process** *(Attributes that are provided to the customer)*		**Interactions During the Service** *(How customers experience the process while it is performed)*	
Faster	**Availability**	Availability of outputs at the required time at the required location in the required format	**Responsiveness**	Willingness or readiness of employees to provide service; timeliness, promptness
	Convenience	Convenience to the users of the outputs	**Accessibility**	Approachability and ease of access; waiting time; hours of operation
Better	**Performance**	Primary performance characteristics of the service fulfilling the basic functional requirements	**Competence**	Possession of the skills and knowledge required to perform the service
	Features	Secondary performance characteristics of the service that supplement the basic functions to enhance the service	**Credibility**	Trustworthiness, believability, honesty, reputation and personnel characteristics of personnel; ability to inspire trust and confidence
	Reliability	Accuracy; dependability in performing the right service right the first time	**Reliability**	Consistency of performance and honouring of promises
	Conformance	Degree of conformance to established standards	**Security**	Confidentiality; freedom from risk, doubt or danger
	Durability	Farsightedness of the outputs, capability of material components of outputs to withstand site conditions	**Communications**	Listening to and communicating to customers and other personnel/parties concerned; use of language skills, audio visual facilities and electronic and other media
	Aesthetics	How the outputs look, feel, sound; neatness, elegance	**Empathy**	Caring, understanding and individualised attention
	Serviceability	Competency, ease and effectiveness of follow-up, changes, adjustments, corrections and troubleshooting	**Courtesy**	Politeness, respect and friendliness
			Style	How the service looks, feels and sounds; physical facilities and resources used; appearance of personnel
Cheaper	**Price**	Cost of co-ordination process (monetary and other)		

5.3 Problems that May Be Encountered in Applying a Multi-attribute Model to Construction Co-ordination

As discussed in Chapter 1, co-ordination on a construction site is a function carried out informally. Further, as discussed in Chapter 2, co-ordination processes feature very low tangibility, very low repetition and a very high degree of co-production by customers. Very low tangibility and very high co-production by customers make identification of the co-ordination processes and definition of their boundaries difficult. Very low repetition of some co-ordination processes makes them become very miscellaneous activities. This situation is further complicated by the fact that most customers of the co-ordinator are internal parties to the project whose relationships are governed by various contractual conditions. Therefore, their expectations are not very straightforward and could even have vested interests in the failure of co-ordination processes (this aspect will be discussed in more detail in Section 5.3.5). Such customers may not even solicit the service. Co-ordination involves lots of problem solving works that are carried out in the minds of the co-ordinators by cognitive psychological processes. While it is difficult to identify cognitive psychological processes, it is even more difficult to identify measurable attributes of them. These are the factors that make managing co-ordination processes more challenging. They could make it difficult to apply a management tool such as the attributes based quality measurement model to construction co-ordination processes. Sections 5.3.1 – 5.3.5 below further elaborate on such difficulties. Table 5.3 presents a summary of these difficulties classified under the process characteristics: Informality, Intangibility, Co-production by Customers, Low Repetition, Unsolicited Service and Problem Solving Work.

Table 5.3: Problems that May be Encountered in Applying a Multi-attribute Model to Construction Co-ordination

Service Process Characteristic	Difficulties in Applying Multi-attribute Method
Informality	• No formally identified or accepted or documented processes. • No set methods of obtaining inputs, processing and delivering outputs. • Processes vary from one individual (service provider) to another to suit his/er style of operation. • Processes are flexibly applied to suit the needs and conveniences of the individual situations. • Difficult to identify regular or repetitive processes and outputs. • Difficult to identify customers and stakeholders
Intangibility	• No tangible processes and outputs. • Difficult to define the processes and the outputs. • Difficult to identify customers, stakeholders and their expectations. • Difficult to identify measurable attributes of the processes, the outputs and the outcomes.
Co-production by Customers	• Processes, their boundaries, and their scope are not clear. • Inputs, outputs, customers, stakeholders and processes are not clear. • Processes should vary to suit the reactions (during the processes) by the customers. Therefore, there is a lack of constant and repetitive nature in the processes. • The customers can have vested interests in the failure of the processes due to their own obligations towards production of the service. • Difficult to identify measurable attributes of the processes and their outputs.
Low Repetition	• Makes them miscellaneous processes carried out in an ad hoc or case-by-case manner. • Difficult to identify regular or repetitive processes, inputs and outputs. • Difficult to identify customers, stakeholders and their expectations.
Unsolicited Service	• The customers will not explicitly request the service. • Difficult to identify the customers, the stakeholders, the processes, inputs and outputs. • Difficult to identify and understand the customer expectations. • No regular or repetitive inputs and feedback. • The service provider needs to be proactive. • The customers could have vested interests in the service failure. • The customers may not co-operate where co-production is required.
Problem Solving Work	• Difficult to identify the cognitive psychological processes involved in the problem solving work. • Difficult to identify measurable attributes of cognitive psychological processes. • Difficult for customers to evaluate the less visible psychological processes of a service provider.

5.3.1 Identifying Processes

Intangibility of the co-ordination function makes it difficult to identify the underlying processes and the outputs. As a result, the industry practitioners find it difficult to define the co-ordination processes and their outputs.

To add to that problem, because of informal approaches to achieving co-ordination at construction sites there does not appear to be any attempt to either formally identify or document the co-ordination processes. There are no set methods for obtaining inputs, processing and delivering outputs. Processes are flexibly applied to suit the needs and conveniences of individual situations. Further, the processes vary from one individual (service provider) to another to suit his/er style of operation. Especially at higher levels of management, individual management styles could affect a lot. Most co-ordination processes involve high levels of management on a construction site, as is evident from the following statements made by respondents to interview surveys conducted during this study:

> It is a correct observation that Project Co-ordinator is a deputy Project Manager.
>
> We would not call him a Project Co-ordinator we will call him an Operations Manager and he will be a senior person. He will be probably second to the Project Manager.
>
> Project Manager himself basically is the key person [to perform construction co-ordination]. He must. He can delegate this (I call that delegation) but he must be the one on top of it.
>
> I would say that Project Manager has a totally important role to perform all these processes.
>
> Ideally, the Project Manager must be involved in every co-ordination so that he knows from top to bottom. But practically it is not possible specially when you come to a big project there are so many meetings and so many things to take care of.

Variation in the co-ordination processes, such as described above, makes it difficult to identify any regular or repetitive processes and outputs that are consistently applied and achieved.

Further, co-production by customers makes both the customers and the service provider react to the actions of each other. Customers may, while the service production process is in progress, alter the requests for service previously made or make additional requests. Customers may participate by supplying different information on the project status or even carryout certain parts of the co-ordination process itself. This can make it very difficult for industry practitioners to describe how the co-ordination processes are performed, identify the exact scope and boundaries of these processes, identify who does what, who contributes what, who receives what, who really are the customers and so on. The wide variety of customers and stakeholders of construction co-ordination processes contributes to the further deepening of this problem. Higgin and Jessop (1965) state, "Construction co-ordination is more descriptive of the relating together of separate activities and their concerted direction towards a common purpose". A co-ordinator has to work with everyone connected with the project and his customers can be numerous. Respondents to interview surveys conducted under this study also confirmed this by responding to the question "Who are the personnel the co-ordinators have to interact with?" by answers such as follows:

> A good project co-ordinator will interact with everybody.
>
> Basically it is the whole team; there is no specific person.
>
> In fact it is almost everything, every trade. Co-ordination involves every trade because every trade requires co-ordination. … Everybody will be affected by these processes.

When so many and varied customers with disparate needs and expectations are co-producers in a process, the process has to vary a lot from one service encounter to another to suit how each customer reacts during the service production. This is compounded by low repetition and the miscellaneous nature of co-ordination problems that require the co-ordination processes to change to suit the individual situations at the site. All these factors make it difficult to identify any repetitive processes that underlie the co-ordination function. Customers not explicitly requesting the co-ordination service (due to co-ordination being an unsolicited service as discussed in more detail in Section 5.3.5) can only add to this difficulty.

It is common experience that construction co-ordination involves lots of problem solving work. The results of the experiment described in Chapter 6 serves to confirm this. For example, the respondents considered that "Identifying strategic activities and potential delays" is the most important co-ordination activity and "analyzing the project performance, detecting variances and dealing with their effects" is a very time consuming co-ordination activity. These problem solving work are carried out in the minds of the co-ordinators by cognitive psychological processes. Such cognitive psychological processes are internalised in a person's mind and are not very visible. Even the very person carrying out the cognitive process and involved in the problem solving work may not be aware of his/er thought process unless s/he has metacognitive capabilities (defined by Flavell (1976) as the knowledge and awareness of one's own cognitive processes and the ability to actively control and manage those processes). Therefore, the attempts by the construction industry practitioners to identify co-ordination processes may result in incomplete results due to their inability to completely capture the cognitive psychological processes that may comprise an important and a significant part of the co-ordination work.

In such a context, it can be very difficult to achieve Step A of the measurement model (given in Section 5.1):

Step A. State the construction co-ordination process to be measured.

It may be due to reasons such as the above that many authors writing about construction project management have, as discussed in Chapter 1, fallen short of comprehensively identifying co-ordination activities. This gap in the current knowledge required the Author to perform the experiment described in Chapter 6 (Experiment 2), in order to focus this study on a few co-ordination processes considered important by construction industry practitioners.

5.3.2 Identifying Customers and Stakeholders

The intangibility of co-ordination processes makes it difficult to understand who are involved in the processes and who receives the outputs. The difficulty in understanding who receives the outputs makes it difficult to understand who are the customers of the processes while difficulty in understanding who are involved in the processes makes it difficult to understand who are the other stakeholders of the processes. These processes being flexibly applied due to the informal approach adopted towards achieving construction co-ordination can only add to the above difficulties because of the lack of regular and repetitive processes as discussed in the previous section.

As also described in the previous section, co-production by customers will make it difficult to identify the exact scope and boundaries of co-ordination processes, identify who does what, who contributes what, who receives what and so on. This makes it further difficult to identify customers and other stakeholders.

Low repetition and the miscellaneous nature of co-ordination problems will also add to the difficulties of identifying customers and stakeholders. This is because there will be more miscellaneous, or ad hoc, problems than regular or repetitive ones. Therefore, there will be more unusual and ad hoc customers than those with regular and repeating needs.

Construction co-ordination being an unsolicited service (discussed in more detail in Section 5.3.5) makes for further difficulty in identifying customers because they have not explicitly requested the service. When the situation is further complicated due to co-production by customers, it is difficult to understand who really are the customers and who are the other participants (other stakeholders).

In the above context, it can be difficult to achieve Steps B and C of the measurement model (given in Section 5.1):

Step B. Identify the customers of the process

Step C. Identify the other stakeholders of the process

5.3.3 Identifying Customer Needs

"A growing number of companies are finding out that giving customers what they want is not nearly as hard as finding out what it is that they want" (Bennett

1990). In a context where processes, inputs, outputs, customers and stakeholders themselves are difficult to identify, identifying customer needs becomes a daunting task. A major pitfall in applying attributes based quality measurement models could be the carrying out of surveys to "determine how satisfied customers are with a number of factors that the [service] organisation believes customers think are important" Miller (1998). As argued below, this risk will be higher when applying attributes based models to measure the quality of construction co-ordination.

Construction co-ordination being an unsolicited service (as discussed in more detail in Section 5.3.5), customers may not explicitly request the service form the project manager and other co-ordinators. This causes difficulties in identifying and understanding even the explicit expectations of the customers. In this context, it will be still difficult to identify their implicit and latent expectations (described in Section 2.5). Further, conditions such as described below will only add to these difficulties.

As discussed in Sections 5.3.1 and 5.3.2, intangibility of co-ordination processes makes it difficult to identify customers, other stakeholders and to define process outputs. That can make it very difficult to identify the expectations of customers and other stakeholders.

Further it was discussed in Sections 5.3.1 and 5.3.2 that low repetition makes it difficult to identify regular or repetitive processes, outputs, customers and stakeholders. This too contributes to difficulties in identifying the expectations of customers and other stakeholders.

In such a context, it will be difficult to comprehensively identify explicit, implicit and latent expectations (described in Section 2.5) of the customers and the other stakeholders, as required in Step D of the measurement model:

> **Step D**. Identify (with the help of a service quality model) those performance characteristics required by the customers and other stakeholders.

5.3.4 Identifying Measurable Attributes

The above difficulties in identifying explicit, implicit and latent expectations (described in Section 2.5) of the customers will cause difficulties in determining the voice of the customers and the above difficulties in identifying process outputs contribute to the difficulties in determining the voice of the process as required in Step E of the measurement model:

> **Step E**. Translate each characteristic desired by customers and other stakeholders into corresponding specifications for the process and the outputs.

Difficulties (discussed in Sections 5.3.1 and 5.3.2) in identifying processes, inputs, outputs, customers and stakeholders will also make it difficult to document the process by flowcharting (or otherwise) as required in Step F and to identify process measures as required in Step G:

> **Step F**. Flowchart (or otherwise document) the process
>
> **Step G**. List the measures internal to the process that control the performance of the process outputs against the requirements and specifications identified above. List the salient features of the process as practised now.

Especially where cognitive psychological processes are involved, as discussed in Section 5.3.1, it will be difficult to document the process by way of flowcharting or otherwise. In such processes, “measures internal to the process” involve the problem solving skills of a construction project manager or a co-ordinator that will be required to do a good job of co-ordination. Such problem solving skills are often cognitive competencies "such as problem solving, critical thinking, question formulation, relevant information searching, making informal judgements, efficient use of information, etc." (Segers *et al.* 1999). Not only that it will be difficult to identify such "measures internal to the process", it will be difficult for the customers to evaluate the process on such measures that are not tangible.

In such a context, it will be difficult to identify measurable attributes of co-ordination processes, thus making it difficult to present a good measurement model to be ranked by the customers and stakeholders as required in Step H:

> **Step H**. Determine how satisfied customers are with performance at the current level and the relative importance customers place on changing the level of each characteristic.

Further the Author feels that even the best of models will bring limited results when faced with the difficulties described in Section 5.3.5 below.

5.3.5 Nature and Attitude of Customers

There is much literature on measures of service quality and eventual satisfaction of the customers. Two main schools of thought that try to conceptualise service quality argue it either as an attitude formed by customers (Cronin and Taylor 1992) or as the gap between customers' expectations and provider's performance (Parasuraman *et al.* 1988). The intention of this is to understand future purchasing intentions/behaviour. Most of this research has been carried out in service industries such as retail sales, banking, fast food, telephones, airlines, laundry, repairs and so on. Customers of such an industry are often members of the public who will approach the service personnel with very straightforward expectations. In contrast, in the construction industry, the customers of a project manager and the co-ordinators come from within the project. They may be client's representatives assigned to the project, consultants, quantity surveyors, subcontractors, suppliers and personnel of different departments of the main contractor itself. Unlike the general public, these project participants are bonded to the project by different contracts requiring each to fulfil many obligations. Problems in their fulfilling such project obligations make them have vested interests in the failure of project co-ordination. Higgin and Jessop (1965) see that construction project participants can have a vested interest in faulty communications in order to claim extra as a consequence. Crichton (1966) states, "builders having agreed [at the tender stage] on unrealistically short schedules for completion rely on some delay for which they can disclaim responsibility and claim an extension of time". Crichton (1966) also pointed out that, "if a builder prices on the basis of particular knowledge of a site, he may lose the job. Therefore, he will suppress his information and hope, when it comes to light, to cover the extra cost". Shamma-Toma *et al.* (1998) add that "contractual procedures have constricted communication among the project participants and the present climate does not encourage contractors to co-operate but, on the contrary, to exploit design errors through claims and extra work to the detriment of quality and cost of the project". Hence, "lack of co-ordination may not universally be considered, in the construction industry, as a disadvantage" (Higgin and Jessop 1965). The problem is that it makes it very difficult to listen to the voice of the customer.

Unlike the general public who may request a service from a service provider, project participants may, due to the vested interests described above, just remain passive and not be interested until there is a clash with the progress of their own work. They may not exercise a “discretion to purchase”. Often, the project manager and the co-ordinators work from behind the scene performing a service that is not directly solicited.

In this context, it may be difficult to or even be inappropriate to consider the measures of quality perceived by such customers to truly reflect the quality of co-ordination. This is not in anyway to underestimate the need to focus on the customer expectations and their satisfaction. In the construction context, certain short-term expectations of some project participants may not reflect the long-term benefit of the project and the satisfaction of the final customers, i.e., the client and the end users. This is because in a construction project, especially in today’s context, all participants are not aligned towards the project goals. Eventual end users of the facility being constructed will usually be too distant from the project and even the very investors of the client organisation may be too distant from the day-to-day operations of the project site. Hence, it will be difficult to achieve Step H:

> **Step H**. Determine how satisfied customers are with performance at the current level and the relative importance customers place on changing the level of each characteristic.

5.4 Hypothesis H1

As elaborated in Sections 5.3.1 – 5.3.5 there are many difficulties in applying an attributes based quality measurement model to co-ordination processes. Therefore a Hypothesis is formulated as follows:

H1 Attributes based quality measurement tools are not applicable to the construction co-ordination processes.

5.5 Proposed Methodology to Test the Hypothesis

To test Hypothesis H1, the Author attempted to apply the attributes based quality measurement model presented in Section 5.1 to measure construction co-ordination processes. In doing so, the hypothesis is tested through the process of falsification (Mason 1996).

Nevertheless, it may be argued that, this *particular* multi-attribute quality measurement model not being applicable to construction co-ordination processes may not preclude *other* multi-attribute quality measurement models being applicable. The Author wish to point out that, Steps A to H of the model adapted for this research are the most basic and essential steps required in applying any multi-attribute quality measurement model to any process:

Step A. State the construction co-ordination process to be measured.

In any multi-attribute quality measurement model, it is necessary to clearly identify the product or the service being measured.

Step B. Identify the customers of the process

Step C. Identify the other stakeholders of the process

Step D. Identify (with the help of a service quality model) those performance characteristics required by the customers and other stakeholders.

In any multi-attribute quality measurement model, it is necessary to identify the customers, other stakeholders and their expectations.

Step E. Translate each characteristic desired by customers and other stakeholders into corresponding specifications for the process and the outputs.

Translating the expectations of customers and other stakeholders into corresponding specifications for the process and the outputs is essential to compare the voice of the process and the voice of the customer. In fact, these specifications are the measurable attributes of the outputs and they need to be identified in the application of any multi-attribute quality measurement model.

Step F. Flowchart (or otherwise document) the process

Step G. List the measures internal to the process that control the performance of the process outputs against the requirements and specifications identified above. List the salient features of the process as practised now.

Flowcharting and documenting is required to develop an in-depth understanding of any manufacturing or service process. Measures internal to the process and salient features of the process are in fact the measurable attributes of the process and they need to be identified in the application of any multi-attribute quality measurement model.

Step H. Determine how satisfied customers are with performance at the current level and the relative importance customers place on changing the level of each characteristic.

Determining customer satisfaction in terms of the identified measurable attributes and understanding the relative importance customers place on each attribute is the ultimate objective of any multi-attribute quality measurement model.

Difficulties in applying these basic and essential Steps A to H to a particular context signify difficulties in applying any multi-attribute quality measurement model to that context. Hence, it is possible to test Hypothesis H1, by applying the attributes based quality measurement model presented in Section 5.1 to measure construction co-ordination processes.

For the purposes of this research, as outlined in Section 5.1, all information required for applying the attributes based model was gathered by interviews on industry practitioners. Most of the interviews needed to be conducted on construction co-ordinators or construction project managers. In the absence of formal knowledge of what activities constitute construction co-ordination function there was a difficulty in deciding on what construction co-ordination processes the application of the attributes based quality measurement model should focus. The survey described in Chapter 6 (Experiment 2) was thus conducted to identify what are construction co-ordination processes and of these what are considered important and time consuming. Based on the focus obtained from that, an interview structure was developed to solicit from construction co-ordinators or construction project managers the information required for applying the attributes based model presented in Section 5.1. The prototype questionnaire developed, difficulties encountered when pilot testing it and subsequent improved versions of it are presented in Chapter 7. The data thus gathered were used to test Hypothesis H1 as presented in Sections 7.4 to 7.10.

Chapter 6

IDENTIFYING CONSTRUCTION CO-ORDINATION PROCESSES

6.1 Need to Limit the Focus to Apply the Attributes Based Quality Measurement Model

Chitkara (1998) and Martin (1976), elaborate that a Project Manager has to carry out Planning, Organising, Staffing, Directing and Controlling. Chitkara (1998) further modifies these duties to suit construction project environment as Planning, Organising, Procuring, Leading and Controlling. Then he states that common to all these functions is the function of co-ordination. It is noticeable to the Author that, most duties and responsibilities of a Construction Project Manager contribute to achieving co-ordination. Construction co-ordination is in fact a very complex process with a vast scope of activities. As Stauss (1993) points out, "a comprehensive questionnaire listing all quality aspects [of a service process] would result in a questionnaire that would exceed by far the normal customer's willingness to answer". In this context, a questionnaire on all quality aspects of the entire co-ordination function will be well beyond the practical size for a survey on the industry. Hence, it was necessary to focus the experiment on testing of Hypothesis 1 on a limited range of co-ordination activities.

As stated in Chapter 1, the author found very little research and discussion on construction co-ordination. One of the major implications for this research is that no ready definition exists of what is construction co-ordination and how it is achieved. That made it not possible to readily identify important co-ordination processes on which to test the attributes based quality measurement model. In this context, the Author performed the following experiment (Experiment 2) to identify what constitutes the construction co-ordination function, what are the more important activities and what are the more time consuming.

6.2 Objectives of Experiment 2

Specifically, the objectives of Experiment 2 are to answer the questions:

- What activities do Project Managers perform to achieve co-ordination in a building project?
- What co-ordination activities do they consider most important?
- What co-ordination activities consume most of their time?

6.3 How an Array of Issues were Collected

In the absence of previous literature on what activities constitute construction co-ordination, the Author initially gathered the best available descriptions and definitions of co-ordination function. Chitkara (1998) states “co-ordination aims at an effective harmonisation of the planned efforts for accomplishing goals”. “Co-ordination is almost equivalent in meaning to ‘control’, ‘planning’ or 'management', but is more descriptive of the relating together of separate activities and their concerted direction towards a common purpose" (Higgin and Jessop 1965). Merriam-Webster Staff and Gove (1971) defines co-ordination, in a more general context, as "combination in most suitable relation for most effective or harmonious result: the functioning of parts in co-operation and normal sequence".

Forsberg *et al.* (1996) describes the Project Co-ordinator's role as "one of augmenting the Project Managers visibility for larger projects. A co-ordinator is chartered, as a representative of the Project Manager who proactively ensures future events will occur as planned. They signal problem areas and recommend solutions. Project co-ordinators:

- Know how the organisation "works".
- Provide expediting help to the project and support organisations.
- Provide independent assessment of project information and status to the Project Manager.
- Ensure planning and milestones are satisfied.
- Ensure control procedures are being adhered to".

Chitkara (1998) describes the Planning Chief's role in co-ordination function as:

- "Communicating promptly the monitored information to all concerned for taking corrective measures to prevent adverse situations.

- Creating a climate of co-operation by avoiding interdepartmental conflicts and resolving all issues affecting the progress of work.

- Providing a proper flow and record of the monitored information through monthly information reports, minutes of meetings, project bulletins and liaison letters.

- Pursuing all the planning and monitoring issues raised by the departments to their logical completion".

Explanations such as the above could be considered as the best available attempts so far to describe the co-ordination function. Still they fall short of the level of detail which numerous authors have described processes such as making a structural design, preparing an estimate, pouring concrete, et cetera.

Chitkara (1998) and Martin (1976), elaborate that a Project Manager has to carry out Planning, Organising, Staffing, Directing and Controlling. Chitkara (1998) further modifies these duties to suit construction project environment as Planning, Organising, Procuring, Leading and Controlling. Then he states that common to all these functions is the function of co-ordination. It is noticeable to the Author that, most duties and responsibilities of a Construction Project Manager contribute to achieving co-ordination.

Therefore, duties and responsibilities of Project Managers in general and more specifically of Construction Project Managers that were, in the Author's opinion, contributing towards achieving co-ordination were gathered from Chitkara (1998), Forsberg *et al.* (1996), Walker (1996), Ritz (1994), Bent (1989), Kerzner and Thamhain (1986), Kliem and Alexander Hamilton Institute (1986), Martin (1976), Taylor and Walting (1973). In doing so, focus was maintained on the contractor's project manager's perspective during the building phase. Duties of clerks of works, construction engineers, etc., from Martin (1992) and Watts (1982) were also gathered. In this fashion, a large list of possible activities that describe the role of a construction project co-ordinator was compiled. The next task was to distil this large list to arrive at a "model of activities that contribute to achieve construction co-ordination", to be included in the questionnaire referred to above and presented to industry practitioners.

6.4 How the Array of Issues was Distilled

As a first step, the activities in this list were categorised under:

- Activities required to manage "Tasks"
- Activities required to manage "Timing"
- Activities required to manage "Resources"
- Activities required to manage "Responsibilities"

Those activities that could not be categorised into either of the above were placed in a "General" category. The resulting matrix is given in Appendix B.

Right through this process of distillation, any activity that could be categorised under more than one category was repeated under each relevant category. Although this increased the number of items to be handled, it later helped in visualising activities that contribute to achieving construction co-ordination under each category of activities.

Many authors, for example Ritz (1994), Kliem and Alexander Hamilton Institute (1986) consider that a Project Manager has to Plan, Organise and Control. Although Chitkara (1998) and Martin (1976) elaborated further as mentioned above, these three functions were considered to be more fundamental for the purposes of this distillation process because the functions such as staffing, procuring, directing and leading could be a subset of organising. Hence, the activities identified under each category in the preceding step were further subdivided into subcategories “Planning”, “Organising”, and “Controlling”.

The arrays of items under each subcategory were still found to be too large to properly visualise activities that contribute to achieve construction co-ordination in each respect. Hence, the Author further subdivided each subcategory as follows.

Planning was subdivided into:

- Identify
- Communicate
- Analyse/Plan/Schedule

Organising was subdivided into:

- Lead
- Facilitate
- Information and Records

Controlling was subdivided into:

- Monitor
- Analyse
- Control/Correct/Maintain
- Record/Communicate

The matrix that resulted is given in Appendix C.

Having sorted the co-ordination activities as above, each was further subdivided into:

- Sequence of Work
- Deployment of Work
- Services, Fixtures and Builder's Work
- Co-operation
- Supervision, Quality and Safety
- Remedial Works
- Attendance to Others

Please refer to Appendix D where the matrix that resulted is given.

Because of the large number of subdivisions, only a few activities came under most categories thus giving a very clear picture of the Project Manager's activities that contribute to achieve construction co-ordination in each respect. Also there were categories into which the Author could not place any activities.

Still the structure with so many subdivisions was judged too complex for presentation to industry practitioners via the questionnaire. Therefore, by careful inspection of the present arrangement of activities it was possible for the Author to visualise that all the co-ordination activities can be identified under just the 5 subheadings:

- Providing Leadership
- Facilitating
- Controlling
- Communicating
- Recording

Then, it was possible to condense the large list of activities into just the 64 activities given in Table 6.1. It was attempted to identify the 64 co-ordination activities such that they totally describe the construction co-ordination function. Some of the listed activities tended to have some areas of overlap. However this was allowed because the intention was to arrive at a totally exhaustive list of activities required to achieve construction project co-ordination rather than the activities listed being mutually exclusive.

Table 6.1: Initial List of Construction Co-ordination Issues Presented to the Industry Practitioners

1. **Providing Leadership**
    - 1.1. Translating documents into task assignments
    - 1.2. Identifying strategic activities and potential delays
    - 1.3. Identifying technical and workforce requirements
    - 1.4. Delegating the work
    - 1.5. Following up the delegated work
    - 1.6. Motivating
    - 1.7. Developing a team spirit
    - 1.8. Resolving differences/conflicts/confusions among participants
    - 1.9. Maintaining proper relationships with client, consultants and the contractor
    - 1.10. Receiving constructive input from all participants in the project
    - 1.11. Establishing and maintaining an effective organisational structure and communication channels
    - 1.12. Interfacing with other Departments/Managers in your organisation outside the project team

2. **Facilitating**
    - 2.1. Identifying/gathering information on requirements of all parties and consolidate for use in planning
    - 2.2. Providing an organised means for gathering information and compiling
    - 2.3. Managing contractual issues
    - 2.4. Interpreting all contractual commitments and documents
    - 2.5. Interfacing/integrating the work on different subsystems
    - 2.6. Agreeing on detail methods of construction
    - 2.7. Improving/altering/eliminating activities and considering better alternatives that may efficiently meet the project objectives
    - 2.8. Analysing the project performance on time, cost and quality, detecting variances from the schedule/requirements and dealing with their effects considering time and resource constraints
    - 2.9. Estimating resource requirements
    - 2.10. Co-ordinating and rescheduling the sequence of onsite work
    - 2.11. Co-ordinating offsite fabrications and their delivery with the onsite work
    - 2.12. Co-ordinating the purchases, delivery and storage of material
    - 2.13. Optimising resource allocation and utilisation
    - 2.14. Supporting own men and subcontractors with tools, equipment and resources
    - 2.15. Explaining and supporting the work of subcontractors
    - 2.16. Identifying or gathering information on defects, deficiencies, ambiguities and conflicts in drawings and specifications and having them resolved
    - 2.17. Obtaining further drawings, specifications and technical details on time for execution
    - 2.18. Identifying and gathering information on builders work requirements (grouting-in, openings, making good, etc.) of all relevant parties and co-ordinate the time and manner of their execution
    - 2.19. Providing general attendance (storage space, testing facilities, scaffolding, plant, power, water, illumination, etc.) to other parties
    - 2.20. Co-ordinate handover of work areas (service areas, plant rooms, service routs, etc.) to other parties
    - 2.21. Care of works of others by making staff and workmen aware, where relevant providing covers, where possible changing the sequence of work, etc.
    - 2.22. In case of defect or damage, proposing remedial work method and programme for executing
    - 2.23. Arranging for compliance with site instructions/directives from the Engineer and revising programmes/ordering material accordingly
    - 2.24. Arranging for timely carrying out of all tests or inspections and approval by Engineer
    - 2.25. Submitting material for approval by the Engineer
    - 2.26. Applying good technical practices
    - 2.27. Applying good administrative procedures
    - 2.28. Facilitating payments to own employees and subcontractors

Continued …………

3. <u>Controlling</u>

3.1. Managing the quality of all work carried out
3.2. Ensuring the timeliness of all work carried out
3.3. Ensuring effective utilisation of manpower, plant and material
3.4. Managing the health, safety and welfare of employees
3.5. Managing the maintenance and safety of plant and machinery
3.6. Ensuring proper and safe delivery, storage and handling of material
3.7. Monitor the budget on all activities and take corrective action
3.8. Controlling project finances
3.9. Monitoring the overall functioning of each section and department of the project
3.10. Ensuring discipline among all employees

4. <u>Communicating</u>

4.1. Liaison with the Client and the Consultants
4.2. Liaison with specialist Consultants, specialist subcontractors, nominated subcontractors, etc.
4.3. Contact with outside authorities
4.4. Communicating project progress, financial/commercial status, plans, schedules, changes, documents, etc., to all relevant participants
4.5. Conducting regular meetings and project reviews
4.6. Communicate instances of poor quality, dangerous or adverse incidents/situations to relevant personnel

5. <u>Recording</u>

5.1. Maintaining records of all drawings, information, directives, verbal instructions and documents received from the Consultants and the Client
5.2. Maintaining records of work done outside the contract, variations, dayworks and all facts/data necessary to support claims
5.3. Maintaining records of quantities of work done and details required for as-built drawings; especially of the work that is to get covered up
5.4. Maintaining records of price escalations where the contract provides extra payments
5.5. Maintaining records of principal deliveries to the site and general particulars of shortages
5.6. Maintaining records of labour and plant deployment, working conditions (such as adverse weather), plant breakdowns, accidents, etc.
5.7. Maintaining records of all tests and inspections
5.8. Publishing daily construction reports in the format required by the Engineer

Using this list of issues as a basis, a questionnaire was prepared to solicit industry practitioners' opinion on construction co-ordination as described in the sections on research objectives and methodology above.

6.5 Questionnaire Survey on Relative Importance of Construction Co-ordination Issues

A questionnaire (given in Appendix E) was then developed to present the array to construction project managers and co-ordinators to enable them to identify activities of "High", "Mid" or "Low" importance and "N/A" those considered not applicable. Sufficient space was also provided enabling respondents to add any activities not listed. The questionnaire also solicited whether the time consumed by each activity in the array was "High", "Mid" or "Low".

Table 6.2: How the Questionnaire was Distributed and the Number of Responses Received

Description of the Recipients	Number of Questionnaires Sent	Number of Responses Received
All the contractors in the NW2 tender list (unlimited contract sum) and in the NW1 tender list (contract sum up to 300 Million Hong Kong Dollars) of the Hong Kong Housing Authority.	51	12
All contractors in the Hong Kong Government Works Branch tender list Group C (any contract sum exceeding 50 Million Hong Kong Dollars) in the Category for Buildings.	73	4
All contractors in the G8 (unlimited contract sum) and G7 (contract sum up to 50 Million Singapore Dollars) tender lists of Construction Industry Development Board, Singapore.	120	17
T O T A L	244	33

The questionnaire was distributed among all the higher-ranking building contractors in Hong Kong and Singapore as shown in Table 6.2. A total of 33 responses were received out of the 244 distributed. The results obtained are summarised below.

The questionnaire also attempted to find out whether the respondents can grossly estimate the percentage of their time that the more time consuming activities may take. However, this attempt failed as only one respondent supplied this information.

6.6 Results of the Questionnaire Survey

Tables 6.3 and 6.4 present the results of the questionnaire survey. The percentages given therein are, the percentages of "High", "Mid" and "Low" responses received by each co-ordination activity out of the total number of responses received by the particular co-ordination activity. Considering, for example, a column with the heading "High":

$$\text{Percentage in "High" column} = \frac{\text{No. of respondents who ranked the activity "High"}}{\text{No. of "High"+"Mid"+"Low" responses on that activity}} \times 100\%$$

(Reasons why the total number of responses vary for some activities is discussed below).

In Table 6.3, the construction co-ordination activities are sorted in the respondents' descending order of the importance attached. Table 6.4 is sorted in the respondents' descending order of the amount of time consumed.

Although the respondents were given an option to state whether any of the activities listed were not applicable to achieving construction co-ordination, only three respondents from Hong Kong and one respondent from Singapore stated that some of them were in fact not applicable. Those activities were:

- Maintaining records of price escalations where the contract provides extra payments 9% (3 responses)

- Publishing daily construction reports in the format required by the Engineer 6% (2 responses)

- Controlling project finances 3% (1 response)

- Facilitating payments to own employees and subcontractors
  3% (1 response)

- Managing the health, safety and welfare of employees
  3% (1 response)

- Agreeing on detailed methods of construction 3% (1 response)

- Managing the maintenance and safety of plant and machinery
  3% (1 response)

- Explaining and supporting the work of subcontractors
  3% (1 response)

- Interfacing with other Departments/Managers in your organisation outside the project team 3% (1 response)

The other respondents did not consider any of the activities given in the array as not applicable to achieving construction co-ordination. It may be that the Author had quite successfully selected the activities or as Chitkara (1998) states, co-ordination is a function so common to all other management functions that the respondents found it difficult to consider any to be not applicable. Nevertheless, some respondents refrained from responding on certain activities in the list. It could have been that they found it difficult to decide on those activities or that our description of the activity was not too clear.

Due to the latter reason, the number of responses for some items in the questionnaire is less than the total number responded. Also, some respondents did not respond to the section on the time consumed. However, in Tables 2and 3 the total number that responded to each question on each co-ordination activity is indicated and that was used as the denominator when calculating the percentages.

Few respondents had suggestions for extra activities. In fact the questionnaire was administered in three rounds. First, to a known few in Singapore, then to all NW2 contractors in Hong Kong and finally to the others in Hong Kong and Singapore. Fortunately, these additions were suggested by the respondents of the earlier two rounds and hence could be tested in the subsequent rounds. Therefore, these activities were available for ranking to a lesser number of respondents. The suggested additions were:

- Preparing co-ordination drawings
- Establishing a Project Quality Plan (PQP)
- Managing nominated subcontractors or utilities undertakers
- Maintaining contract documents and amendments to contract at construction office

The net result of this survey is that the respondents identified the following as the six most important co-ordination activities:

- Identifying strategic activities and potential delays

- Ensuring the timeliness of all work carried out
- Maintaining records of all drawings, information, directives, verbal instructions and documents received from the Consultants and the Client
- Maintaining proper relationships with client, consultants and the contractor
- Managing the quality of all work carried out
- Liaison with the Client and the Consultants

The following six appear to consume most of the Construction Project Co-ordinators' time:

- Conducting regular meetings and project reviews
- Analysing the project performance, detecting variances and dealing with their effects
- Identifying/gathering information on requirements of all parties and consolidate for use in planning
- Interpreting all contractual commitments and documents
- Resolving differences/conflicts/confusions among participants
- Liaison with the Client and the Consultants

Table 6.3 : Construction Co-ordination Activities Sorted in the Respondents' Descending Order of the Importance Attached

No.	Construction Co-ordination Activity	Importance					Time Consumed			
		High	Mid	Low	N/A	No. Resp	High	Mid	Low	No. Resp
1.	Identifying strategic activities and potential delays 91%		9%	0%	0%	33	28%	59%	14%	29
2.	Ensuring the timeliness of all work carried out	84%	16%	0%	0%	32	10%	69%	21%	29
3.	Maintaining re cords of all drawings , infor mation, directives, verbal instructions and documents received from the Consultants and the Client	79% 21%		0%	0%	33	24%	62%	14%	29
4.	Maintaining proper relationships with client, consultants and the contractor	79%	15%	6%	0%	33	24%	62%	14%	29
5.	Managing the quality of all work carried out	78%	16%	6%	0%	32	21%	66%	14%	29
6.	Liaison with the Client and the Consultants	76%	18%	6%	0%	33	41%	45%	14%	29
7.	Managing contractual issues	70%	27%	3%	0%	33	21%	76%	3%	29
8.	Maintaining records of work done outsi de the contract, variations, dayworks and all facts/data necessary to support claims	70% 27%		3%	0%	33	31%	59%	10%	29
9.	Controlling project finances	69%	25%	3%	3%	32	28%	38%	34%	29
10.	Establishing an d m aintaining an effec tive organisation al str ucture an d communication channels	67% 24%		9%	0%	33	31%	34%	34%	29
11.	Identifying or gathering information on defects, deficiencies, ambiguities and conflicts in drawings and specifications and having them resolved	67% 24%		9%	0%	33	34%	48%	17%	29
12.	Liaison with s pecialist Consultants, specialist subcont ractors, nominate d subcontractors, etc.	64% 33%		3%	0%	33	24%	66%	10%	29
13.	Maintaining contract documents and amendments to contract at construction office	64% 32%		5%	0%	22	10%	40%	50%	20
14.	Interpreting all contractual commitments and documents 64%		27%	9%	0%	33	45%	45%	10%	29
15.	Monitor the budget on all activities and take corrective action	64%	27%	9%	0%	33	14%	64%	21%	28
16.	Conducting regular meetings and project reviews 64%		27%	9%	0%	33	48%	48%	3%	29

Table 6.3 continued …………

No.	Construction Co-ordination Activity	Importance					Time Consumed			
		High	Mid	Low	N/A	No. Resp	High	Mid	Low	No. Resp
17.	Analysing the project perform ance on time, cost and qu ality, detecting variances from the schedule/r equirements an d dealing wi th their ef fects considering time and resource constraints	63% 31%		6%	0%	32	48%	34%	17%	29
18.	Submitting material for approval by the Engineer	61%	27%	12%	0%	33	18%	54%	29%	28
19.	Co-ordinate han dover of work areas (service areas, p lant roo ms, service routs, etc.) to other parties	58% 33%		9%	0%	33	10%	62%	28%	29
20.	Obtaining fur ther drawings, specificati ons and t echnical d etails o n tim e fo r execution	55% 42%		3%	0%	33	14%	59%	28%	29
21.	Facilitating payments to own employees and subcontractors	53%	38%	6%	3%	32	11%	36%	54%	28
22.	Ensuring effective utilisation of manpower, plant and material	52%	45%	3%	0%	33	17%	45%	38%	29
23.	Developing a team spirit	52%	42%	6%	0%	33	17%	38%	45%	29
24.	Communicate instances of poor qua lity, dangerous or adverse incidents/situations to relevant personnel	52% 42%		6%	0%	33	7%	55%	38%	29
25.	Arranging for timely carrying out of al l tests or inspections and approval b y Engineer	52% 39%		9%	0%	33	10%	45%	45%	29
26.	Managing the health, safety and welfare of employees 52%		36%	9%	3%	33	17%	45%	38%	29
27.	Identifying technical and workforce requirements	50%	44%	6%	0%	32	15%	48%	37%	27
28.	Communicating project prog ress, fi nancial/commercial status, plans, schedules, changes, documents, etc., to all relevant participants	48% 42%		9%	0%	33	31%	52%	17%	29
29.	Interfacing/integrating the work on different subsystems 47%		31%	22%	0%	32	29%	39%	32%	28
30.	Co-ordinating and rescheduling the sequence of onsite work	45%	48%	6%	0%	33	28%	52%	21%	29
31.	Maintaining records of quantities of wo rk done and details requ ired for as-built drawings; especially of the work that is to get covered up	45% 48%		6%	0%	33	28%	52%	21%	29
32.	Identifying/gathering information on requirements of all parties an d consolidate for use in planning	45% 42%		12%	0%	33	48%	28%	24%	29
33.	Managing nominated subcontractor or utility undertaker	44%	56%	0%	0%	9	22%	78%	0%	9

Table 6.3 continued …………

No.	Construction Co-ordination Activity	Importance					Time Consumed			
		High	Mid	Low	N/A	No. Resp	High	Mid	Low	No. Resp
34.	Care of works of others by making staff and workmen aware, where relevant providing covers, where possible changing the sequence of work, etc.	44%	41%	16%	0%	32	7%	41%	52%	27
35.	Maintaining records of price escalations where the contract provides extra payments	44%	38%	9%	9%	32	12%	52%	36%	25
36.	Resolving differences/conflicts/confusions among participants	42%	55%	3%	0%	33	45%	28%	28%	29
37.	Following up the delegated work	42%	52%	6%	0%	33	31%	38%	31%	29
38.	Receiving constructive input from all participants in the project	42%	52%	6%	0%	33	21%	52%	28%	29
39.	Agreeing on detail methods of construction	42%	45%	9%	3%	33	11%	71%	18%	28
40.	Managing the maintenance and safety of plant and machinery	42%	45%	9%	3%	33	7%	45%	48%	29
41.	Translating documents into task assignments	41%	41%	19%	0%	32	32%	43%	25%	28
42.	Motivating	39%	55%	6%	0%	33	10%	38%	52%	29
43.	Ensuring proper and safe delivery, storage and handling of material	39%	52%	9%	0%	33	7%	45%	48%	29
44.	Improving/altering/eliminating activities and considering better alternatives that may efficiently meet the project objectives	39%	48%	12%	0%	33	21%	54%	25%	28
45.	Co-ordinating offsite fabrications and their delivery with the onsite work	39%	48%	12%	0%	33	7%	55%	38%	29
46.	Maintaining records of all tests and inspections	39%	48%	12%	0%	33	3%	41%	55%	29
47.	Co-ordinating the purchases, delivery and storage of material	39%	45%	15%	0%	33	7%	55%	38%	29
48.	Delegating the work	39%	36%	24%	0%	33	7%	29%	64%	28
49.	Arranging for compliance with site instructions/directives from the Engineer and revising programmes/ordering material accordingly	36%	55%	9%	0%	33	10%	62%	28%	29
50.	Applying good technical practices 36%		52%	12%	0%	33	11%	36%	54%	28
51.	Applying good administrative procedures	34%	47%	19%	0%	32	15%	41%	44%	27
52.	Monitoring the overall functioning of each section and department of the project	33%	55%	12%	0%	33	17%	52%	31%	29

Table 6.3 continued …………

No.	Construction Co-ordination Activity	Importance					Time Consumed			
		High	Mid	Low	N/A	No. Resp	High	Mid	Low	No. Resp
53.	Preparing co-ordination drawings	33%	43%	24%	0%	21	16%	58%	26%	19
54.	Estimating resource requirements	30%	58%	12%	0%	33	7%	52%	41%	29
55.	In case of d efect or d amage, proposing remedial work method and programme for executing	30% 48%		21%	0%	33	10%	48%	41%	29
56.	Optimising resource allocation and utilisation 27%		58%	15%	0%	33	7%	48%	45%	29
57.	Identifying and gathering inf ormation on builders work requirements (grouting-in, op enings, making good, etc.) o f all relevan t parties an d co-ordinate the time and manner of their execution	21% 64%		15%	0%	33	7%	69%	24%	29
58.	Ensuring discipline among all employees	21%	61%	18%	0%	33	10%	34%	55%	29
59.	Establishing Project Quality Plan (PQP) 20%		70%	10%	0%	10	10%	50%	40%	10
60.	Contact with outside authorities 18%		73%	9%	0%	33	10%	41%	48%	29
61.	Explaining and supporting the work of subcontractors	18%	64%	15%	3%	33	7%	52%	41%	29
62.	Providing an organised means for gathering information and compiling	18%	55%	27%	0%	33	10%	38%	52%	29
63.	Maintaining records of principal deliveries to the site and general particulars of shortages	15% 73%		12%	0%	33	0%	45%	55%	29
64.	Providing general attendance (storage sp ace, t esting fac ilities, scaffolding, plant, power, water, illumination, etc.) to other parties	15% 61%		24%	0%	33	7%	41%	52%	29
65.	Maintaining records of labour and plant d eployment, working conditions (such as adverse weather), plant breakdowns, accidents, etc.	12% 67%		21%	0%	33	0%	41%	59%	29
66.	Supporting own men and subcontractors with tools, equipment and resources	12%	52%	36%	0%	33	0%	28%	72%	29
67.	Publishing daily construction reports in the format required by the Engineer	9%	61%	24%	6%	33	7%	44%	48%	27
68.	Interfacing with other Departm ents/Managers in your organisation outside the project team	6% 59%		31%	3%	32	7%	29%	64%	28

Table 6.4 : Construction Co-ordination Activities Sorted in the Respondents' Descending Order of the Amount of Time Consumed

No.	Construction Co-ordination Activity	Importance					Time Consumed			
		High	Mid	Low	N/A	No. Resp	High	Mid	Low	No. Resp
1.	Conducting regular meetings and project reviews 64%		27%	9%	0%	33	48%	48%	3%	29
2.	Analysing the project performance on time, cost and quality, detecting variances from the schedule/requirements and dealing with their effects considering time and resource constraints	63% 31%		6%	0%	32	48%	34%	17%	29
3.	Identifying/gathering information on requirements of all parties and consolidate for use in planning	45% 42%		12%	0%	33	48%	28%	24%	29
4.	Interpreting all contractual commitments and documents 64%		27%	9%	0%	33	45%	45%	10%	29
5.	Resolving differences/conflicts/confusions among participants	42%	55%	3%	0%	33	45%	28%	28%	29
6.	Liaison with the Client and the Consultants	76%	18%	6%	0%	33	41%	45%	14%	29
7.	Identifying or gathering information on defects, deficiencies, ambiguities and conflicts in drawings and specifications and having them resolved	67% 24%		9%	0%	33	34%	48%	17%	29
8.	Translating documents into task assignments	41%	41%	19%	0%	32	32%	43%	25%	28
9.	Maintaining records of work done outside the contract, variations, dayworks and all facts/data necessary to support claims	70% 27%		3%	0%	33	31%	59%	10%	29
10.	Communicating project progress, financial/commercial status, plans, schedules, changes, documents, etc., to all relevant participants	48% 42%		9%	0%	33	31%	52%	17%	29
11.	Following up the delegated work	42%	52%	6%	0%	33	31%	38%	31%	29
12.	Establishing and maintaining an effective organisational structure and communication channels	67% 24%		9%	0%	33	31%	34%	34%	29
13.	Interfacing/integrating the work on different subsystems 47%		31%	22%	0%	32	29%	39%	32%	28
14.	Identifying strategic activities and potential delays 91%		9%	0%	0%	33	28%	59%	14%	29
15.	Co-ordinating and rescheduling the sequence of onsite work	45%	48%	6%	0%	33	28%	52%	21%	29
16.	Maintaining records of quantities of work done and details required for as-built drawings; especially of the work that is to get covered up	45% 48%		6%	0%	33	28%	52%	21%	29

Table 6.4 continued …………

No.	Construction Co-ordination Activity	Importance					Time Consumed			
		High	Mid	Low	N/A	No. Resp	High	Mid	Low	No. Resp
17.	Controlling project finances	69%	25%	3%	3%	32	28%	38%	34%	29
18.	Liaison with s pecialist Consultants, specialist subcont ractors, nominate d subcontractors, etc.	64%	33%	3%	0%	33	24%	66%	10%	29
19.	Maintaining re cords of all drawings , infor mation, directives, verbal instructions and documents received from the Consultants and the Client	79%	21%	0%	0%	33	24%	62%	14%	29
20.	Maintaining proper relationships with client, consultants and the contractor	79%	15%	6%	0%	33	24%	62%	14%	29
21.	Managing nominated subcontractor or utility undertaker	44%	56%	0%	0%	9	22%	78%	0%	9
22.	Managing contractual issues	70%	27%	3%	0%	33	21%	76%	3%	29
23.	Managing the quality of all work carried out	78%	16%	6%	0%	32	21%	66%	14%	29
24.	Improving/altering/eliminating activities and co nsidering be tter alt ernatives that may efficiently meet the project objectives	39%	48%	12%	0%	33	21%	54%	25%	28
25.	Receiving constructive input from all participants in the project	42%	52%	6%	0%	33	21%	52%	28%	29
26.	Submitting material for approval by the Engineer	61%	27%	12%	0%	33	18%	54%	29%	28
27.	Monitoring the overall function ing of each s ection and depar tment of the project	33%	55%	12%	0%	33	17%	52%	31%	29
28.	Ensuring effective utilisation of manpower, plant and material	52%	45%	3%	0%	33	17%	45%	38%	29
29.	Managing the health, safety and welfare of employees 52%		36%	9%	3%	33	17%	45%	38%	29
30.	Developing a team spirit	52%	42%	6%	0%	33	17%	38%	45%	29
31.	Preparing co-ordination drawings	33%	43%	24%	0%	21	16%	58%	26%	19
32.	Identifying technical and workforce requirements	50%	44%	6%	0%	32	15%	48%	37%	27
33.	Applying good administrative procedures	34%	47%	19%	0%	32	15%	41%	44%	27
34.	Monitor the budget on all activities and take corrective action	64%	27%	9%	0%	33	14%	64%	21%	28
35.	Obtaining fur ther drawings, specificati ons and t echnical d etails o n tim e fo r execution	55%	42%	3%	0%	33	14%	59%	28%	29

Table 6.4 continued …………

No.	Construction Co-ordination Activity	Importance					Time Consumed			
		High	Mid	Low	N/A	No. Resp	High	Mid	Low	No. Resp
36.	Maintaining r ecords of price es calations wher e the con tract pro vides extr a payments	44%	38%	9%	9%	32	12%	52%	36%	25
37.	Agreeing on detail methods of construction	42%	45%	9%	3%	33	11%	71%	18%	28
38.	Facilitating payments to own employees and subcontractors	53%	38%	6%	3%	32	11%	36%	54%	28
39.	Applying good technical practices 36%		52%	12%	0%	33	11%	36%	54%	28
40.	Ensuring the timeliness of all work carried out	84%	16%	0%	0%	32	10%	69%	21%	29
41.	Co-ordinate han dover of work areas (service areas, p lant roo ms, service routs, etc.) to other parties	58%	33%	9%	0%	33	10%	62%	28%	29
42.	Arranging for com pliance with site instructions/directives from the Enginee r and revising programmes/ordering material accordingly	36%	55%	9%	0%	33	10%	62%	28%	29
43.	Establishing Project Quality Plan (PQP) 20%		70%	10%	0%	10	10%	50%	40%	10
44.	In case of d efect or d amage, proposing remedial work method and programme for executing	30%	48%	21%	0%	33	10%	48%	41%	29
45.	Arranging for timely carrying out of al l tests or inspections and approval b y Engineer	52%	39%	9%	0%	33	10%	45%	45%	29
46.	Contact with outside authorities 18%		73%	9%	0%	33	10%	41%	48%	29
47.	Maintaining contract documents and amendments to contract at construction office	64%	32%	5%	0%	22	10%	40%	50%	20
48.	Motivating	39%	55%	6%	0%	33	10%	38%	52%	29
49.	Providing an organised means for gathering information and compiling	18%	55%	27%	0%	33	10%	38%	52%	29
50.	Ensuring discipline among all employees	21%	61%	18%	0%	33	10%	34%	55%	29
51.	Identifying and gathering inf ormation on builders work requirements (grouting-in, op enings, making good, etc.) o f all relevan t parties an d co-ordinate the time and manner of their execution	21%	64%	15%	0%	33	7%	69%	24%	29
52.	Communicate instances of poor qua lity, dangerous or adverse incidents/situations to relevant personnel	52%	42%	6%	0%	33	7%	55%	38%	29

Table 6.4 continued …………

No.	Construction Co-ordination Activity	Importance					Time Consumed			
		High	Mid	Low	N/A	No. Resp	High	Mid	Low	No. Resp
53.	Co-ordinating offsite fabrications and their delivery with the onsite work	39%	48%	12%	0%	33	7%	55%	38%	29
54.	Co-ordinating the purchases, delivery and storage of material	39%	45%	15%	0%	33	7%	55%	38%	29
55.	Estimating resource requirements	30%	58%	12%	0%	33	7%	52%	41%	29
56.	Explaining and supporting the work of subcontractors	18%	64%	15%	3%	33	7%	52%	41%	29
57.	Optimising resource allocation and utilisation 27%		58%	15%	0%	33	7%	48%	45%	29
58.	Managing the maintenance and safety of plant and machinery	42%	45%	9%	3%	33	7%	45%	48%	29
59.	Ensuring proper and safe delivery, storage and handling of material	39%	52%	9%	0%	33	7%	45%	48%	29
60.	Publishing daily construction reports in the format required by the Engineer	9%	61%	24%	6%	33	7%	44%	48%	27
61.	Care of works of others by making staff and workmen aware, where relevant providing covers, where possible changing the sequence of work, etc.	44% 41%		16%	0%	32	7%	41%	52%	27
62.	Providing gener al attend ance (storage sp ace, t esting fac ilities, scaffolding, plant, power, water, illumination, etc.) to other parties	15% 61%		24%	0%	33	7%	41%	52%	29
63.	Delegating the work	39%	36%	24%	0%	33	7%	29%	64%	28
64.	Interfacing with other Departm ents/Managers in your organisation outside the project team	6% 59%		31%	3%	32	7%	29%	64%	28
65.	Maintaining records of all tests and inspections	39%	48%	12%	0%	33	3%	41%	55%	29
66.	Maintaining records of princip al deliveries to the site and general particulars of shortages	15% 73%		12%	0%	33	0%	45%	55%	29
67.	Maintaining records of labour and plant d eployment, working conditions (such as adverse weather), plant breakdowns, accidents, etc.	12% 67%		21%	0%	33	0%	41%	59%	29
68.	Supporting own men and subcontractors with tools, equipment and resources	12%	52%	36%	0%	33	0%	28%	72%	29

6.7 Comments on the Quantitative Results

Although this is quantitative research conducted in the absence of any similar previous research, the following discussion will serve to further substantiate the results given above.

The results show that the respondents considered "Identifying strategic activities and potential delays" as the most important activity to achieve construction co-ordination. This finding validates statements such as by Fayol (1949) that "The best liaison officer would be the General Manager visiting all departmental heads in turn". Therein Fayol suggests that visiting all departments and identifying problems is so important that the General Manager himself should perform it. A Senior Project Manager of a building contractor when interviewed (in a subsequent experiment) by the Author shared a similar view as follows where he felt that this activity is something that he himself has to perform thus contributing his experience and knowledge to the benefit of the project:

> Site walk and eye contact are very important. I observe all problems that need co-ordination by walking the site, observing and meeting people. I do it myself. Not that I distrust my subordinates but I am the Project Manager because I am the most experienced person here. If I do not identify the potential problems and co-ordinate, the project will not benefit from my experience and knowledge! My subordinates too contribute.

Another Senior Project Manager stated that it is important to identify which activities are "going to have greater impact than the other activities". Then a Project Manager can spend his scarce time managing such important activities:

> Ideally, the Project Manager must be involved in every co-ordination so that he knows from top to bottom. But practically it is not possible specially when you come to a big project where there are so many meetings and so many things to take care of. It is impossible for you to get involved in every co-ordination meeting. … It is important to identify which are the critical activities for co-ordination. Then you pay more

> attention to them as the Project Manager. Because, you know that this activity is going to have greater impact than the other activities. So, again strike a balance. Specially those activities that are likely to cause delay. Sometimes when it comes to the actual project, it is quite difficult – it is easier said than done, when you are in an actual project you will realise.

A Managing Director of a construction company considered that identifying strategic activities plays an important role in the efforts to improve the industry:

> Special areas to speedup the work just by way of planning – I do not think there is any more leeway around. Planning has been around for 300 years – you would have done the same as I would have done. So, you need to be different to change the duration of construction. Only way to change the industry is none other than the process "Identifying strategic activities".

Therein he states that there is not much leeway to speedup the work just by way of planning. Only way to change the industry is none other than the process "Identifying strategic activities"!

Further, Forsberg *et al.* (1996) described the Project Co-ordinator's role as one of augmenting the Project Managers visibility for larger projects. A finding of the Tavistock studies was that "forms of control [in construction sites] are drawn from direct observation of the building team at work and from talks with them about what they were doing" (Crichton 1966). The present experiment has vindicated this.

The result that "Conducting regular meetings and project reviews" is a very time consuming co-ordination activity was also confirmed by a few follow-up interviews held by the Author. The Construction Project Managers who were interviewed stated that they rely a lot on the weekly and monthly co-ordination meetings to achieve co-ordination. Though they claimed that such meetings consumed a lot of their time, it appears to play a vital role in co-ordinating the project participants.

Ensuring the timeliness of all work carried out was also considered very important by the respondents. The Author feels that this is a key aspect of co-ordination. It was to be expected that respondents would consider it important. Nevertheless, respondents considered identifying strategic activities and potential delays even more important.

Chitkara (1998) points out that co-ordination is essential both within and among the various departments to fill up the voids created by changing situations in the systems, procedures and policies. In this context, the results of this survey indicating that "Maintaining records of all drawings, information, directives, verbal instructions and documents received from the Consultants and the Client" is important and "Analysing the project performance, detecting variances and dealing with their effects" is time consuming could be vindicated.

From another point of view highlighted by previous research carried out by both Tavistock Institute and Shamma-Toma *et al.* (1998), there is significance in the following two results of this survey where the activities:

- Maintaining records of all drawings, information, directives, verbal instructions and documents received from the Consultants and the Client
- Interpreting all contractual commitments and documents

were ranked as both important and time consuming. It is common experience that usually there are many such directives and communications by the Consultants and the Client and that most contractual arrangements and documents are complex. Therefore, the above two activities may be both important and time consuming to contractors working in a context where, as Shamma-Toma *et al.* (1998) state, “contractual procedures have constricted communication among the project participants and present climate does not encourage contractors to co-operate but, on the contrary, to exploit design errors through claims and extra work to the detriment of quality and cost of the project”. Further, Higgin and Jessop (1965) see that construction project participants can have a vested interest in faulty communications in order to claim extra as a consequence. For example, Crichton (1966) states that builders having agreed [at the tender stage] on unrealistically short schedules for completion rely on some delay for which they can disclaim responsibility and claim an extension of time.

Nevertheless, “Identifying/gathering information on requirements of all parties and consolidate for use in planning” was also reported to be consuming a lot of time. This in fact is an activity by which the Project Managers focus on the needs of all stakeholders of the project. This result indicates that Project Managers do spend much time on it.

It is noteworthy that 12 co-ordination activities that were ranked as high in importance were also ranked as highly time consuming. The relative rankings are graphically depicted in Table 6.5. Similarly, at the lower end of the ranking, the six activities that were ranked as least important were also ranked low in the time they consume. Please see Table 6.6 for a graphical depiction of relative rankings.

Table 6.5: Construction Co-ordination Activities that Ranked High in Both Importance and Time Consumed

No.	Activities that Ranked High in Importance		No.	Activities that Ranked High in Time Consumed
1.	Identifying strategic activities and potential delays		1.	Conducting regular meetings and project reviews
2.	Ensuring the timeliness of all work carried out		2.	Analysing the project performance on time, cost and quality, detecting variances from the schedule/requirements and dealing with their effects considering time and resource constraints
3.	Maintaining records of all drawings, information, directives, verbal instructions and documents received from the Consultants and the Client	3.		Identifying/gathering information on requirements of all parties and consolidate for use in planning
4.	Maintaining proper relationships with client, consultants and the contractor		4.	Interpreting all contractual commitments and documents
5.	Managing the quality of all work carried out		5.	Resolving differences/conflicts/confusions among participants
6.	Liaison with the Client and the Consultants		6.	Liaison with the Client and the Consultants
7.	Managing contractual issues		7.	Identifying or gathering information on defects, deficiencies, ambiguities and conflicts in drawings and specifications and having them resolved
8.	Maintaining records of work done outside the contract, variations, dayworks and all facts/data necessary to support claims	8.		Translating documents into task assignments
9.	Controlling project finances		9.	Maintaining records of work done outside the contract, variations, dayworks and all facts/data necessary to support claims
10.	Establishing and maintaining an effective organisational structure and communication channels	10.		Communicating project progress, financial/commercial status, plans, schedules, changes, documents, etc., to all relevant participants
11.	Identifying or gathering information on defects, deficiencies, ambiguities and conflicts in drawings and specifications and having them resolved	11.		Following up the delegated work
12.	Liaison with specialist Consultants, specialist subcontractors, nominated subcontractors, etc.	12.		Establishing and maintaining an effective organisational structure and communication channels
13.	Maintaining contract documents and amendments to contract at construction office	13.		Interfacing/integrating the work on different subsystems
14.	Interpreting all contractual commitments and documents		14.	Identifying strategic activities and potential delays
15.	Monitor the budget on all activities and take corrective action		15.	Co-ordinating and rescheduling the sequence of onsite work
16.	Conducting regular meetings and project reviews		16.	Maintaining records of quantities of work done and details required for as-built drawings; especially of the work that is to get covered up
17.	Analysing the project performance on time, cost and quality, detecting variances from the schedule/requirements and dealing with their effects considering time and resource constraints	17.		Controlling project finances
18.	Submitting material for approval by the Engineer		18.	Liaison with specialist Consultants, specialist subcontractors, nominated subcontractors, etc.
19.	Co-ordinate handover of work areas (service areas, plant rooms, service routs, etc.) to other parties	19.		Maintaining records of all drawings, information, directives, verbal instructions and documents received from the Consultants and the Client
20.	Obtaining further drawings, specifications and technical details on time for execution	20.		Maintaining proper relationships with client, consultants and the contractor

Table 6.6: Construction Co-ordination Activities that Ranked Low in Both Importance and Time Consumed

No.	Activities that Ranked Low in Importance		No.	Activities that Ranked Low in Time Consumed
60.	Contact with outside authorities		60.	Publishing daily construction reports in the format required by the Engineer
61.	Explaining and supporting the work of subcontractors		61.	Care of works of others by making staff and workmen aware, where relevant providing covers, where possible changing the sequence of work, etc.
62.	Providing an organised means for gathering information and compiling		62.	Providing general attendance (storage space, testing facilities, scaffolding, plant, power, water, illumination, etc.) to other parties
63.	Maintaining records of principal deliveries to the site and general particulars of shortages	63.		Delegating the work
64.	Providing general attendance (storage space, testing facilities, scaffolding, plant, power, water, illumination, etc.) to other parties	64.		Interfacing with other Departments/Managers in your organisation outside the project team
65.	Maintaining records of labour and plant deployment, working conditions (such as adverse weather), plant breakdowns, accidents, etc.	65.		Maintaining records of all tests and inspections
66.	Supporting own men and subcontractors with tools, equipment and resources		66.	Maintaining records of principal deliveries to the site and general particulars of shortages
67.	Publishing daily construction reports in the format required by the Engineer		67.	Maintaining records of labour and plant deployment, working conditions (such as adverse weather), plant breakdowns, accidents, etc.
68.	Interfacing with other Departments/Managers in your organisation outside the project team	68.		Supporting own men and subcontractors with tools, equipment and resources

Results of this survey depict the opinion of personnel from building contractors in Hong Kong and Singapore. Nevertheless for comparison, opinion was solicited from a limited number of construction industry practitioners engaged in civil engineering construction and services. Also, 3 responses were received from building contractors in UK. Due to limitations in space, the tabulated results from these respondents are not included here. The Author observes that, considering the limitations of a quantitative survey, there is no major variation in the opinion between building industry practitioners and other respondents. Hence, one could safely assume that these results are valid for the entire construction industry.

Chapter 7

TESTING THE SUITABILITY OF THE ATTRIBUTES BASED QUALITY MEASUREMENT MODEL

7.1 The Method for Testing Hypothesis H1

This chapter describes Experiment 3 conducted to test Hypothesis H1:

H1: Attributes based quality measurement tools are not applicable to the construction co-ordination processes.

In view of the measurement theory presented in Chapter 2 and the arguments presented in Chapters 3, 4 and 5, attributes based quality measurement tools can be considered applicable to construction co-ordination if they can:

- identify and measure attributes pertaining to processes, outputs and outcomes. "Attributes" are such as performance, reliability, availability, convenience.
- identify the implicit, explicit and latent expectations (defined in Section 2.5) of the customers and evaluate the satisfaction at all such levels
- be applied to customers as well as other stakeholders (owner/shareholders, employees and society) thus measuring quality on all these four dimensions
- generate measurement results that can be utilised to improve the processes

In Chapter 5, a generic multi-attribute quality measurement model was adapted to the construction co-ordination context. Hypothesis H1 was tested by applying this model to those construction co-ordination processes considered important by industry practitioners (given in Section 7.2) and testing its capability of generating information required to make measurements as stated above. (Please see the justification of the methodology in Section 7.1.1). It was necessary to collect the information required for applying the measurement model by in-depth interviews conducted on industry practitioners as described in Section 7.3. The data analysis is presented in Sections 7.4 to 7.10.

7.1.1 Justification of the Research Methodology

As discussed in Chapter 3, multi-attribute quality measurement methods are popularly used in many service industries and business sectors. However, the Author's argument, as presented in Section 5.3, is that there are difficulties in applying this method to construction co-ordination processes because of the process characteristics: Informality, Intangibility, Low Repetition, Problem Solving Work, Co-production by Customers and Unsolicited Service. The way of verifying whether such difficulties are real, is by applying a generic multi-attribute quality measurement model to construction co-ordination processes considered important by industry practitioners and testing its capability of generating information required to make measurements as stated in Section 7.1.

It was argued in Section 5.5 that, Steps A to H of the multi-attribute quality measurement model adopted for this purpose in Chapter 5, are the most basic and essential steps required in applying any multi-attribute quality measurement model to any process. Difficulties in applying these basic and essential Steps A to H to construction co-ordination context signify difficulties in applying any multi-attribute quality measurement model to that context.

Information required from the industry was detailed knowledge required for application of the measurement model to construction co-ordination processes. Considering the general lack of experience in the application of quality measurement techniques in the construction industry (discussed in Chapter 1) and the lack of formal knowledge of construction co-ordination processes (discussed in Chapters 1 and 6), it was decided to conduct in-depth interview surveys as described in Section 7.3. For the reasons explained in Section 1.6.3, this experiment was conducted with industry practitioners who would willingly contribute to the research, instead of attempting to focus on a selected construction site. For the reasons discussed in Section 1.5 and in the following paragraph, it was not attempted to conduct the survey on a statistical sample of the industry. Reasons for primarily targeting project managers and co-ordinators for the surveys is given at the beginning of Section 7.3.

As discussed in Section 7.3, the respondents had to be given lots of flexibility in answering the survey questions and thus the interviews could not be too rigidly structured. The data gathered, therefore, consisted of descriptions of many aspects of applying the measurement model. Therefore, Hypothesis H1 was tested using logic arising from argument based on such descriptive data. Mason (1996) states that, “in qualitative research the logic of probability is rarely used” and such alternative forms of logic based on arguments can be used.

7.2 Focus Obtained from the Survey Described in Chapter 6

In the experiment described in Chapter 6 (Experiment 2), the industry practitioners indicated the important co-ordination activities as presented in Table 6.3. From these, the Author selected the following three as the processes (a "process" is defined in Section 5.1) on which to focus the application of the multi-attribute quality measurement method (reasons for such focusing were given in Section 6.1):

1. Identifying strategic activities and potential delays

2. Ensuring the timeliness of all work carried out

3. Liaison with the Client and Consultants

1 and 2, above, are the highest ranking in Table 6.3. However, the third process, "Liaison with the Client and Consultants", although ranked sixth in Table 6.3, was selected because the activity ranked third was on maintaining records and the activity ranked fourth, "Maintaining proper relationships with client, consultants and the contractor", is very similar to "Liaison with the Client and Consultants". Further, "Liaison with the Client and Consultants" was ranked sixth in terms of the time consumed also thus justifying it being included in this study. Hence, the experiment described in this chapter (Experiment 3) was focused on these three processes.

7.3 Developing the Interview Structure and Conducting the Survey

Very closely following the format of the attributes based quality measurement model presented in Chapter 5, prototype 1 of the interview structure (presented in Appendix F) was developed to solicit from construction project managers the information required to apply the model on the three co-ordination processes selected above. The reason was that, in multi-attribute quality measurement methods, "lists of relevant quality attributes are always established [by the service provider] and respondents [customers] are asked in interviews to evaluate and weight the attributes of a particular service" (Stauss 1993). Therefore, the interview structure was designed to request project managers to first identify the customers and the stakeholders of the processes and then state from his/er perspective the:

- implicit expectations
- explicit expectations and
- latent expectations

of these parties. This was followed by questions such as:

- What originates the process? When is it carried out?
- What are the specific objectives of the process?
- What are the data and other resources required?

- Who are the personnel/parties involved in the process?
- What are their specific contributions to the process?
- Any special analysis/processing required and how will they be done?
- How will the outputs be transmitted/communicated and who are the targeted recipients?
- What are the measures internal to the process that control the performance of the process outputs against the requirements and specifications identified above?
- What are the salient features of the process that give the above outputs?

Such information obtained from the construction project managers was intended to provide a foundation to develop the next set of questionnaires/interview structures for customers and stakeholders of co-ordination processes soliciting what their expectations are.

However, it was apparent that the interview structure in Appendix F is too tedious. Stauss (1993) also points out that questionnaires for multi-attribute quality measurements tend to become tedious. Nevertheless, using this structure an interview was conducted with a construction project manager with about 25 years experience in the Hong Kong construction industry carrying out a wide variety of both building and civil engineering works. More important was the fact that he was personally known to the Author and was ready to exercise patience with an interview structure being tested. For the reasons given in Section 1.6.3, it was decided to collect data from industry practitioners who would willingly contribute to the research rather than applying the method on a selected construction site.

During the interview it was clear that although this particular interviewee struggled for more than two hours trying to provide all the information requested (without much success), no other construction project manager would be able to afford so much time and effort. Not only was the interview too long and tedious, the interviewee found it very difficult to give straightforward answers to most questions. In line with the arguments presented in Chapter 5, he found it very difficult to identify specific customers and other stakeholders of these processes. It may be a further extension of this difficulty that he also experienced great difficulty in stating implicit, explicit and latent expectations of these parties. These difficulties will be discussed in greater detail in the following sections analysing the interview results.

Because of the difficulties encountered in the latter interview, it was decided to make the interview easier for the respondent by allowing more flexibility in the way of expressing the opinion. The interview structure was revised to first help the interviewee recall his/er experience on the context that we wish to discuss and then ask more specific questions as described below.

- First open a general discussion on the three co-ordination processes we have identified. Just to see what they have to say about:

    (a) performing the processes

    (b) personnel they interact with

- Then provoke a discussion on:
  - what they are *formally* supposed to do in these three co-ordination processes; and
  - what they *informally* end up doing

- Discuss around whom in the contractor's organisation the above three co-ordination processes are centred; ask them how the processes are organised – Who does what, when, where and how?

- Persuade them to speak on the customer needs/expectations in general terms
  - needs/expectations of customers
  - needs/expectations of other personnel/parties concerned

- Then get them to speak on customer needs/expectations in depth, in relation to the processes.
  - Talk about outputs and outcomes of the processes
  - Discuss the process outcomes in-depth
  - Show the service quality model (given in Table 5.2) and discuss the outputs in-depth

- Discuss how the present co-ordination processes satisfy these expectations and discuss where and in which directions they should improve.

The prototype 2 of the interview structure designed in this manner is presented in Appendix G. Two more Interviews were conducted with two very experienced project managers from Hong Kong. Still both respondents failed to provide all the information expected. Especially when answering Q3, they stated that they achieve co-ordination on construction sites by having regular co-ordination meetings with all project participants where they proactively bring up issues of possible conflict into the discussion and resolve them. Also they regularly walk around the site to lookout for any imminent problems, critically study the drawings, specifications and any other details to identify possible problems or conflicts and bring together the relevant parties to resolve them. Their vast experience gained from similar construction work in the past is the main instrument used in this process. They pointed out that there is no ready recipe to achieve co-ordination and thus failed to identify any predictable flow of process to achieve site co-ordination. In fact, they stated that there are no specific inputs or outputs involved other than the project manager or his/her representative proactively bringing up relevant issues and soliciting information from relevant parties. The only output considered important was recording on paper (either as meeting minutes or at least as notes) all meetings and discussions and establishing these outcomes by distributing the records to the relevant parties. Hence, they found it very difficult to identify any specific measures for the outputs. Most measures they identified were very general and will be discussed in detail in the next section dealing with the analysis of interview results. They also stated that there are no specific customers for co-ordination processes. The co-ordinator has to work with all parties to a construction project. In this context when answering Q 4, they found it very difficult to identify expectations of the customers. They stated that the project participants may not come to them and ask for some matter to be co-ordinated, but will be very dissatisfied if some matter overlooked by the co-ordinator causes losses. Therefore, since both Q 3 and Q 4 were not answered with much success, the respondents found it also difficult to answer Q 5 and Q 6. Hence both interviews conducted using this version of the structure virtually broke down at this point.

> Then Questions 5, 6 and 7, I must say I got thoroughly lost.

Was the comment by one of the respondents who had spent some time to prepare for the interview in advance.

Therefore it was decided to revise the interview structure again as shown in Appendix H. The main difference made was to add four supplementary questions to solicit information on how co-ordination is achieved in certain contexts. The Q 4, Q 5 and Q 6 of the prototype 2 structure were just left in a separate page at the end of this improved (also the final) version, so that they could be presented to the interviewee only if it was felt that s/he might be able to answer them.

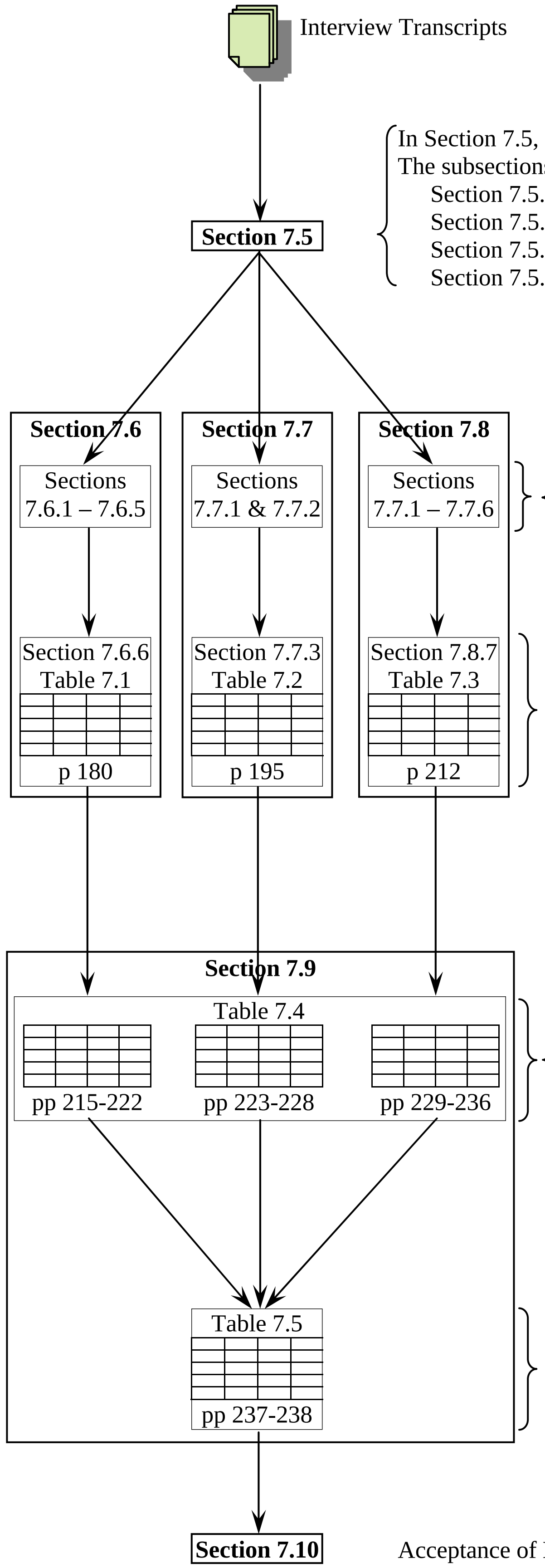
In the survey that followed, the respondents were able to answer the four supplementary questions thus imparting lots of knowledge on how co-ordination is achieved in a construction site. Nevertheless, possibly due to the long interview structure and general difficulties in describing co-ordination processes (discussed in Sections 5.3.1 to 5.3.5), many project managers and senior co-ordinators contacted by the Author were reluctant to give interviews. Five more interviews in Hong Kong (altogether 8) and 9 in Singapore were conducted. In fact two respondents from Singapore were more interested in describing to the Author how they achieve co-ordination rather than going by the interview structure. The results are analysed in Sections 7.4 to 7.10.

7.4 An Overview of the Analysis of Interview Results

Figure 7.1 provides an overview of how the analysis of results is carried out in three phases in the following sections of this chapter.

In the first phase, the analysis of survey results will be directed towards developing an understanding (as presented in Section 7.5) of how the three co-ordination processes concerned are carried out at construction sites. As identified in the previous chapters, there is a lack of formal knowledge on this aspect of construction management. The understanding thus gained became the foundation for the next phase of the analysis.

In the next phase, presented in Sections 7.6 to 7.8, the process characteristics informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work (discussed in Section 5.3 when formulating Hypothesis H1) will be identified in the three co-ordination processes based on the survey responses received. It will be evident from the ensuing discussion that this knowledge is very necessary for the last stage of the analysis (presented in Section 7.9) where applicability of the multi-attribute quality measurement model to these processes is discussed.



In Section 7.5, interview transcripts are analysed to understand "How Co-ordination is Achieved in a Construction Site". The subsections focus on:

Section 7.5.1 How co-ordination is achieved in the initial planning stage
Section 7.5.2 How co-ordination is achieved in the day-to-day co-ordination at a construction site
Section 7.5.3 Presents a discussion of the validity of the results obtained through the analysis of qualitative data
Section 7.5.4 Presents a summary of the discussion presented in Sections 7.5.1 and 7.5.2

In Sections 7.6, 7.7 and 7.8, interview transcripts are further analysed to identify in the three co-ordination processes, the six process characteristics: (1) informality, (2) intangibility, (3) low repetition, (4) co-production by customers, (5) unsolicited service and (6) problem solving work.

Following 5 aspects of the process 'Identifying strategic activities and potential delays' is discussed in Section 7.6

7.6.1 The Initial Planning Stage
7.6.2 Design Co-ordination
7.6.3 Co-ordinating Specialist Subcontractors
7.6.4 The General Approach to Day-To-Day Co-ordination
7.6.5 Co-ordinating Onsite Facilities

Following 2 aspects of the process 'Ensuring the timeliness of all work carried out' is discussed in Section 7.7

7.7.1 The General Approach to Ensuring the Timeliness of Construction Work
7.7.2 Managing the Timeliness of Subcontracted Work

Following 6 aspects of the process 'Liaison with the Client and Consultants' is discussed in Section 7.8

7.8.1 Liaison on Decisions Required for the Progress of Work
7.8.2 Understanding the Exact Needs of the Client
7.8.3 Liaison on Imminent Construction Problems
7.8.4 Protocol for Liaison with the Client
7.8.5 Liaison on Design Problems
7.8.6 Maintaining Good Human Relations

Tables 7.1, 7.2 and 7.3 present an overview of the characteristics informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work identified in the co-ordination processes analysed.

Table 7.4 presents the analysis of the difficulties the above process characteristics will pose to the application of Steps A to H of the attributes based quality measurement model (presented in Section 5.1) to the three co-ordination processes concerned.

- Columns 1 to 4 of Table 7.4 present a summary of the analysis presented in Sections 7.6 to 7.8.
- Column 5 presents an analysis of the process characteristics identified in Column 4, in terms of potential difficulties (discussed in Section 5.3) of applying Steps A to H of the multi-attribute quality measurement model, in the contexts summarised in Column 3.
- Column 6 with its eight sub-columns (A to H) is a graphical illustration of the findings of Column 5 on difficulties in applying Steps A to H.

Because Table 7.4 is lengthy, it is not easy to visualise the results presented in Column 6. Therefore, the information in Columns 1, 2, 4 and 6 are presented again in Table 7.5.

Acceptance of Hypothesis H1, that "Attributes based quality measurement tools are not applicable to the construction co-ordination processes".

Figure 7.1: An Overview of the Analysis of Interview Results

In the final phase, presented in Section 7.9, it is analysed how the above process characteristics will cause difficulties in applying Steps A to H (given in Section 5.1) of the multi-attribute quality measurement model. Based on this argument, Hypothesis H1, that "Attributes based quality measurement tools are not applicable to the construction co-ordination processes" is accepted (please see Section 7.10).

In the following sections of this chapter, numbers with the prefix "Qt" refer to quotations from interview transcripts that are given in full in Appendix I.

7.5 How Co-ordination is Achieved in a Construction Site

It was stated by the respondent project managers and co-ordinators that the three co-ordination processes concerned:

1. Identifying strategic activities and potential delays
2. Ensuring the timeliness of all work carried out
3. Liaison with the Client and Consultants

are carried out through regular co-ordination meetings, making direct observations at the site and proactively bringing up various problems into discussion. In Section 7.5.1 it is analysed how these processes are carried out during the initial planning stage at the beginning of a construction project. Then Section 7.5.2 it is analysed how these processes are applied to achieve day-to-day co-ordination at a construction site.

7.5.1 The Initial Planning Stage

At the beginning of a construction project, at the tendering stage and before mobilising onsite, contractors identify strategic activities and potential delays by studying the job in great detail [Qt 1]. The Project Manager should understand at least 95% of the job [Qt 2], develop a plan based on past experience in the industry, get feedback from senior supervisors and various subcontractors involved and using their comments sum up the overall programme [Qt 3 to 5]. In fact, it is strategic activities that are identified at this early stage and identifying potential delays is an ongoing process throughout the construction phase [Qt 6 & 7]. However, as described in Section 1.5, this research focuses on the construction stage.

7.5.2 The Day-To-Day Co-ordination at a Construction Site

Once such planning is done, the day-to-day co-ordination at a construction site is carried out primarily through regular meetings [Qt 8 to 10] and onsite observations [Qt 11 & 12]. To achieve construction co-ordination they use micro programmes, monitor regularly, and have regular meetings [Qt 11]. While the Project Manager may follow the more critical activities in detail, he must have good supervisors who are "ready to go all over the site everyday and know what is exactly happening" [Qt 11]. It was considered important to have face-to-face meetings where parties involved in the issue are present and their site staff "who know exactly what is going on" at the site are present.

The respondents elaborated on the need for very short-term day-to-day planning where the site situation is daily observed and reviewed [Qt 13]. This has to be done, however well you have done the initial planning, and however much you try to stick to it. Such need for flexibility arises because there are many parties involved in a construction project and project managers should be able to think laterally, sideways to see what else can they do to get around it [Qt 14]. In fact they need to have a long-term, a midterm and a day-to-day plan [Qt 13]. Then they need to have daily meetings or daily reviews where short-term problems are identified and solved or plans are altered accordingly. Such day-to-day co-ordination is felt very useful and effective.

Memos and letters were considered to be less effective at a construction site [Qt 12]. Anything that does not pose a major critical problem is left to be handled at the weekly co-ordination meetings and this procedure can save some hassle [Qt 15]. Therefore, co-ordinators prefer simple methods where they can avoid elaborate communications and feedback.

Nevertheless, by asking additional questions offhand during the interviews, the Author attempted to find out from the respondent Project Managers whether they really meant the opinions as expressed. The following is a typical conversation that resulted. Questions asked by the interviewer (the Author) are shown in *italics*.

Q: As you say these co-ordination processes are performed very casually, by talking to each other, hand-written notes, et cetera. I was trying to see whether any specific outputs and inputs are expected or specified in construction projects over here in Hong Kong.

A: None I am aware of. No.

Q: All happens informally?

A: Yes.

Q: As and when required the Project Manager or the Operations Manager has to identify whom to send outputs, from whom to solicit inputs, and perform it.

A: Basically, the Project Manager is the Captain of the construction team and he has got to decide who does what. That, he is responsible for it. Construction work may be different to any other organisation. It is a team of people and it is a matter of getting the best out of the people you got in the team. That is what the Operations Manager has got to do. That is also what the Project Manager has got to do too. He has to make sure that the Operation Managers work properly. … So, the Operations Manager or the Co-ordinator has to assess his people and decide who is going to do what. There is no one system that works well for everything.

Q: Then I thought you may be regularly sending out notes, memos, etc. within the company or making communications within the project team?

A: We tend to talk a lot, between our sites offices and head office. There are some memos going out that is of course only if something very important. As a rule, mostly by discussion and might be confirmed in writing. Apart from that, formal monthly reports both internal and external. There is no other formal reporting procedure.

I can tell you it does not work that way. There is not that many people involved and with the sheer volume of information that goes through, sometimes a hand written note is as effective as anything. A hand written note and then it comes back with the answer written on it. That tends to be the most useful. If you type out a formal memo, then it starts to distance the Operations Manager from his people. You don't make it too formal. That would be my suggestion anyway. You got to work together as a team and you do not want to start painting people into corners. Typing out official memos not that it cost time of the typist; because then you get a typed answer back as well – which is not what you really want. All you want to see is the answer – quickly! So, on our construction site, a hand written note tends to work as well. … Eyes contact and hand written note are particularly the best if you work it out.

Q: How do the subordinates of the Project Manager or the Operations Manager at the site and all the junior levels below them, get to know of the requirements of their operations and what to do, when to do, what is happening, what precautions to be taken, whom else to talk to … is that through informal discussions?

A: Yes. There is no organisation chart that goes on to say whom not to speak to. Most things are resolved by discussions. Most people also have an allocation of what duties they are supposed to do and they are responsible for doing those duties – duty statement. They are generally wrapped up in the operating procedures of the Project. There is an Operating Procedure as to who can do what generally – more of what is not done and restricted, more to who can talk to the Client and who can spend what.

In the above discussion, the respondent has further emphasised that he is not aware of any specific co-ordination inputs and outputs, to and from a project manager that are expected or specified in construction projects in Hong Kong.

He has made it clear that co-ordination in a construction project is achieved by talking a lot, resolving by discussions and later confirming in writing. There are some memos going out, but only if something is very important. The Operating Procedures speak "more of what is not done and restricted …".

It was further stated that a quality plan specifies the responsibilities of individual site staff and everybody knows how to do the work, "but [co-ordinators] have to co-ordinate it so that they will not clash or affect any other people's work" [Qt 16]. Then the interviewer (the Author) asked the same respondent "Do quality policies and quality plans suggest how co-ordination should be achieved?" They "do not have a very written procedure" and "look at it on a case-by-case basis" where the "contract manager and the project manager have to look at the whole situation, make a decision" [Qt 17]. Quality Policy and Quality Plans spell out the roles, but they do not specify communications, co-ordination, when to follow what and so on, "because then you will be too restricted. Everybody, every consultant, every client you deal with is different. They work differently. It is a different culture in every company" [Qt 18]. A quality assurance manual does not have a working plan to identify what can be done to improve co-ordination [Qt 19]. The respondent stated that they feel that "co-ordination is something that is intangible and not easily written down … because [they] believe in flexibility".

However, contrary to the suggestion by the Tavistock studies (Higgin and Jessop 1965 and Crichton 1966), some respondents did not consider this type of approach to achieving co-ordination as an "informal approach" [Qt 20 & 21].

This is because they have records of all meetings and any other discussions are also captured by way of recording or confirming in writing.

On communications with the client, it was stated that there might be informal discussions between personnel of client, consultants and contractor. Then they need to be "rounded back into an official channel" [Qt 22]. Every attempt is made to capture and record all onsite discussions between the client, the consultants and the contractor. Often they discuss onsite first and then record in writing [Qt 23]. They strike delicate balance between the verbal and written communications within the contractor's organisation [Qt 24].

The discussion so far is further strengthened by the three responses Qt 25 to 27, that describe the very casual and offhand approaches applied and the very simple techniques used to achieve co-ordination. In these responses, it could be observed that construction project managers achieve co-ordination by "knowing what is next to be done and knowing the effect or consequence of something not done" [Qt 25], by "constant dialogue" [Qt 26], by "identifying and bringing out problems early with the experience of the past projects" [Qt 27] and so on. They seem to rely less on sophisticated scheduling software and other analytical tools because of problems in putting in all constraints required in them [Qt 25]. The respondent of Qt 27 feels that he has "absorbed the job" thus finds no need to refer to the documented programme.

It is useful to recall at this point the announcement by Russell Lincoln Ackoff, one of the founders of the field of Operations Research (OR), that "The future of operations research is past … American Operations Research is dead even though it has yet to be buried … there is little chance for its resurrection because there is so little understanding of the reasons for its demise" (Ackoff 1979). He describes as follows how analytical OR tools fall short of the needs of managers:

> Managers are not confronted with problems that are independent of each other, but with dynamic situations that consist of complex systems of changing problems that interact with each other. I call such situations *messes*. Problems [addressed in OR] are abstractions extracted from messes by analysis; they are to messes as atoms are to tables and chairs. We experience messes, tables and chairs; not problems and atoms.
>
> Because messes are systems of problems, the sum of the optimal solutions to each component problem taken separately is *not* an optimal solution to the mess. The behaviour of a mess depends more on how the solutions to its parts interact than on how they act independently of each other. But the unit in OR is a problem, not a mess. Managers do not solve problems; they manage messes.
>
> Effective management of messes requires a particular type of *planning*, not problem solving [as done in OR].

Ackoff (1979) further states that OR modelling is inappropriate to the type of planning required by managers. In fact the project manager who stated Qt 27 claiming that he does not read the programme, was managing a very large project in Singapore, was in good control of it and his team and was well on top of the situation. He had progressed above the habit of fire fighting that is commonly prevalent at construction sites. He even could spare the time to take the author around to see the site and stated that all his staff and himself have used all their leave for the year 1999.

7.5.3 Validity of the Results

As stated in Section 7.1, logic of probability was not used in the above argument. It was entirely based on the descriptive data collected at the interviews. However, because of the flexibility given to the respondents, their answers were differently structured and articulated in their own style. Therefore it was not possible to, for example, count how many respondents stated particular phrases. Carroll and Johnson (1990) state, "Such informal analysis is usually employed when there is only limited knowledge about the task [or the process under study], how it is done and what information is used by the decision maker". They further explain that it is typical to focus on the best responses where the respondents have verbalised well. Mason (1996) states that, "in qualitative research the logic of probability is rarely used" and alternative forms of logic based on arguments can be used. Something the Author noticed in the 17 interviews conducted was that, not a single respondent expressed a view different to what is concluded above. Further, the results agree with previous research where Shamma-Toma *et al.* (1998) state "Social order and co-ordination [in a construction project] is a day-to-day accomplishment of project participants". Poon (1999) confirms the need for short term planning and management by stating that from time to time, decisions are required to be made onsite because of such reasons as incomplete planning, client's variations, imperfect site conditions, limited resources, nature of works, et cetera. Many decisions had to be made either within one hour or on the same day. Poon (1999) further state that experience was the most important contributing factor in making such decisions. Crichton (1966) state that "informal (and, within one definition, unscientific) management practises [seen to be employed in construction projects], calling for almost hour-to-hour redeployment by an experienced site manager, have kept the job going without undue delay or the generation of unacceptable cost". He further confirms "These [informal] forms of control are drawn from direct observation of the building team at work and from talks with them about what they were doing. Most of their [site personnel's] forms of behaviour are undertaken quite consciously and their existence is known to all members of the building team. They are, nevertheless, informal in that they are not spoken of on the record; nor would they appear in the handbooks or formal reports and literature of the industry – except as procedures to be avoided" (Crichton 1966).

7.5.4 Summary

The discussion so far on how the three co-ordination processes concerned are carried out can be summarised, as follows. They are carried out through regular co-ordination meetings, by making direct observations at the site and proactively bringing up various problems into discussion. Strategic activities are first identified at an early stage of the project, possibly at the tender stage or before mobilising onsite. Identifying potential delays is an ongoing process throughout the construction phase. Many meetings are held both within the construction team (including subcontractors) and with the client and the consultants to communicate all problems and discuss possible solutions. Further, the processes depend heavily on regular onsite observations and the co-ordinators' capability (based on their knowledge and prior experience) to proactively bring up potential problems into discussion to workout solutions. In a construction project, these forms of very short-term day-to-day planning were found to be both necessary and effective. Documents such as Quality Policies, Quality Plans and Operating Procedures spell out roles of the site personnel, but they do not replace the need for this type of co-ordination. Co-ordination in a construction site is thus achieved in such informal manner: by observing, talking a lot, resolving by discussions and later confirming in writing. There are some memos going out, but only if something is very important. In this context, capturing any discussion by way of subsequent recording was considered very important. Although only the Project Manager was officially authorised to speak to the client and the consultants, the other staff were allowed to discuss the matters provided such discussions were captured by way of recording. Very simple and casual techniques were employed to achieve co-ordination: “knowing what is next to be done and knowing the effect or consequence of something not done”, by “constant dialogue”, by “identifying and bringing out problems early with the experience of the past projects” and so on. They seem to rely less on sophisticated scheduling software and other analytical tools because of problems in putting in all constraints required for such tools.

The above findings of this section will be further strengthened by the discussions presented in Sections 7.6 to 7.8 where the process characteristics of informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work (discussed in Section 5.3 when formulating Hypothesis H1) will be identified in the three co-ordination processes concerned.

7.6 Identifying Strategic Activities and Potential Delays

7.6.1 The Initial Planning Stage

As discussed in Section 7.5.1, identifying strategic activities is first carried out at an early stage of the project, possibly at the tender stage or before mobilising onsite. From Qt 28 it can be observed that the initial planning process involves the cognitive process of “going into great detail” and “identifying where the problems are going to lie”. The respondent Project Manager’s decision to study the sections of a concrete pour, his identification of a “2 m beam with lots of holes and lots of tie beams coming into it" where "you've got lots of rebar" and so on are results of his cognitive psychological processes. His study of "how long it is going to take", "how many pours it is going to desire in this critical area", "how many lifts of formwork do I have to do in this particular critical area" involve his critical thinking skills and analytical skills. It is common experience that, in the construction industry there are no predetermined and laid down procedures on how to carryout these processes. Schön (1983) describes the knowledge by which people perform this type of operation as 'knowing-in-action' or "the characteristic mode of ordinary practical knowledge. … We behave according to rules and procedures that we cannot usually describe and of which we are often unaware". Schön (1983) further describes that knowing-in-action has the following properties:

- There are actions, recognitions and judgements which we know how to carryout spontaneously; we do not have to think about them prior to or during their performance.

- We are often unaware of having learned to do these things, we simply find ourselves doing them.

- In some cases, we are once aware of the understandings which were subsequently internalised in our feeling for the stuff in action. In other cases, we may never have been aware of them. In both cases, however, we are usually unable to describe the knowing which our action reveals (Schön 1983).

Therefore, it is difficult to understand how the process of 'Identifying strategic activities and potential delays' is carried out; it is difficult to understand the salient features of the process as practised now. The co-ordinators themselves are not too aware of how they perform this activity. In this context it is difficult to identify the measures internal to the process that control the performance of the process outputs against the requirements and specifications. Considering the example in Qt 28:

- It is difficult to identify whether the project manager has really "gone into great detail"?

- It is difficult to identify whether s/he has identified everywhere "where the problems are going to lie"?

- It is difficult to identify customers' expectations. For example, if some unforeseen problem occurs, will the customers still accept that the project manager has "gone into great detail" and identified everywhere "where the problems are going to lie" and accept that this was truly an unforeseeable problem? Else, are the customers expecting more rigour and foresight by the project manager?

The discussion so far endorses the argument presented in Section 5.3 that the problem solving nature of the co-ordination activities makes it difficult to identify the processes and to identify measurable attributes of the processes.

Furthermore, such processes are internalised within the project manager and it is difficult for the other project participants to observe and identify them. Their results will not be felt unless the project manager fails to identify an important issue thus causing problems at a later stage in the project. Hence, these processes and their outputs are intangible. For example, in Qt 28:

- The other project participants will not be able to observe whether the project manager is really "going into great detail".

- Their opinion of the project manager is not likely to be formed at the planning stage based on the observations of less visible planning processes. It will be formed after witnessing advantages brought to the project and problems avoided due to farsightedness of the project manager or after experiencing problems that could have been averted by the project manager. For example a client's project staff said:

> Proactiveness and the initiative to see something before it happens is the important thing we are looking for. … We were satisfied when contractor became proactive.

Another respondent project manager emphasised as follows on the importance for a project manager to be proactive.

> The basic processes are – we have to be involved in identifying problem areas. Talking about the strategic activities and potential delays, I think the basic here is to get involved, as the project manager's procativeness in identifying problems and identifying potential problems is important.

A project manager being proactive and performing cognitive psychological processes to identify potential problems is neither much visible nor tangible to the other participants of the project. Intangibility of the processes and their outputs makes it difficult to identify the customers and the other stakeholders also. This is because it is not easy to visualise the processes and their outputs. For example it is neither easy to visualise how the project manager "goes into great detail" nor the outputs of his study in great detail nor the recipients of those outputs. Therefore, it will be difficult to identify the expectations of the customers and other stakeholders and to identify measurable attributes of the processes, outputs and outcomes. Even when measurable attributes are identified it will be difficult for the customers (and other stakeholders) to evaluate the less tangible processes against them.

A respondent described the process by which he prepares the "critical path programme" [Qt 29]. This description further endorses the above argument on the nature of the processes carried out to identify strategic activities at the early stages of the project. For example, the "two-pronged" [Qt 29] approach he described is his personal style or approach to solve the co-ordination problem. It is based on the knowledge he has developed as 'knowing-in-action' (Schön 1983) that he knows to look at the "complexity of the structure itself and the site upon which it is located". None of the other respondents spoke of such two-pronged approach that may be widely accepted in the construction industry. It is a process internalised in the project manager and intangible or not too visible to the other participants of the project.

In Qt 29, the respondent identifies the difficult areas to work in, ones that have the least access, ones that have the most complicated construction or mechanical plant and equipment to install and so on. Such identification is not carried out at the request of the customers of these processes (i.e., the contactor's other staff and the subcontractors who are going to work in this area) to look in to all these aspects of the difficulties to carryout their work. However, they are bound to be most dissatisfied if the Project Manager failed to look into these details and co-ordinate accordingly. Therefore, this co-ordination activity is an unsolicited service. It could be observed in the above response that, while the customers do not solicit the co-ordination service, the project manager is burdened with the difficult task of identifying the customers themselves. Finding the project participants who will get affected (even from secondary and tertiary effects of a possible problem) and making contingency plans has to be done by the project manager. For example, the statement: "Bored piling – Is it far from the wall? Is it a wide area? Is it a soggy site? … Is it going to be difficult to actually pile? – Is it going to be difficult to put foundations in?" [Qt 29].

Qt 30 (stated by the same respondent as Qt 29) describes some potential delays the respondent Project Manager would identify. It is noteworthy that this process is carried out neither at the request of the international suppliers/subcontractors nor the consultants outside the country to co-ordinate their work with the onsite work or with the work of each other. It is an unsolicited service that has to be performed by the main contractor's Project Manager. It could be noted in the above discussion that there are no inputs to these processes other than the potential problems identified through project manager's cognitive psychological process. The outputs are given to the customers without any solicitation, i.e., any expectation on their part. Therefore, it is difficult to understand the customer expectations, identify measurable attributes of the process and so on. Even if measurable attributes are identified, it will be difficult to have them evaluated by the customers. Thus as argued in Section 5.3, it is difficult to apply the multi-attribute quality measurement model in such contexts.

Although the other project participants may not solicit the co-ordination services, the Project manager (or the co-ordinator) has to involve the relevant parties and solicit their expertise to identify strategic activities and potential delays [Qt 4 & 31]. "Then the real co-ordination will come in with feedback from various subcontractors involved in the programme" [Qt 4]. Therefore the co-ordination process of 'Identifying strategic activities and potential delays' relies on co-production by the customers. Such co-production in the co-ordination processes by subcontractors and other project participants makes it difficult to understand many aspects of the co-ordination processes such as: Who are the co-ordinators? (Or who form the team of co-ordinators and who do not?) Who is responsible for what? Who shares what aspects of the process? Who are the customers? Who are the other stakeholders? The following three responses illustrate that there is no clear understanding in the construction industry as to who should carryout the co-ordination work.

> You drive it. You should call the shots. When you say co-ordination, you become the centre point.

> In many poorly managed contracts, they leave the co-ordination to the subcontractor. … So, in the ideal situation, the main contractor's co-ordination will be just asking for feedback and saying "Can you do more? Can you do less?" and make sure that you push the other related activities to accommodate each other. You do not leave it to the subcontractors to co-ordinate among themselves "OK I will do this I will do that etc.".

> Of course as a main contractor still you have to co-ordinate among them [subcontractors] but they can co-ordinate at that level first and subsequently put it up to the higher level – so much easier.

Another opinion was that the main contractor should "go through the process with each individual subcontractor" to uncover all potential problems that lie ahead [Qt 32]. In such context, Latham (1994) recommends:

> Subcontractors should undertake that, in the spirit of teamwork, they will co-ordinate their activities effectively with each other and thereby assist the main contractor's overall programme.

Qt 32 further illustrates how the customers of a project co-ordinator become co-producers of the process. In the example given therein, the customers of the co-ordination process had to provide tacit information on technical details and logistics pertaining to their subcontract works in the project. In that process they may have to check certain details on their subcontract works and feedback to the co-ordinator, continue to provide updates on the status of the subcontract works, communicate the co-ordinator's decisions to the personnel carrying out the subcontract works and so on thus participating (or co-producing) in the co-ordination process itself. Such "co-production" makes the co-ordination process, its ownership and its customers unclear. Hence it will be difficult to identify measurable attributes of the processes and their outputs. Thus as argued in Section 5.3, it is difficult to apply the multi-attribute measurement model.

***In summary*:** Identifying strategic activities is first carried out at an early stage of the project through cognitive processes and knowledge developed as 'knowing-in-action'. They are less visible problem solving processes and even the process outputs are intangible to the other project participants. Further, identification of strategic activities is not carried out at the request of the customers of these processes and the project manager is burdened with the difficult task of identifying the customers themselves. The outputs are given to the customers without any solicitation, i.e., any expectation on their part. Therefore, it is difficult to identify the customers (and other stakeholders), understand the customer expectations, identify measurable attributes of the process and so on. Even if measurable attributes are identified, it will be difficult to have them evaluated by the customers. Project manager (or the co-ordinator) has to involve the relevant parties and solicit their expertise to identify strategic activities and potential delays. Therefore this co-ordination process relies on co-production by the customers. Please see Table 7.1 in Section 7.6.6. It would be further argued in Section 7.9 how these process characteristics, Problem Solving Work, Intangibility, Unsolicited Service and Co-production by Customers, cause problems in applying the multi-attribute quality measurement model to the Process of 'Identifying Strategic Activities and Potential Delays'.

7.6.2 Design Co-ordination

After the initial planning, when it comes to the implementation or the construction stage, the respondents expressed that an informal way of working becomes significant in the project management practise. For example, in Qt 33, the respondent illustrated how they do the initial planning to "make it sure that all things fit together". Then he stated, "That is what it formally goes – It informally ends up? … Sorting this out sorting that out with particular subcontractors, design consultants, trying to get it done, trying to expedite it without necessarily going into lots of paper work. … There are lots of things we can formally and informally do – ends up doing informally". Thus the respondent pointed out that informal way of working plays a significant role in construction site co-ordination.

In such a context, the burden of design co-ordination falls on the contractor [Qt 34]. According to the formal site management protocol, this has to be the consultant's duty. However, the main contractor may have a more detailed knowledge of potential problems than the designers [Qt 34]. Somebody within the main contractor has to be consistently looking at it and be experienced enough to detect them. The progress of work may suffer if the main contractor does not use such knowledge and experience to get the drawings and specifications refined. The contractor having to co-ordinate the drawings, although the formal protocol requires the consultant to do so, demonstrates the informal approach adopted to achieve co-ordination at a construction site. This should be an ongoing process [Qt 34]: "You cannot anticipate these from the beginning because some of the ductings and some of the runs are not decided yet.

Only as you develop you receive all the information. … So, this is one of the very important co-ordination activities – is to check the design".

The design co-ordination process involves preparation of co-ordination drawings. Preparation of the drawings could be an established procedure. However, mere preparation of the drawings will not solve the co-ordination problem. The statement "Somebody has to be consistently looking at it and experienced enough to say "Hey! A potential trouble is coming up there!"" [Qt 34] illustrates that it requires the cognitive psychological process of identifying the potential problems with the help of the drawing. The phrase "experienced enough to say" illustrates that practical knowledge gained by prior experience is involved in this process.

A contractor gets involved in drawing co-ordination without solicitation by the consultant so that the construction work can progress without any disruption [Qt 35 to 37]. Thus it is an unsolicited service performed by the contractor's project manager. This process and its outputs are intangible that it will not be felt unless the project manager fails to identify a potential problem and the work gets disrupted.

The statement: "Somebody happily draws his pipe running through the corridor and somebody else puts his Air-con duct right perpendicular across" [Qt 35] illustrates that design co-ordination is an unsolicited process. Design co-ordinator "got to be on his toes" to identify these problems. Further, the statement "But you must be able to visualise the moment you see a drawing …" [Qt 35], illustrates that this is a cognitive psychological process carried out to solve problems. As Schön (1983) describes, the knowledge to "visualise the moment you see" is 'knowing-in-action' or practical knowledge developed from prior experience.

A designer "is not the person who actually looks at every detail of it" [Qt 36]. "He does not know and he does not care" whether his design cannot be achieved due to other problems. "These are the grey areas and these are the left out areas that the main contractor got to take care and this will make a successful project" [Qt 36]. The respondent continued to further describe how a main contractor's project team must have structural, architectural and M&E specialists to co-ordinate "among each discipline and among other trades" [Qt 37]. These responses further endorse our discussion so far on the nature of design co-ordination processes; unsolicited and intangible processes informally performed by main contractors to identify and solve potential problems.

Qt 38 by a mechanical engineer further confirms that construction co-ordination is an unsolicited service. The expectations of the customers are, "You should be aware as the co-ordinator of this job … chase us and get the drawing in … that is what you call co-ordination!" [Qt 38]

***In summary*:** After the initial planning, when it comes to the implementation or the construction stage, an informal way of working becomes significant in the project management practise. In such a context, the burden of design co-ordination falls on the contractor, although, according to the formal site management protocol this has to be the consultant's duty. The design co-ordination process involves using practical knowledge gained by prior experience and applying cognitive psychological process to identify potential problems. A contractor gets involved in drawing co-ordination without solicitation by the consultant, so that the construction work can progress without any disruption. This process and its outputs are intangible that, it will not be felt unless the project manager fails to identify a potential problem and the work gets disrupted. Please see Table 7.1 in Section 7.6.6. It would be further argued in Section 7.9 how these process characteristics, Informality, Problem Solving Work, Unsolicited Service and Intangibility, cause problems in applying the multi-attribute quality measurement model to the Process of 'Identifying Strategic Activities and Potential Delays'.

7.6.3 Co-ordinating Specialist Subcontractors

The following discussion on co-ordinating specialist subcontractors illustrates how unforeseen problems often lie in the specialist contractor's work. "You have to be very careful when you want to make a change, particularly if it involves or affects your specialist subcontractors. The first thing is you must check with the specialist subcontractors" [Qt 39]. It illustrates the significance of co-production in construction co-ordination where changes need to be checked with many parties, especially the specialist subcontractors. The project manager has to use cognitive skills to identify the specialist subcontractors affected. Thus, identifying customers of a process such as this could be challenging.

Qt 40 further illustrates that construction co-ordination is an unsolicited service. The statement "I am only designing the window. I do not care how the wall is. Somebody else has now put up the cladding and he is not going to look at what the window details are" [Qt 40], highlights that the subcontractors are not going to request their work to be co-ordinated with the work of the others. Still the main contractor's project manager has to provide this service though it is not solicited.

The statement "So, these are what we call inputs that Project Manager must learn to look at. All these come from experience" [Qt 40] shows that inputs for this process are collected through Project Manager's cognitive psychological processes. "All these come from experience" illustrates the practical knowledge or 'knowing-in-action' (Schön 1983) involved in the process. However, such cognitive processes are not tangible to other project participants. Still they are essential to avoid possible clashes between the works of disparate parties involved in the project and to ensure smooth progress of the site work.

***In summary*:** Unforeseen problems often lie in the work of specialist contractors and any changes concerning such work should be checked with them. Thus co-production is a significant characteristic of this process. The project manager has to use cognitive skills and knowledge developed through experience to identify the specialist subcontractors affected in any situation. Such processes are not tangible to other project participants. Further, subcontractors are not going to request their work to be co-ordinated with the work of the others. Still the main contractor's project manager has to provide this service though it is not solicited. Please see Table 7.1 in Section 7.6.6. It would be further argued in Section 7.9 how these process characteristics, Co-production by Customers, Unsolicited Service, Problem Solving Work and Intangibility, cause problems in applying the multi-attribute quality measurement model to the Process of 'Identifying Strategic Activities and Potential Delays'.

7.6.4 The General Approach to Day-To-Day Co-ordination

The discussion so far on co-ordination processes was further reinforced by the responses received on the general approach to achieving day-to-day co-ordination at construction sites. The general approach is to "be proactive and to identify the problem without waiting for the problem to surface and try to solve it. From our experience in similar kind of projects in the past, problems they encounter … can be recurring. … The only way to minimise [defects] is to detect the problems early and to ensure that works progress smoothly" [Qt 41].

The statement "we have to identify, discover the problem" [Qt 41] further indicates the cognitive psychological processes involved, while the statement "bring it up early so that everybody is aware" highlights both the informality of the process employed to identify the problems and the fact that it is an unsolicited service. The respondent described how they identify problems due to design, workmanship and materials through "experience in similar kind of projects in the past" [Qt 41], thus illustrating the contribution the contractor informally makes to the construction project using the practical knowledge gained in the sites. Identifying problems through experience and cognitive psychological processes, then avoiding the problem or providing solutions to it through practical knowledge gained in past projects are not processes that are very visible and tangible to the other project participants.

Usually the people onsite have the primary concern of getting work done on time; after that comes the quality. They often neglect to check whether the specification or the detail being followed is wrong [Qt 42]. In a construction site where many variations or changes to the design occur, site personnel can easily be following an outdated drawing. The co-ordinators have to provide an unsolicited service of checking all these. "This is essential to make sure that everything is OK" [Qt 42].

The statements in Qt 43: "When people go in to do installation … they should be talking to other people. … So, keep asking questions … understand the whole process and work backwards from the commissioning date" further illustrate the informal approach towards achieving co-ordination. Rather than following the formalised protocol, the process relies on "talking to other people", "asking questions" and "understanding the whole process". Rather than relying on documented method statements and network programmes, they prefer to "work backwards from the commissioning date". Crichton (1966) also had observed that "forms of [site] control are drawn from direct observation of the building team at work and from talks with them about what they were doing". Further, the phrases "talking to other people" and "asking questions" illustrate the element of co-production in the co-ordination processes.

***In summary*:** The general approach to day-to-day co-ordination is to be proactive and to identify the problem without waiting for the problem to surface and try to solve it. Identification is done through cognitive psychological processes using the practical knowledge gained in the sites. It was argued that the process characteristics of Problem Solving Work, Intangibility, Unsolicited Service, Informality and Co-production by customers are significant in this context. Please see Table 7.1 in Section 7.6.6. It would be further argued in Section 7.9 how these process characteristics cause problems in applying the multi-attribute quality measurement model to the Process of ‘Identifying Strategic Activities and Potential Delays’.

7.6.5 Co-ordinating Onsite Facilities

The respondents described that co-ordination of onsite facilities is also an unsolicited service. The statements: “they forgot or they delayed the installation of the passenger hoist … to facilitate the workers to go up. Then when they got very far up, they realised that the architectural works is not following up … because the workers refused to move up and down manually climbing the stairs” [Qt 44] illustrates how the people who needed to go up and down did not solicit the service. The same respondent continued to describe how temporary facilities onsite need to be planned and co-ordinated. Otherwise, they might suddenly become critical [Qt 45]. The response clearly describes how the subcontractors will not come to the project manager or co-ordinator to verify whether both cranes will be available for their lifting needs, further illustrating that this aspect of co-ordination is an unsolicited service.

Qt 46 further confirms our discussion so far that co-ordinating the onsite facilities is an unsolicited service. It further illustrates that the lifting needs of each subcontractor need to be found out and then planned for. Thus the process involves co-production by customers.

The involvement of problem solving processes in co-ordinating onsite facilities is illustrated in Qt 45 and 46 by statements such as the following:

> … loading on scaffolding, high ceiling space, external scaffolding – you need to plan and design from day one or as soon as possible and review its effects [Qt 45].
>
> Because of miscalculations or some last minute changes you find that you have affected many trades and your progress will suffer [Qt 45].
>
> … ten fellows waiting for hoist to lift the material up and you find out that even if you work round the clock you cannot manage all these people [Qt 46].

A project manager analysing the loading on scaffolding, high ceiling space, time required to hoist material and so on are not visible or tangible to other participants of the construction project.

Further on the subject of on site facilities, a project manager of a Japanese contractor working in Singapore illustrated how the knowledge of local requirements, local authorities, local bylaws and so on are important to construction co-ordination [Qt 47]. Such requirements may not be contractually established. Nevertheless they are very important to achieve the planned progress. This is another illustration of the informal approach towards achieving co-ordination at construction sites.

***In summary*:** The respondents described that co-ordination of onsite facilities is also an unsolicited service. Temporary facilities onsite need to be planned and co-ordinated. Otherwise, they might suddenly become critical. Needs of each subcontractor for onsite facilities have to be found out and then planned for. Thus the process involves co-production by customers. A project manager needs to analyse the loading on scaffolding, high ceiling space, time required to hoist material and so on, thus involving problem solving processes. Such processes are not visible or tangible to other participants of the construction project. A project manager often has to be aware and allow for requirements that may not be contractually established but very important to achieve the planned progress. Thus, informal approaches towards achieving co-ordination too become significant. Please see Table 7.1 in Section 7.6.6. It would be further argued in Section 7.9 how these process characteristics, Unsolicited Service, Co-production by Customers, Problem Solving Work, Intangibility and Informality, cause problems in applying the multi-attribute quality measurement model to the Process of 'Identifying Strategic Activities and Potential Delays'.

7.6.6 Summary of Process Characteristics that Cause Difficulties in Applying Multi-attribute Quality Measurement models

Summaries of discussions in Sections 7.6.1 to 7.6.5 are given at the end of each section. Further, Columns 1 to 4 of Table 7.4 (given in Section 7.9) serve as a summary of the above discussion on 'identifying strategic activities and potential delays'. Still, as given in Table 7.1 it is useful to present an overview of the characteristics informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work identified in the process 'identifying strategic activities and potential delays'. Therein it is noticeable that intangibility, unsolicited service and problem solving work were characteristics identified in all the five aspects of the process discussed in this section. Informality was not identified in the Initial Planning Stage while co-production by customers was not identified in Design Co-ordination. Low Repetition was not identified at all in this process.

In the fifth column of Table 7.4, it is analysed how the said characteristics cause difficulties in the application of Steps A to H (presented in Section 5.1) of the multi-attribute quality measurement model, which is the final phase of the analysis in this experiment.

Table 7.1: Characteristics of the Process 'Identifying Strategic Activities and Potential Delays' that Cause Difficulties in Applying Multi-attribute Quality Measurement Model

Section	Co-ordination Aspect	Process Characteristics that Cause Difficulties					
		IF	IG	CP	LR	US	PS
7.6.1	The Initial Planning Stage		●	●		●	●
7.6.2	Design Co-ordination	●	●			●	●
7.6.3	Co-ordinating Specialist Subcontractors		●	●		●	●
7.6.4	The General Approach to Day-To-Day Co-ordination	●	●	●		●	●
7.6.5	Co-ordinating Onsite Facilities	●	●	●		●	●

Key: - IF - Informality; IG - Intangibility; CP - Co-production by Customers; LR - Low Repetition; US - Unsolicited Service; PS - Problem Solving Work

● - Indicates that difficulties (in applying multi-attribute quality measurement model) occurring due to the process characteristic were identified in the above discussion.

7.7 Ensuring the Timeliness of All Work Carried Out

How contractors ensure the timeliness of the work carried out is analysed in this section. As stated in Section 7.4, the aim of this analysis is to identify the co-ordination process characteristics (informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work) that affect (as discussed in Section 5.3) the applicability of multi-attribute quality measurement methods.

7.7.1 The General Approach to Ensuring the Timeliness of Construction Work

Qt 48 is a typical response that illustrates the processes carried out to ensure the timeliness of work carried out. The statements: “Review it even if daily, weekly, depending on the activities, how critical they are. … Plan according to anything that is delaying … solve all problems that arise” [Qt 48] illustrate the flexible approach adopted to ensure the timeliness of all work carried out at a construction site. The frequency of site personnel monitoring the work depends on how important or how critical the activities are and they plan according to what is delaying. It illustrates that the procedures applied are flexible and they act according to the situation to solve whatever problems that arise.

Further, the statements in Qt 48: “we have to come up with ways of achieving the schedule. At the same time we have to plan according to anything that is delaying us and we must overcome by increasing resources or by a different method of construction or something. We have to solve all problems that arise and then that would be step by step we finish up the job”, indicate the problem solving work involved in these processes.

In response to the questions asking for the inputs and outputs (please see Q 4 in Appendix H) of the co-ordination process, a Senior Co-ordinator from Singapore illustrated [Qt 49] the flexible and informal approach he applies to ensure timeliness of the work carried out. The statements: “It is purely the experience that tell because ultimately the productivity of a particular trade is not that clearly established in the local context. … We also have to be flexible. … How the planning is done basically depends on experience" [Qt 49] illustrate the flexible and informal approach adopted. Singapore is a country where norms for building works are established. Nevertheless, the respondent felt that "it is purely the experience that tell" [Qt 49] the productivity sufficiently accurately for his needs. As described by Schön (1983) experience is the "practical knowledge" that is internalised in the co-ordinator that s/he applies to understand the duration for a particular trade to perform an activity, how many labourers are required, the kind of material that ought to be onsite the preparation work required and so on.

Seeing an opportunity or a delay in the project, seeing a transportation problem or a storage problem or a problem of double handling or triple handling of material [Qt 49] depends on the co-ordinator's cognitive skills. Providing solutions to them depend on his critical thinking abilities and problem solving skills. These are processes internalised in the co-ordinator and not very visible (or tangible) to the other project participants. Even the very co-ordinator carrying out such cognitive process and involved in the problem solving work may not be aware of his/er thought process unless s/he has metacognitive capabilities (defined by Flavell (1976) as the knowledge and awareness of one's own cognitive processes and the ability to actively control and manage those processes). Hence, documenting these processes (as required in the multi-attribute quality measurement model), identifying measurable attributes in them and asking the other project participants to evaluate them may not be very practical, especially in the construction site context.

Further the statement in Qt 49: "you get the programmes and we will establish with subcontractors and suppliers whether these things can be met, if not what are the alternatives" illustrates how other project participants become co-producers in the co-ordination process. As described in Section 7.6.1, co-production makes it difficult to understand the process, its inputs/outputs, its participants, their responsibilities and so on thus making it difficult to apply the multi-attribute quality measurement model.

Another Project Manager described [Qt 50] how they 'ensure the timeliness of all work carried out'. Therein, the statement: "We have meetings with our engineers, all our in-house engineers. There you get feedbacks – "this is going to be delayed", "there is a problem here", …" [Qt 50] further illustrates how other project participants become co-producers in the co-ordination process.

The statements in Qt 50: "It is more discussion and less recording. … The planner will be going through it and talking to me most of the time. Most of the time it is verbal communication than on paper. We again become flexible to see how we can change various things to best achieve the target date" illustrate the informal nature of this process.

The same respondent gave an example [Qt 51] of how they managed a situation where a subcontractor was failing to achieve the time target given. The statement: "There are certain things that can be spoken in the mind, certain things by verbal conversations and there are certain things that have to be analysed on a piece of paper" [Qt 51] is another illustration of the informal approach adopted. Further the statement: "You do not need a planner [software] you just do it on excel or you can do it by hand even, you just need a bar" [Qt 51] is an example of the simple scheduling techniques used in construction sites.

The statement in Qt 51: “The moment you see that there are not many people working onsite, you must go and find out how much of work all these guys have to do” is an example of the casual and informal approach adopted by this Project Manager. Therein the Project Manager made a random observation that “there are not many people working onsite”. So he “suddenly realised [that] there is something wrong here” [Qt 51] and took action to avoid the delay. The observation by the Project Manager was not a result of a formal reporting procedure but a result of the cognitive psychological processes carried out by him during his site walks to observe imminent problems. Based on his experience and practical knowledge he realised that something is wrong. Then using his critical thinking skills and aided by a very simple analytical tool, a bar chart, he analysed whether there are enough resources mobilised to achieve the required progress. Such processes are not very tangible to other participants of the project. Further, it is evident from Qt 51 that the subcontractor who was lagging behind did not request the above services from the Project Manager. It can be seen from the statement “He looked at it and said I am very sorry, I will bring more men now” [Qt 51] that in this particular case, the subcontractor had not even realised (or has not judged on his own) that there was a problem in the amount of resources mobilised by him. The service rendered by the Project Manager was an unsolicited service.

Subcontractor related problems such as the above are dealt by a project manager on a case-by-case basis. Subcontractors at a particular construction site may have a wide variety of problems. Doing a bar chart and analysing the labour requirement [Qt 51] is not a process the project manger does to every subcontractor on a regular basis, say fortnightly or monthly. It will only be done as and when needed by the circumstances. Hence these processes have a low level of repetition. During such a process, how the subcontractor reacts and co-produces also changes the process. Therefore, such co-production increases the variability of the processes and makes it difficult to identify any repetitive process that underlie.

The same respondent continued to describe [Qt 52] that, "Project management means continuously monitoring, you cannot layback". His further statements: "On paper, there is a procedure here that every week subcontractors keep submitting how many workers are there. [It is] OK if you have a large organisation here, a lot of staff to check labour charge. … We work here with a minimum staff. … So all what we do is – we do hands-on, everyone is hands-on, so they go and have a look and they know what is happening at the site. They do not work much on paper, but it works. That is the only way!" [Qt 52] illustrate how the work is actually carried out at construction sites. All these were stated in response to the questions on "data inputs" to co-ordination processes (please see Q 4 in Appendix H) asked by the interviewer (the Author).

Another respondent described as follows [Qt 53] that he does not rely much on sophisticated scheduling software. "I must clarify that these are all human inputs. All the constraints to programme that software – you have to put in your constraints. Over reliance on these what you call artificial intelligence and they pointing it out to you may be a problem because it is the constraint that you first put in. If you have put in the wrong constraints or the wrong considerations, the whole thing would not workout. … If you do not link those activities to the other activities, when one delays, the other does not show a delay". Then he states "Experience is one thing that functions particularly well" [Qt 53].

An M&E contractor stated how the informal approach to achieving timeliness of work can be beneficial to the project [Qt 54]. Obviously the respondent Project Manager has worked to achieve better satisfaction of the client instead of arguing strictly contractually that the delay by others justifies an extension of time for his company. He has in fact chosen to 'partner' the client to achieve the project objectives by taking the stance: "You can find thousand odd reasons to prove the delay. … If you want to see how to get it done, then you will have thousand odd ways. All these inputs, you are creating it for yourself by looking at various things" [Qt 54]. The response illustrates the flexibility of his approach to achieving timeliness of the construction work and also meeting the expectations of the customer.

The statement in Qt 54: "All these inputs, you are creating it for yourself by looking at various things" illustrates how the Project Manager's personal style of operation has a significant effect on the processes and how it is flexibly applied to suit the needs and conveniences of individual situations. It makes it difficult to identify a regular repetitive process as required by the multi-attribute quality measurement model.

In Qt 55 the Project Manager explained how he prefers to speak to the other contractors and co-ordinate the matters onsite rather than bringing them up at the meetings and recording. He states "you can get things done faster" by talking to people in this manner. The more documented method adopted at this site by the consultant's co-ordinator was considered inefficient [Qt 55]. However, informal processes of talking to each other are not as visible and obvious as the more formal processes thus making it (as described in Section 5.3) difficult to apply the attributes based quality measurement method.

The above respondent continued to explain [Qt 56] how he co-ordinates to achieve efficient use of onsite facilities by "talking" to other contractors. Further, he felt that this type of co-ordination work does not have to be recorded [Qt 57]. It was his opinion that "the contract document is the contract document" [Qt 57]. There was a more efficient way of working without being that formal. The emphasis by the civil contractor's representative (in that site) on taking minutes and how statements should be written therein was considered "an utter waste of time" [Qt 57].

The statements in Qt 57: "consultant could have put a person there who understands whole project and the whole process. He must call the shots and say this is the programme … and follow the progress. … He should not be a postman … collecting data from one party to the other – any clerk can do it, he does not have to be an engineer" illustrates the problem solving work involved in the co-ordination processes.

***In summary*:** The approach to ensure the timeliness of construction work is informal and flexibly applied depending on how important or how critical the activities concerned are. The project manager's personal style of operation significantly affects how the processes are carried out. The processes involve problem solving effort applied to analyse resource deployment, construction methods and so on. The problems are not identified through formal reporting procedures but through cognitive psychological processes that are intangible. Other project participants co-produce in these co-ordination processes by way of analysing whether planned pace of work can be achieved, suggesting better alternatives, providing feedback on the progress and so on. In such context, it was argued that co-ordination processes are low in repetition because much of co-ordination problems at site are handled in a case-by-case manner. Further, co-ordinators carryout these processes without solicitation by other project participants. Please see Table 7.2 in Section 7.7.3. It would be further argued in Section 7.9 how these process characteristics, Informality, Problem Solving Work, Intangibility, Co-production by Customers, Low Repetition and Unsolicited Service, cause problems in applying the multi-attribute quality measurement model to the Process of 'Ensuring the Timeliness of All Work Carried Out'.

7.7.2 Managing the Timeliness of Subcontracted Work

Managing subcontractors who are lagging behind the schedule involves studying and analysing "what is the problem holding them back" and either solving it or helping the subcontractor to solve it [Qt 58 and 59]. Therefore, this process requires the problem solving skills of the co-ordinator. The following examples of problem analysis (excerpted from Qt 58 and 59) are carried out by the Project Manager through cognitive psychological processes.

> … what is the problem holding them back. Who is causing the delay? It may not be them, it may be somebody before them, it could be the work that is very difficult … [Qt 58]

> … identifying the critical area. Sometimes your subcontractor may put ducting in the wrong place where he has to actually wait for a while [Qt 59].

Analysing whether is it "the work that is very difficult" [Qt 58] and "identifying the critical area" [Qt 59] requires Project Managers' practical knowledge, experience and critical thinking skills. Qt 51 (analysed in section 7.7.1) is also an illustration of a Project Manager performing cognitive psychological processes, using his practical knowledge and performing critical thinking and problem solving processes to manage a problem where a subcontractor was failing to achieve the time target. Such processes are not very visible to the other project participants and hence intangible. The project manager has to perform such problem solving processes without solicitation by the subcontractor [Qt 60]; "All subcontractors will like to hide their problems "no problem, do not worry we can finish!""

The statement in Qt 60: "If this 20% is critical for the rest of the 80%, fine, then if he achieved that you know he can finish. But if his achieving 20% is not critical for the rest of the 80%, then you must be able to say "no, no, no, this cannot work"" illustrates that evaluating the progress of a subcontractor involve co-ordinator's critical thinking skills. Identifying the rate of progress in the construction work is not a straightforward exercise [Qt 61]. "There is no way to say that look you have to finish 50% by 50% mark in the time line and 100% by 100% mark" [Qt 61]. Further, the statement "When it comes to the last 30% – or we are talking about 50% onwards – we will have to really look into that. It is a precautionary matter" [Qt 61] further illustrates that this aspect of co-ordination is an unsolicited service. The rate of progress in construction work could have a high fluctuation [Qt 62]. "This is what is unique, this is what makes co-ordination so critical" [Qt 62]. The statement "but to find out and give instructions – on what is behind schedule, planning – the ability, experience to be able to see the consequential effects and how, what should be done to make sure that these corrective actions that you put in be able to bring you back on to schedule" [Qt 62] elaborates the problem solving skills needed by the co-ordinator to rectify the delay.

It is common experience that changes to the construction schedule cannot be done purely based on mathematical formulae of the critical path programme. Qt 63 and 64 describe how contractors work to recover from a delay that has occurred. They illustrate how such action require a good knowledge of what activities are critical, what activities have floats, what activities can be crashed, what changes in the sequence of work are possible and so on. Based on such knowledge, the recovery from the delay should be mapped by the co-ordinator using critical thinking and problem solving skills [Qt 63 and 64].

As mentioned before in Section 7.7.1, another important aspect of such problem solving processes is that they are not repetitive. Problem analysis such as given below (excerpted from the responses given so far in this section) are examples of case-by-case handling of situations (please see the comments in *italics*). Subcontracted work can run into a wide variety of problems having special needs. Such problems are special cases in their own exceptional circumstances and it will not be practical to document repetitive procedures on how to handle them.

> Why is he not cutting the earth, why is he not levelling the earth, is it a rainy season, how we can overcome these … plan it with proper access, proper drainage … [Qt 58] *[Comment: The solution depends on the technicalities of the earthwork process and the weather at that time].*

> Put in more labour or … put in more labour hours [Qt 60]. *[Comment: The choice of these two options depends on lots of conditions pertaining to the situation such as availability of labour, availability of space for more persons to work, availability of tools and equipment, environmental considerations such as noise pollution and so on].*
>
> Do a crash programme to a contractor … have all the activities listed up, see when and when they have to finish … do a bar chart … see the bars overlapping … see how things fall into place … see how many people you need for this job … need 16 men but you have only 4 men here [Qt 62]. *[Comment: Similar to the above example, the analysis depends on lots of conditions pertaining to the situation such as availability of labour, availability of space for more persons to work, availability of tools and equipment, environmental considerations such as noise pollution and so on].*
>
> Say Activity A delays Activity B, but you cannot shorten Activity B, because Activity B is already out of your control or at its best. Now you have to look at what follows Activity B – Activity C … plan so that the 3rd or the 4th activity that follows can be made to adjust and catch back on time [Qt 63]. *[Comment: The course of action depends on which activity can be shortened in the reality that prevail onsite and not on the mathematics of the network calculation].*
>
> Do a catch-up programme to expedite the matter … subsequently if really the matter could not be completed … provide contingencies such as crashing more on the sequence and using the floats [Qt 64]. *[Comment: The catch-up programme and other contingencies depend on the options available onsite, which are often entwined in a complex manner].*

Managing subcontractors could be very tricky and require employing strategies that suit the situation [Qt 65]. The respondent points out how the strategy had to be changed when a subcontractor lagging behind the schedule due to not mobilising sufficient resources, tactically started work in many areas to avoid the work being given out to others [Qt 65]. It is an example of how the co-ordination process was affected by the reaction of (or co-production by) the subcontractor (the customer). Therefore, in this type of co-ordination work there is no common or universal procedure or recipe. Thus the practitioners find it difficult to identify standard processes of co-ordination.

The same respondent further elaborated how “Project managers and staff should be able to be flexible”, “see in practical sense”, “take early decisions”, “work back from commissioning [of the plant]”, “see what is important now”, “get the substantial completion or practical completion, to prove to the client that our system is working" and so on, "because these are all man made equipment. Once you put into operation only you are going to see problem. So you need to have sufficient time to correct it" [Qt 66]. The response further elaborates the informal approach applied in construction co-ordination. "Critical path could be identified during the original planning. You can stick to that, but project managers should have the overall view of the contract to see in practical sense whether it is moving and then take early decisions" [Qt 66].

Qt 67 and 68 contribute to further confirm that 'ensuring timeliness of work carried out' is an unsolicited service, because, "Basically, they [subcontractors] take care of their own work and it is up to the main contractor to make sure that they are doing their parts" [Qt 67]. "In the ideal situation, the main contractor's co-ordination will be just asking for feedback and saying "Can you do more? Can you do less?" and make sure that you push the other related activities to accommodate each other" [Qt 68]. However, some contractors encourage certain level of co-ordination by the subcontractors themselves, especially on the technical matters [Qt 69]. Nevertheless is it evident from this response by a Senior Project Manager, how difficult it is to develop a culture where subcontractors will talk to one another and work together. In the case of Qt 69, the subcontractors have worked together in a number of previous projects and obviously the project manager had encouraged them to work together understanding each other. Such co-operation among the subcontractors is not what is usually seen at the construction sites and co-ordination usually remains an unsolicited service. Nevertheless, the respondent states that "as a main contractor still you have to co-ordinate among them" but the subcontractors working together can save time.

A respondent described his approach towards successful management of both his subordinates and subcontractors as, "You must tell what is expected from everybody. Rules are laid. Under the big framework of rules, you be flexible" [Qt 70]. The response illustrates the informal and flexible approach adopted towards managing construction sites. In the context of ensuring the timeliness of work carried out, the respondent further described how a little flexibility can help [Qt 71]. The attitude was "if we help this fellow [subcontractor] here, he will get this job done and finished". The regimented approach of the Contracts Engineer (in that company) was considered as being penny-wise pound-foolish. The statement "So, it is situational management again – what situation you are in, what situation they are in" further illustrates this point [Qt 71].

***In summary*:** Managing subcontractors who are lagging behind the schedule involves studying and analysing problems that hold them back. The co-ordinator has to apply cognitive psychological process, practical knowledge, experience, critical thinking skills and so on, which are processes intangible to other participants of the project. Very often such problems are solved case-by-case, hence the co-ordination processes involved are low in repetition. The processes further vary depending on how the subcontractors (customers) concerned co-produce. The respondents elaborated that they apply a very flexible and informal approach. Subcontractors usually do not request their work to be co-ordinated to ensure timeliness, thus it is an unsolicited service performed by the co-ordinators. Please see Table 7.2 in Section 7.7.3. It would be further argued in Section 7.9 how these process characteristics, Informality, Problem Solving Work, Intangibility, Co-production by Customers, Low Repetition and Unsolicited

Service, cause problems in applying the multi-attribute quality measurement model to the Process of 'Ensuring the Timeliness of All Work Carried Out'.

7.7.3 Summary of Process Characteristics that Cause Difficulties in Applying Multi-attribute Quality Measurement models

Summaries of discussions in Sections 7.7.1 to 7.7.2 are given at the end of each section. Further, as in the case of Section 7.6, Columns 1 to 4 of Table 7.4 (given in Section 7.9) contain a summary of the above discussion on 'ensuring the timeliness of all work carried out'. Still, as given in Table 7.2 it is useful to present an overview of the characteristics informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work identified in the process 'ensuring the timeliness of all work carried out'. Therein it is noticeable that all six characteristics identified in aspects of the process (The General Approach to Ensuring the Timeliness of Construction Work and Managing the Timeliness of Subcontracted Work) discussed in this section.

In the fifth column of Table 7.4, it is analysed how the said characteristics cause difficulties in the application of Steps A to H (presented in Section 5.1) of the multi-attribute quality measurement model, which is the final phase of the analysis in this experiment.

Table 7.2: Characteristics of the Process 'Ensuring the Timeliness of All Work Carried Out' that Cause Difficulties in Applying Multi-attribute Quality Measurement Model

Section	Co-ordination Aspect	Process Characteristics that Cause Difficulties					
		IF	IG	CP	LR	US	PS
7.7.1	The General Approach to Ensuring the Timeliness of Construction Work	●	●	●	●	●	●
7.7.2	Managing the Timeliness of Subcontracted Work	●	●	●	●	●	●

Key: -
- IF - Informality
- IG - Intangibility
- CP - Co-production by Customers
- LR - Low Repetition
- US - Unsolicited Service
- PS - Problem Solving Work
- ● - Indicates that difficulties (in applying multi-attribute quality measurement model) occurring due to the process characteristic were identified in the above discussion.

7.8 Liaison with the Client and Consultants

As discussed in Section 7.5, the process of 'liaison with the Client and Consultants' is mainly carried out by regular meetings. One respondent elaborated that there are two types of meetings, viz. progress meetings and technical meetings; "same whether here [Singapore] or Hong Kong, it makes no difference. Weekly, biweekly meetings are the same, they ask, you answer, "You are slow. Why are you slow? Resources?"" [Qt 72]. However, as presented in this section, the respondents pointed out that, in such discussions contractors often go beyond the contractual responsibility and the formal management protocol at the site to understand the expectations of the client, point out design problems, create goodwill and so on. Such extra effort by contractors make a significant contribution towards achieving co-ordination in construction projects.

According to contractors, they do this because the responsibility rests on them to co-ordinate, achieve time targets and deliver a functional product at the end of the project. Therefore, it is argued that the process characteristics of informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work (discussed in Section 5.3 when formulating Hypothesis H1) are significant.

7.8.1 Liaison on Decisions Required for the Progress of Work

In a traditional 'bid and build' contract, the consultants should understand the client's requirements, develop the designs and give to the contractor to build. Any problems that the contractor encounter at the construction stage should be communicated to the consultant who is supposed solve them. Nevertheless, the respondents described [Qt 73] that the contractor has to informally communicate with the client to obtain information on the latter's requirements or to pressurise the consultant to give outstanding information. The motivation for the contractor to do so comes from the fact that it is the contractor who is responsible for achieving the programme and quickly need the information to smoothly proceed with the work [Qt 73]. "Sometimes because he cannot get these information quick enough from the consultant … he may have to go direct to the owner". If one subcontractor cannot proceed, there will be a chain reaction on all the subsequent trades [Qt 73].

The statement in Qt 73: "And if that happens, there will be lots of finger pointing" describes the present culture in the construction industry. Therefore, informal liaison with the client makes a significant contribution to achieving co-ordination in a construction project. A consultant in a construction project organisation is supposed to hold a senior rank and greater responsibility than the contractor. Nevertheless the statement: "he [contractor] cannot get these information quick enough from the consultant" illustrates that neither the client nor consultants solicit this co-ordination service. Therefore it will be difficult to identify the client's and the consultants' expectations of this co-ordination process. In fact consultants may have vested interests in the failure of this process because it highlights their ineffectiveness and the shortcomings of the design to the client. As discussed in Section 5.3, such unsolicited nature and vested interests makes it difficult to apply the multi-attribute quality measurement model to the process.

Three other respondents who share a similar opinion elaborated [Qt 74 to 76] that the client needs to be made aware of the problems so that they may help the contractor and consider not imposing liquidated damages. Hence the responses further confirm the informal environments that prevail at construction sites.

The statements such as "Talk to them nicely, that is how to get information" [Qt 74] and "make them know your problem and hopefully they will help you out" [Qt 75] further illustrate that co-ordination is an unsolicited service. Neither the client nor consultants will check with the contractor whether all required information is available. Though unsolicited, it is a service critical for the smooth progress of the construction project.

It is common experience that commercial decisions such as selecting suppliers can get delayed. A respondent described how a contractor would informally liaise to get to know, as early as possible, which brand is likely to be accepted so that the co-ordination drawings can be prepared [Qt 77].

Another respondent from Singapore elaborated why the finishes need to be decided (or confirmed) early [Qt 78]. In a construction project the contractor needs to follow-up such matters and get the client's confirmation early. The statement "if they [client or consultant] do not make decisions, it is going to affect my work" [Qt 78] is another illustration that this type of co-ordination work is an unsolicited process. Further, the example "If the flooring material of living room and bedroom are different, my base floor levels must be different" [Qt 78] illustrates the tacit details of the construction process that a contractor needs to be attentive to. It is common experience that clients and consultants often do not follow the construction process in such detail.

Further, this co-ordination process performed by the contractor's co-ordinator to obtain information on the client's requirements or to pressurise the consultants to give outstanding information, depends on the client's co-operation and willingness to entertain the contractor's informal queries and the degree of co-operation provided. For example, the statement "Formal way is by way of letter, by way of formal meeting, informal way is we can just give a call and ask or ask him when you meet" [Qt 77]. Another respondent stated:

> So, sometimes he [contractor] may have to go direct to the owner, unless the owner says "Do not bother me talk to my consultant" – and it is a separate story.

Therefore, the client is a co-producer in the process of 'liaison with the client'. As pointed out in Section 5.3, co-production makes processes vary to suit the reactions (during the processes) by the customers, thus making it difficult to apply multi attribute quality measurement models.

Further the processes such as checking on the sanitary ware type [Qt 77], floor finishes [Qt 78] and so on are not highly repetitive. They depend on the specific situations in the project and are handled in a case-by-case manner. Due to co-production by clients, discussed above, these processes further loose repetitive nature, thus as discussed in Section 5.3, it is difficult to apply the multi-attribute quality measurement model.

Another important aspect of liaison with the client and consultants is to discuss problems early [Qt 79]. By tackling a problem in advance, a solution can be worked out at a lower cost, with more flexibility and in time for the work to continue undisrupted. Therefore all parties to the problem can be happy [Qt 79].

The statement in Qt 79: “the main key personnel is the – the main player is the developer or the developer’s representative. They must make the decision early. Consultant, must resolve the design discrepancy early. Then the subcontractor must always bring up any problems encountered early” describes the challenge faced by construction co-ordinators. The responsibility of co-ordination rests on the main contractor. The other project participants do not solicit the service of co-ordination. It is the main contractor who is responsible to look at the “big picture” of delivering a functional project on schedule.

***In summary*:** Contractors have to informally liaise with clients and consultants to quickly get the information required for the progress of work. Contractors’ co-ordinators perform this unsolicited service because it is the contractors who are responsible for the progress of work. Success of this process depends heavily on co-production by the client and the consultants by way of entertaining the informal requests for information. Such co-ordination activities concern specific situations in the project and are handled in a case-by-case manner and hence low in repetition. Please see Table 7.3 in Section 7.8.7. It would be further argued in Section 7.9 how these process characteristics, Informality, Unsolicited Service, Co-production by Customers and Low Repetition, cause problems in applying the multi-attribute quality measurement model to the Process of 'Liaison with the Client and Consultants'.

7.8.2 Understanding the Exact Needs of the Client

The contractors further described how they need to informally communicate with the client to exactly find out the needs of the latter. Often in special situations, the acceptance criteria of the client and consultants can differ [Qt 80]. "Therefore you have to talk to all these people. It is challenging!" [Qt 80]. Thus, it is another example of an unsolicited liaison process carried out by the contractor to ensure a trouble free project.

Further, if the contractor is careful, such omissions will not be very common and therefore this is not a very repetitive process. The process will also depend on the client's attitude towards handling a construction error, thus, co-production by the customer will have a significant impact on this liaison process.

Construction contracts often put the responsibility of the design on the contractor. The statement in Qt 81: “consultant will say, even if I approve the drawing, I can ask you to change it” illustrates this aspect. In such a context, contractors find it useful to go beyond the formal site management protocol to exactly find out the needs of the client beyond what is specified by the consultant and provided in the contract. A respondent described how they extensively discuss every minute detail with the client’s electrical engineer to “produce the switchboards, test and deliver with zero rework” [Qt 81]. The latter two paragraphs of Qt 81 portray his commitment to maintain a favourable environment with the client and consultants, win their confidence and deliver a trouble free project. They proceeded on informal channels to suggest to the consultant the possible alternative ways of commissioning, to show to the client (“*not with records*, but by actual facts and by truthfulness”) that they “are trying to give them [client] a good product” and to “build-up confidence” [Qt 81]. Such project where the contractor ‘partners’ the client will obviously be better than a project that results in a client dissatisfied with a contractually correct contractor.

Another respondent project manager described how it is important to liaise with the client on decisions which are very personnel such as colour schemes [Qt 82]. He further elaborated that “structural decisions or simple architectural decisions [are] quite easy to get by”, but colour scheme for example is not a logical decision [Qt 82]. “Somebody will look at it and say I do not like this colour. It is “*I* do not like” you see, it is not “Why this colour is not suitable?” … Somebody is going to say “I do not like *that* green”. Somebody will say I prefer a darker green or somebody will say I like a lighter green! This is not a technical decision. It is pure personal choice. This kind of thing it is something to watch out for and this got to be handled with a lot of tact and diplomacy …" [Qt 82]. Such informal communications will make a significant contribution towards delivering a trouble free, successful project and achieving client satisfaction.

It is noteworthy that the consultant did not request the contractor to "sit and talk" to them "every time a drawing is prepared" and ask "are you happy with this, are you happy with that" and so on [Qt 81]. The client did not request the contractor to liase "on choices and decisions which are very personnel" [Qt 82]. It was the contractor who had "to watch out for this" matter and handle "with a lot of tact and diplomacy and make sure that you [contractor] get this done" [Qt 82]. Such comments further confirm that liaison with clients and consultants is an unsolicited service.

As described before, processes such as discussing the details of switchboards [Qt 81], getting approval on colour schemes [Qt 82] are managed on a case-by-case manner depending on the project circumstances and therefore not very repetitive. Also the process depends on the client's or consultants' willingness to entertain the contractor's informal queries and the degree of co-operation provided, thus, the client and consultants are co-producers in the liaison process.

***In summary*:** At times, the acceptance criteria of the client and consultants differ; consultants change already approved drawings causing drastic consequences to the contractor; clients have delicate personal preferences on matters such as colour schemes. For such reasons, contractors find that informal liaison with clients and consultants is essential for the smooth progress of the project. They are unsolicited processes performed by the contractor and the success depends heavily on co-operation or co-production by clients and consultants. The processes concern specific circumstances of the project that require case-by-case handling, thus low in repetition. Please see Table 7.3 in Section 7.8.7. It would be further argued in Section 7.9 how these process characteristics, Informality, Unsolicited Service, Co-production by Customers and Low Repetition, cause problems in applying the multi-attribute quality measurement model to the Process of 'Liaison with the Client and Consultants'.

7.8.3 Liaison on Imminent Construction Problems

Another aspect of liaison highlighted by the respondents was that the clients implicitly expect the contractors to be proactive and bring to light any imminent construction problems. As presented in the following discussion, when something goes wrong the clients may blame the contractor for not telling them earlier refuse to grant compensation such as extension of time or extra payments. If the client asks for information on A and if B is also affected, the contractor must inform that [Qt 83]. On changes to the design, the contractor should warn the client "if you want such thing [design change], such consequence can happen and will affect the overall situation … or sometimes you must insist [to the client], "Please change or you will have very serious consequences"" [Qt 84].

Contractor's co-ordinator would identify such problems through cognitive psychological processes. It will require the application of practical knowledge developed from prior experience, critical thinking skills and problem solving skills. Such processes are not visible to the other project participants and will not have a tangible effect on them unless the contractor fails to carryout the process resulting in an unforeseen problem in the project. As evident from the above responses, clients need to be advised without their soliciting such service. Further, this is not a formal reporting procedure under the normal site management protocol. In this context, a respondent Project Manager stated that bad co-ordination is waiting for things to happen and then reacting [Qt 85]. Clients' such expectations from the contractors may stem from the fact that the latter is likely to be more aware of the onsite problems than the consultants. The contractors are more aware of tacit details of the construction processes and thus the imminent problems. "If the contractor cannot manage and co-ordinate, then there is no point in having even the best consultant you can have" [Qt 86]. Also, because the contractor holds a lower position in the management hierarchy of the project, it may be easier to palm over the problems to the contractor. Hence, the responsibility for co-ordination rests with the contractor [Qt 87 and 88]. In such contexts it is useful for contractors to go beyond the formal site management protocol and informally liaise with client and consultants. On variations and changes that may lead to construction problems, a respondent further elaborated: "Otherwise the contractor would be blamed "Why didn't you tell me earlier? You did not tell me, so now you are not entitled to such extension of time or such benefits"" [Qt 89].

The statement in Qt 89: "must to be able to look at the consequence fully and explain," indicates the critical thinking skills and analytical skills required by the process. The statement: "Why didn't you tell me earlier?" indicates that clients will implicitly expect this service though they would not solicit it. The same respondent continued to give an example of how the present status of the site work may affect the decision on a design change and the contractor is best capable of informing such matters to the client [Qt 90]. "We are forgetting that my opening for the small door is already formed and now I need to re-cut the opening! Not only the cost of such opening, you might have electric ducting put right next to it. So the electrical ducting too need to be shifted!" [Qt 90]. The response illustrates that identifying all problems associated with a design change requires cognitive psychological processes, critical thinking skills and problem solving skills. Such identification of problems will not have a tangible effect on the other participants of the project unless the contractor fails to identify some problem associated with the process thus causing an unforeseen problem.

Another respondent expressed the importance of keeping the client and the consultant informed of any potential problems so that they will not "get surprises" when such problems suddenly surface and "push a panic button" [Qt 91]. In such a situation of panic, the client or the consultant may interrupt the contractor's work, disturbing the smooth progress of the project and thus causing adverse effects on the contractor. The statement: "So, keeping your clients and the consultants informed is *always a good thing*" [Qt 91] illustrates that this is an informal and unsolicited process.

Further, the client needs to be informed of changes in the external conditions, i.e., local bylaws, requirements, regulations and so on that may impact the project [Qt 92]. "This can have very serious effects and the client will be very unhappy even though it is something beyond your control as a contractor". They may blame the contractor "Why you did not tell me earlier. This kind of thing you need to keep me informed" [Qt 92]. Identifying such external issues require experience, cognitive skills and critical thinking skills. The respondent further stated "the client is always right and the consultant is always on top of the contractor and we [contractor] must keep them happy by informing" [Qt 92] thus illustrating the informal and unsolicited natures of this process.

***In summary*:** Liaison on imminent construction problems require identification of such problems through cognitive psychological processes, application of practical knowledge developed from prior experience and skills of critical thinking and problem solving. Such processes are not visible to the other project participants and will not have a tangible effect on them unless the contractor fails to carryout the process resulting in an unforeseen problem in the project. The respondents elaborated that clients and consultants implicitly expect the co-ordinator to be proactive, thus illustrating that this is an unsolicited service informally carried out by the contractor to avoid problems. Please see Table 7.3 in Section 7.8.7. It would be further argued in Section 7.9 how these process characteristics, Problem Solving Work, Intangibility, Unsolicited Service and Intangibility, cause problems in applying the multi-attribute quality measurement model to the Process of 'Liaison with the Client and Consultants'.

7.8.4 Protocol for Liaison with the Client

According to the formal protocol, only the contractor's project manager is allowed to speak to the client and consultants. However as mentioned in Section 7.5.2, in a construction site environment where lots of informal liaison takes place, it is not surprising that this rule is also not strictly adhered to. A prime reason for this was that, "Sometimes if you try to go through the Project Manager or the Construction Manager to contact the consultant, the work will get delayed.

So, they make a sort of instant solution or the answer. Therefore, sometimes it is better to let the site engineer handling that work to directly deal with the consultant as long as all these discussions have been recorded" [Qt 23]. They "always feel that verbal communication is the most effective; in the sense of time it is the fastest" [Qt 24]. The process is carried out informally without always going through the project manager. Therefore, construction project participants often discuss onsite first and then record in writing through the project manager [Qt 23, 24 and 93]. Every attempt is made to capture and record all onsite discussions between the client, the consultants and the contractor. Another respondent said:

> As a rule, mostly by discussion and might be confirmed in writing … it is often better to talk to each other – to somebody before you write to them.

Such processes of discussing first and then recording will depend on co-production by the parties involved, i.e., how the parties to the discussion react, how they come to a consensus and the trust and the understanding between them. Thus, in a construction site with many specialist consultants or in a large site with lots of staff of the client and consultants, the contractor's processes for communicating with them can vary from one situation to another. This makes it difficult to apply attributes based quality measurement model to the process of liaison with the client.

***In summary*:** The respondents stated that they adopt informal channels of communications onsite because it is faster and effective than going by the formal protocol. Success of such informal liaison depends on how the relevant parties co-produce in the process. In a project with a variety of parties to liaise with, the co-ordinator's communication processes would lack repetition. Please see Table

7.3 in Section 7.8.7. It would be further argued in Section 7.9 how these process characteristics, Informality, Co-production by Customers and Low Repetition, cause problems in applying the multi-attribute quality measurement model to the Process of 'Liaison with the Client and Consultants'.

7.8.5 Liaison on Design Problems

Design problems are also major issues at construction sites that require liaison. The respondents stated that "drawings come with various discrepancies" [Qt 94]. In the informal environments that prevail in construction sites, "eventually the contractor may end up having to spot all the discrepancies and co-ordinate all the drawings for the consultant" [Qt 95].

The statements: "a column may be positioned at a wrong place" [Qt 94], "about 80% [problems] still have to be resolved – the drawings come with various discrepancies" [Qt 94] and "the contractor may end up having to spot all the discrepancies" [Qt 95] illustrate the problem solving work involved. It requires the co-ordinator to apply cognitive psychological process, experience and critical thinking skills to "to spot all the discrepancies" [Qt 95].

A designer having missed certain parts of a design may want the contractor to propose [Qt 96]. "May be it is so complicated, the consultant would not have the time to do it" [Qt 96]. According to the respondent, the attitude among consultants is to palm over such difficult work to the contractor, saying "you tendered for the project, you are supposed to know how to build it" [Qt 96]. So the contractor "may end up helping a consultant to do a design" [Qt 96]. It further illustrates the informal approach applied. Although the contractor is contractually entitled for a variation due to missing details in drawings and specification, one respondent stated how they informally "go and talk to them [consultants] all the time and say look you missed this out" [Qt 97]. Such informal liaison is very likely result in higher satisfaction of the client and consultants. It may further develop goodwill and a better business relationship for the future.

***In summary*:** The contractors go beyond the formal management protocol at construction sites to co-ordinate the drawings, help consultants in design work, point out missing details in drawings and specification and so on. It requires the co-ordinator to apply cognitive psychological process, experience and critical thinking skills. Please see Table 7.3 in Section 7.8.7. It would be further argued in Section 7.9 how these process characteristics, Informality and Problem Solving Work, cause problems in applying the multi-attribute quality measurement model to the Process of 'Liaison with the Client and Consultants'.

7.8.6 Maintaining Good Human Relations

The respondents emphasised the importance of maintaining good human relations with the staff of the client and consultants. Liaison needs to be done amicably and diplomatically thus maintaining very good rapport among all the people [Qt 98]. Writing letters to the client and consultants "claiming for extension of time and extra on overheads" could be very offensive [Qt 98]. The responses illustrate how contractors try to avoid making the transactions at the site too formal and contractual. Problems would occur "when people stop talking to each other …

Writing to each other is not necessarily good – sometimes. But certainly people must talk to each other" [Qt 99]. From the respondent's statement "it is often better to talk to each other – to somebody before you write to them. To make sure that the man understands its content before you put it under writing!" it could be observed that the informal approach contributes to conducting liaison amicably and diplomatically. Qt 99 was stated by a project manager in Hong Kong, who hails from a Western culture. A project manager in Singapore, who hails from an Asian culture, stated that Asian way of doing things is to make the paymaster happy [Qt 100]. Thus it is difficult, especially in the construction industries of Asia, to strictly go by the contract. "So you have to be a very PR man" [Qt 100]. He continued to give an example of how they would diplomatically handle a design problem. "So it is how you rephrase your question. Instead of going direct so that everybody will know" [Qt 101]. Another respondent described that, in handling design problems, "If it is a *sensitive* one [problem], we have to go informally … after the meeting we talk one to one. … If it is a *genuine* one [problem] then we go formally discussing the technical things. … My objective is to let the project move smoothly" [Qt 102]. It illustrates how the process of liaison with the client and consultants is flexibly applied depending on whether the issue in concern is "sensitive" or "genuine".

Three other respondents expressed [Qt 103 to 105] how good human relations are necessary for a contractor to successfully manage a project. They highlight the facts that doing a proper job alone is not enough, the human relations are also important. A good first impression formed by the consultants may make them "go a bit easy" [Qt 104] on the contractor and good human relations formed with the developer or the client is useful when there is a need to claim extension of time [Qt 105]. Therefore, the above discussion illustrates the informal approach applied by construction contractors to conduct liaison with the client and consultants amicably and diplomatically to maintain very good rapport among all the people thus letting "the project move smoothly" [Qt 102].

***In summary*:** The respondents illustrated how contractors try to avoid making the transactions at the site too formal and contractual, in order to maintain good human relations and achieve higher satisfaction of customers. Please see Table 7.3 in Section 7.8.7. It would be further argued in Section 7.9 how this process characteristic (Informality) causes problems in applying the multi-attribute quality measurement model to the Process of 'Liaison with the Client and Consultants'.

7.8.7 Summary of Process Characteristics that Cause Difficulties in Applying Multi-attribute Quality Measurement models

Summaries of discussions in Sections 7.8.1 to 7.8.6 are given at the end of each section. Further, similar to Sections 7.6 and 7.7, Columns 1 to 4 of Table 7.4 (given in Section 7.9) contain a summary of the above discussion on 'liaison with the client and consultants'. Still, as given in Table 7.3 it is useful to present an overview of the characteristics informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work identified in the process 'liaison with the client and consultants'. Therein it is noticeable that informality was identified in all six aspects of the process discussed above while intangibility was identified only in Liaison on Imminent Construction

Problems. The characteristic Problem Solving Work was identified only in the aspects Liaison on Imminent Construction Problems and Liaison on Design Problems.

In the fifth column of Table 7.4, it is analysed how the said characteristics cause difficulties in the application of Steps A to H (presented in Section 5.1) of the multi-attribute quality measurement model, which is the final phase of the analysis in this experiment.

Table 7.3: Characteristics of the Process 'Liaison with the Client and Consultants' that Cause Difficulties in Applying Multi-attribute Quality Measurement Model

Section	Co-ordination Aspect	Process Characteristics that Cause Difficulties					
		IF	IG	CP	LR	US	PS
7.8.1	Liaison on Decisions Required for the Progress of Work	●		●	●	●	
7.8.2	Understanding the Exact Needs of the Client	●		●	●	●	
7.8.3	Liaison on Imminent Construction Problems	●	●			●	●
7.8.4	Protocol for Liaison with the Client	●		●	●		
7.8.5	Liaison on Design Problems	●					●
7.8.6	Maintaining Good Human Relations	●					

Key: -
- IF - Informality
- IG - Intangibility
- CP - Co-production by Customers
- LR - Low Repetition
- US - Unsolicited Service
- PS - Problem Solving Work
- ● - Indicates that difficulties (in applying multi-attribute quality measurement model) occurring due to the process characteristic were identified in the above discussion.

7.9 Problems in Applying the Attributes Based Quality Measurement Method

In Sections 7.6 to 7.8, the process characteristics informality, intangibility, low repetition, co-production by customers, unsolicited service and problem solving work (discussed in Section 5.3 when formulating Hypothesis H1) were identified in the three co-ordination processes concerned:

1. Identifying strategic activities and potential delays
2. Ensuring the timeliness of all work carried out
3. Liaison with the Client and Consultants

In this section, the difficulties the said characteristics will pose to the application of Steps A to H of the attributes based quality measurement model (presented in Section 5.1) to the above three co-ordination processes will be analysed. The Steps A to H are:

Step A. State the construction co-ordination process to be measured.

Step B. Identify the customers of the process

Step C. Identify the other stakeholders of the process

Step D. Identify (with the help of a service quality model) those performance characteristics required by the customers and other stakeholders.

Step E. Translate each characteristic desired by customers and other stakeholders into corresponding specifications for the process and the outputs.

Step F. Flowchart (or otherwise document) the process

Step G. List the measures internal to the process that control the performance of the process outputs against the requirements and specifications identified above. List the salient features of the process as practised now.

Step H. Determine how satisfied customers are with performance at the current level and the relative importance customers place on changing the level of each characteristic.

For clarity and ease of presentation, the analysis is presented in tabular form in Table 7.4. Tables save words and comparisons.

Columns 1 to 4 of Table 7.4 present a summary of the analysis presented in Sections 7.6 to 7.8. Column 5 presents an analysis of the process characteristics identified in Column 4, in terms of potential difficulties (discussed in Section 5.3) of applying Steps A to H of the multi-attribute quality measurement model, in the contexts summarised in Column 3. Column 6 with its eight sub-columns (A to H) is a graphical illustration of the findings of Column 5 on difficulties in applying Steps A to H.

Because Table 7.4 is lengthy, it is not easy to visualise the results presented in Column 6. Therefore, the information in Columns 1, 2, 4 and 6 are presented again in Table 7.5. Therein, it could be observed that all the steps of the multi-attribute quality measurement model encounter difficulties when being applied to the construction co-ordination processes considered.

Table 7.4: Difficulties in Applying the Multi-attribute Quality Measurement Model

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.6	**Identifying Strategic Activities and Potential Delays**											
7.6.1	The Initial Planning Stage	Co-ordinator carries out cognitive psychological process and applies experience to study in great detail the works to be carried out and identify potential problems.	Problem solving work	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●
		Co-ordinators themselves are not aware of their cognitive psychological processes. Also such processes are internalised within the co-ordinator and difficult for other project participants to visualise them. Results of the process will not be felt unless the co-ordinator fails to identify an important issue thus causing problems at a later stage in the project.	Intangibility	Difficult to identify the process as required in Step A and to identify customers and stakeholders as required in Steps B and C. Difficult to identify expectations of the customers and stakeholders as required in Step D. Difficult to identify the voice of the customer and the voice of the process as required in Step E. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●	●	●	●	●	●	●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.6.1	The Initial Planning Stage (… Continued)	The processes of studying the work and identifying potential problems are not carried out at the request of the other participants of the project.	Unsolicited Service	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●
		Details of the construction processes are worked out with various subcontractors involved in the work.	Co-production by Customers	Difficult to identify customers and stakeholders as required in Steps B and C. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●	●	●	●		●	●
7.6.2	Design Co-ordination	Contractor has to co-ordinate drawings.	Informality	Difficult to identify regular or repetitive process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G.	●					●	●	

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.6.2 Design	Co-ordination (… Continued)	Cognitive psychological process carried out and co-ordinator's experience is applied to identify potential problems with the help of the drawings.	Problem solving work	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●
		Without solicitation by consultants or even subcontractors, contractor gets involved in design co-ordination to ensure undisrupted progress of work.	Unsolicited Service	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●
		The other project participants will not feel the process unless the co-ordinator fails to identify a problem and works get disrupted.	Intangibility	Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.				●	●		●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.6.3	Co-ordinating Specialist Subcontractors	Any changes to construction work needs to be checked with the specialist subcontractors.	Co-production by Customers	Difficult to identify the process as required in Step A. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G.	●			●	●	●	●	
		Specialist subcontractors do not look at other related work.	Unsolicited Service	Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E.				●	●			
		Cognitive psychological processes carried out and the co-ordinator's experience is applied to identify potential clashes with specialist subcontractors' work.	Problem solving work	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying A	B	C	D	E	F	G	H
7.6.3	Co-ordinating Specialist Subcontractors (… Continued)	Cognitive psychological processes carried out to avoid possible clashes between the works of disparate parties are not tangible to other project participants.	Intangibility	Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.				●	●		●	●
7.6.4	The General Approach to Day-To-Day Co-ordination	Cognitive psychological process carried out and co-ordinator's experience is applied to identify potential problems.	Problem Solving Work	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●
		Co-ordinator's experience verbal communications, informally asking questions and working back from commissioning date are methods used to identify potential problems.	Informality	Difficult to identify the process as required in Step A. Difficult to identify the voice of the customer as required in Step E. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G.	●				●	●	●	

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.6.4	The General Approach to Day-To-Day Co-ordination (… Continued)	Problems have to be brought up early for discussion with other project participants. Co-ordinators have to check whether up-dated drawings and specifications are used.	Unsolicited Service	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●
		Identifying problems through experience and cognitive psychological processes, avoiding problems or providing solutions through practical knowledge are not tangible to the other project participants.	Intangibility	Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.				●	●		●	●
		Co-ordination process requires talking to other project participants, asking questions and understanding their work.	Co-production by Customers	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying A	B	C	D	E	F	G	H
7.6.5	Co-ordinating Onsite Facilities	Persons who need the onsite facilities may not request it or verify the availability.	Unsolicited Service	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●
		Onsite facilities required by each party to the project have to be found out and planned for.	Co-production by Customers	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.6.5	Co-ordinating Onsite Facilities (… Continued)	The process of planning onsite facilities involve calculations and analysis.	Problem Solving Work	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●
		Co-ordinator's processes of checking, analysing and planning onsite facilities are not tangible to other project participants.	Intangibility	Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.				●	●		●	●
		The process may require a knowledge of the local conditions.	Informality	Difficult to identify regular or repetitive process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G.	●					●	●	

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.7	**Ensuring the Timeliness of All Work Carried Out**											
7.7.1	The General Approach to Ensuring the Timeliness of Construction Work	The frequency of site personnel monitoring the work depends on how important or how critical the activities are and they plan according to what is delaying. Procedures applied are flexibly according to the situation. Often relying on judgement based on experience rather than using established norms. Use of verbal communication rather than letters and memos. Reliance on site observations rather than formal reporting procedures. Simple scheduling techniques such as bar charts are used rather than sophisticated scheduling software. Not going strictly contractually but trying accommodate the client's needs.	Informality	Difficult to identify regular or repetitive process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G.	●					●	●	

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.7.1	The General Approach to Ensuring the Timeliness of Construction Work (… Continued)	Opportunity or delays in the project, transportation problems or storage problems are identified by cognitive psychological processes. Solving them depend on critical thinking abilities and problem solving skills.	Problem Solving Work	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●
		Whether the programmes can be met and if not the alternatives possible are established with the subcontractors and suppliers. Regular meetings are held with other project participants where feedback on the status of their work and problems faced are obtained.	Co-production by Customers	Difficult to identify the process as required in Step A. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G.	●			●	●	●	●	
		Processes carried out by observations at site, cognitive psychological processes, critical thinking, problem solving, using experience to judge, verbal communications and so on are not visible to the other project participants.	Intangibility	Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.				●	●		●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.7.1	The General Approach to Ensuring the Timeliness of Construction Work (… Continued)	Delayed par ties do not request the project manager to manage them to ensure timeliness.	Unsolicited Service	Difficult to identify customers as required in Step B. Difficult to iden tify expectations of th e customers as required in Step D. Difficult to ide ntify the vo ice of the custom er as required in Step E. Difficult to identif y m easurable attr ibutes of the process, outputs and outcomes as required in Step G. Even when m easurable at tributes are id entified, difficult for cus tomers to evaluat e them as required in Step H.		●		●	●		●	●
		Project Manager's personal sty le of operation has a significant effect on the processes. Procedures flex ibly applied to s uit the needs and convenien ces of individual situations. Case-by-case handling of situations.	Low Repetition	Difficult to id entify regu lar or repet itive proc ess as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identif y m easurable attr ibutes of the process, outputs and outcomes as required in Step G.	●					●	●	

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.7.2	Managing the Timeliness of Subcontracted Work	Involves studying and analysing the problem holding the subcontractor back and solving it. Cognitive psychological processes are used. Requires the Project Manager's practical knowledge, experience, critical thinking skills and problem solving skills. Rate of progress of work is not uniform. Judging the progress requires critical thinking skills.	Problem Solving Work	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●
		Studying, analysing and solving problems, using practical knowledge and experience, cognitive psychological processes and so on are not visible to other project participants.	Intangibility	Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.				●	●		●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.7.2	Managing the Timeliness of Subcontracted Work (… Continued)	Subcontractors do not request to be managed for timeliness; in fact they will like to hide their problems.	Unsolicited Service	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●
		Process is affected by the reaction to the process by the subcontractor.	Co-production by Customers	Difficult to identify the process as required in Step A. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G.	●			●	●	●	●	

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.7.2	Managing the Timeliness of Subcontracted Work (… Continued)	Subcontracted work can run into a wide variety of problems having special needs and they are handled on a case-by-case basis.	Low Repetition	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●
		Co-ordinator should be able to be flexible, see in practical sense, take early decisions, work back from the commissioning date and so on. It is situational management – what situation you are in ? What situation the subcontractor is in?	Informality	Difficult to identify regular or repetitive process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G.	●					●	●	

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.8	**Liaison with the Client and Consultants**											
7.8.1	Liaison on Decisions Required for the Progress of Work	The contractor has to informally communicate with the client to obtain information on the latter's requirements as early as possible or to pressurise the consultant to give outstanding information.	Informality	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G.	●					●	●	
		Client needs to be made aware of the problems so that they may help the contractor and consider not imposing liquidated damages. Consultants may have vested interests in this process because it highlights their ineffectiveness and the shortcomings of the design to the client. Neither the client nor consultants will check with the contractor whether all required information is there. The responsibility of co-ordination rests on the main contractor. The other project participants do not solicit the service of co-ordination. It is the main contractor who is responsible to look at the "big picture" of delivering a functional project on schedule.	Unsolicited Service	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.8.1	Liaison on Decisions Required for the Progress of Work (… Continued)	Processes performed by the co-ordinator depend on the client's willingness to entertain the informal queries and the degree of co-operation provided.	Co-production by Customers	Difficult to identify the process as required in Step A. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G.	●			●	●	●	●	
		Processes depend on the specific situations in the project and are handled in a case-by-case manner. Due to co-production by clients, discussed above, processes vary to suit the reactions (during the processes) by the customers and further loose repetitive nature.	Low Repetition	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.8.2	Understanding the Exact Needs of the Client	Contractors need to communicate with the client to exactly find out the needs of the latter. Acceptance criteria of the client and consultants can differ. Contractors find it useful to go beyond the formal site management protocol to exactly find out the needs of the client beyond what is specified by the consultant and provided in the contract. It is important to liaise with the client on decisions which are very personnel such as colour schemes.	Informality	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G.	●					●	●	
		Clients would not request the contractor to find out their exact needs. Clients do not request the contractor to liase on choices and decisions which are very personnel. but the contractor has to watch out for them and handle with lots of tact and diplomacy and make sure that they are done	Unsolicited Service	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.8.2	Understanding the Exact Needs of the Client (… Continued)	Processes performed by the co-ordinator depend on the client's willingness to entertain the informal queries and the degree of co-operation provided.	Co-production by Customers	Difficult to identify the process as required in Step A. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G.	●			●	●	●	●	
		Processes depend on clients' attitude. Processes depend on the specific project circumstances and are managed in a case-by-case manner.	Low Repetition	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●
7.8.3	Liaison on Imminent Construction Problems	Contractor's co-ordinator would identify imminent construction problems through cognitive psychological processes. It requires application of practical knowledge developed from prior experience, critical thinking skills and problem solving skills.	Problem Solving Work	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.8.3	Liaison on Imminent Construction Problems (… Continued)	The process will not have tangible effects on other project participants unless the contractor fails to carryout the process resulting in unforeseen problems in the project.	Intangibility	Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.				●	●		●	●
		Clients and consultants need to be advised on imminent construction problems without their soliciting such service.	Unsolicited Service	Difficult to identify customers as required in Step B. Difficult to identify expectations of the customers as required in Step D. Difficult to identify the voice of the customer as required in Step E. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.		●		●	●		●	●
		This is not a formal reporting procedure under the normal site management protocol.	Informality	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G.	●					●	●	

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.8.4	Protocol for Liaison with the Client	Construction p roject participants often discuss o nsite first and then record in writing through the project manager The proces s is carried out informally with out alway s going through the project manager.	Informality	Difficult to id entify regu lar or repet itive proc ess as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identif y m easurable attr ibutes of the process, outputs and outcomes as required in Step G.	●					●	●	
		The pro cess depends on how the parties to the discussion react.	Co-production by Customers	Difficult to identify the process as required in Step A. Difficult to iden tify expectations of th e customers as required in Step D. Difficult to ide ntify the vo ice of the custom er as required in Step E. Difficult to flowchart the process as required in Step F. Difficult to identif y m easurable attr ibutes of the process as required in Step G.	●			●	●	●	●	
		In a constru ction site wi th m any specialist consul tants or in a large site with lots of staff of the cl ient and consultan ts the process for communicating with the cli ent can vary from one situation to another.	Low Repetition	Difficult to identify customers as required in Step B. Difficult to iden tify expectations of th e customers as required in Step D. Difficult to ide ntify the vo ice of the custom er as required in Step E. Difficult to identif y m easurable attr ibutes of the process, outputs and outcomes as required in Step G. Even when m easurable at tributes are id entified, difficult for cus tomers to evaluat e them as required in Step H.		●		●	●		●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying: A	B	C	D	E	F	G	H
7.8.5	Liaison on Design Problems	Contractor may end up having to spot all the discrepancies and co-ordinate all the drawings for the consultant.	Informality	Difficult to identify regular or repetitive process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G.	●					●	●	
		Requires the co-ordinator to apply cognitive psychological process, experience and critical thinking skills to spot all the discrepancies.	Problem Solving Work	Difficult to identify the process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process as required in Step G. Even when measurable attributes are identified, difficult for customers to evaluate them as required in Step H.	●					●	●	●

Table 7.4 continued …………

① Section	② Co-ordination Aspect	③ Summary of Co-ordination Process Analysis	④ Process Characteristics that Cause Difficulties	⑤ Difficulties in Applying the Steps of the Multi-attribute Quality Measurement Model	⑥ Summary of Steps A to H with Difficulties in Applying							
					A	B	C	D	E	F	G	H
7.8.6	Maintaining Good Human Relations	Contractors try to avoid making the transactions at the site too formal and contractual. It is considered better to talk to other project participants before writing. Especially in the construction industries of Asia, it is difficult to go strictly by the contract. The process is flexibly applied depending on whether the issue in concern is "sensitive" or "genuine". A good first impression formed by the consultants may make them go a bit easy on contractor and good human relations formed with the developer or the client is useful when there is a need to claim extension of time.	Informality	Difficult to identify regular or repetitive process as required in Step A. Difficult to flowchart the process as required in Step F. Difficult to identify measurable attributes of the process, outputs and outcomes as required in Step G.	●					●	●	

Table 7.5: Summary of the Findings of Table 7.4

Section	Co-ordination Aspect	Process Characteristics that Cause Difficulties	Summary of Steps A to H with Difficulties in Applying: A	B	C	D	E	F	G	H
7.6	**Identifying Strategic Activities and Potential Delays**									
7.6.1	The Initial Planning Stage	Problem solving work	●					●	●	●
		Intangibility	●	●	●	●	●	●	●	●
		Unsolicited Service		●		●	●		●	●
		Co-production by Customers		●	●	●	●		●	●
7.6.2	Design Co-ordination	Informality	●					●	●	
		Problem solving work	●					●	●	●
		Unsolicited Service		●		●	●		●	●
		Intangibility				●	●		●	●
7.6.3	Co-ordinating Specialist Subcontractors	Co-production by Customers	●			●	●	●	●	
		Unsolicited Service				●	●			
		Problem solving work	●					●	●	●
		Intangibility				●	●		●	●
7.6.4	The General Approach to Day-To-Day Co-ordination	Problem Solving Work	●					●	●	●
		Informality	●				●	●	●	
		Unsolicited Service		●		●	●		●	●
		Intangibility				●	●		●	●
		Co-production by Customers	●					●	●	●
7.6.5	Co-ordinating Onsite Facilities	Unsolicited Service		●		●	●		●	●
		Co-production by Customers		●		●	●		●	●
		Problem Solving Work	●					●	●	●
		Intangibility				●	●		●	●
		Informality	●					●	●	
7.7	**Ensuring the Timeliness of All Work Carried Out**									
7.7.1	The General Approach to Ensuring the Timeliness of Construction Work	Informality	●					●	●	
		Problem Solving Work	●					●	●	●
		Co-production by Customers	●			●	●	●	●	

Table 7.5 continued …………

Section	**Co-ordination Aspect**	**Process Characteristics that Cause Difficulties**	**Summary of Steps A to H with Difficulties in Applying**							
			A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
7.7.1	The General Approach to Ensuring the Timeliness of Construction Work (… Continued)	Intangibility				●	●		●	●
		Unsolicited Service		●		●	●		●	●
		Low Repetition	●					●	●	
7.7.2	Managing the Timeliness of Subcontracted Work	Problem Solving Work	●					●	●	●
		Intangibility				●	●		●	●
		Unsolicited Service		●		●	●		●	●
		Co-production by Customers	●			●	●	●	●	
		Low Repetition		●		●	●		●	●
		Informality	●					●	●	
<u>7.8</u>	**<u>Liaison with the Client and Consultants</u>**									
7.8.1	Liaison on Decisions Required for the Progress of Work	Informality	●					●	●	
		Unsolicited Service		●		●	●		●	●
		Co-production by Customers	●			●	●	●	●	
		Low Repetition		●		●	●		●	●
7.8.2	Understanding the Exact Needs of the Client	Informality	●					●	●	
		Unsolicited Service		●		●	●		●	●
		Co-production by Customers	●			●	●	●	●	
		Low Repetition		●		●	●		●	●
7.8.3	Liaison on Imminent Construction Problems	Problem Solving Work	●					●	●	●
		Intangibility				●	●		●	●
		Unsolicited Service		●		●	●		●	●
		Informality	●					●	●	
7.8.4	Protocol for Liaison with the Client	Informality	●					●	●	
		Co-production by Customers	●			●	●	●	●	
		Low Repetition		●		●	●		●	●
7.8.5	Liaison on Design Problems	Informality	●					●	●	
		Problem Solving Work	●					●	●	●
7.8.6	Maintaining Good Human Relations	Informality	●					●	●	

7.10 Accepting Hypothesis H1

The analysis presented in Section 7.5 revealed that the three co-ordination processes concerned:

1. Identifying strategic activities and potential delays
2. Ensuring the timeliness of all work carried out
3. Liaison with the Client and Consultants

are carried out through regular co-ordination meetings, making direct observations at the site and proactively bringing up various problems into discussion and so on. In such a context, as presented in Sections 7.6 to 7.8, it was possible to identify characteristics of:

- informality
- intangibility
- low repetition
- co-production by customers
- unsolicited service
- problem solving work

among the co-ordination processes that make it difficult to identify a predictable flow of processes, the personnel involved, the customers and other stakeholders, the interactions or inputs and outputs between these parties, expectations of these parties and so on.

Then in Section 7.9 it was presented how these characteristics cause difficulties in applying Steps A to H:

Step A. State the construction co-ordination process to be measured.

Step B. Identify the customers of the process

Step C. Identify the other stakeholders of the process

Step D. Identify (with the help of a service quality model) those performance characteristics required by the customers and other stakeholders.

Step E. Translate each characteristic desired by customers and other stakeholders into corresponding specifications for the process and the outputs.

Step F. Flowchart (or otherwise document) the process

Step G. List the measures internal to the process that control the performance of the process outputs against the requirements and specifications identified above. List the salient features of the process as practised now.

Step H. Determine how satisfied customers are with performance at the current level and the relative importance customers place on changing the level of each characteristic.

of the multi-attribute quality measurement systems to the three co-ordination processes concerned. It could be observed from Table 7.5 that the process characteristics:

- 'Co-production by Customers' often cause difficulties in applying Steps A, D, E, F and G
- 'Informality' often cause difficulties in applying Steps A, F and G
- 'Intangibility' often cause difficulties in applying Steps D, E, G and H
- 'Low Repetition' often cause difficulties in applying Steps B, D, E, G and H

- ‘Problem Solving Work’ often cause difficulties in applying Steps A, F, G and H
- ‘Unsolicited Process’ often cause difficulties in applying Steps B, D, E, G and H

It was argued in Section 5.5 that, above Steps A to H are the most basic and essential steps required in applying any multi-attribute quality measurement model to any process. Difficulties in applying these basic and essential Steps A to H to construction co-ordination context signify difficulties in applying any multi-attribute quality measurement model to that context.

On the strength of these arguments, Hypothesis H1, that “Attributes based quality measurement tools are not applicable to the construction co-ordination processes”, was accepted.

Chapter 8

TESTING THE SUITABILITY OF THE CRITICAL INCIDENT TECHNIQUE (CIT)

8.1 Hypothesis H2

In Section 3.7 the Critical Incident Technique (CIT) was described as a powerful tool that could be applied to construction co-ordination processes because of the following features:

- Provides opportunities for the service provider to understand many tacit details of how customers think, what is important to them, their objectives, values, expectations and so on.

- At the time of collecting data we do not attempt to make the respondents fit into our definition of quality or our model of quality. This allows the customers to think about services the way they normally do and provide an authentic account of the service experience.

- Descriptions of negative experiences makes it possible to identify implicit expectations and explicit expectations while descriptions of delightful experiences indicate latent expectations among the customers. (The terms implicit, explicit and latent expectations are explained in Section 2.5)

- Due to co-production by customers in the co-ordination processes, their descriptions on critical incidents will describe many valuable aspects of the service production process in addition to the facets of outputs and outcomes.

- Respondents when describing the critical incident, are likely to describe certain aspects of the problem solving skills of the construction project manager or the co-ordinator.

- This technique can be applied to survey the opinion of all stakeholders of the process viz. customer, shareholders, employees and the community

Therefore a Hypothesis is formulated as follows:

H2: The Critical Incident Technique (CIT) is a practical method for measuring the quality of construction co-ordination processes.

The rest of this chapter describes how this hypothesis was tested.

8.2 The Method for Testing Hypothesis H2

In view of the measurement theory presented in Chapter 2 and the arguments presented in Chapter 3, the Critical Incident Technique (CIT) can be considered a practical method to measure construction co-ordination if it can:

- measure at the three levels of process, output and outcome

- be applied to customers as well as other stakeholders (owner/shareholders, employees and society) thus measuring quality on all these four dimensions

- identify the implicit, explicit and latent expectations (explained in Section 2.5) of customers/stakeholders and evaluate the satisfaction of them all

- be applied to co-ordination processes despite the process characteristics of Informality, Intangibility, Co-production by Customers, Low Repetition, Unsolicited Service and Problem Solving Work

- generate measurement results that can be utilised to improve the processes

Hypothesis H2 was tested by (Experiment 4) interviewing a number of stakeholders of construction co-ordination processes and requesting each to describe at least one critical incident. The stories of critical incidents thus received were analysed to check whether they are capable of providing the information required to make measurements that satisfy the above criteria. Please see the justification of the methodology in Section 8.3.1.

8.3 Developing the Interview Structure and Conducting the Survey

Stauss (1993) states that, a survey of critical incidents involves two questioning steps. The first requests a "comprehensive description of the incident in the customer's own words", followed by a query as to "which circumstances were decisive for the customer's evaluation". Bitner *et al.* (1990) had adopted the following format of questions:

- Think of a time when, as a customer, you had a particularly *satisfying (dissatisfying)* interaction with an employee of an airline, hotel or restaurant.

- When did the incident happen?

- What specific circumstances led up to this situation?
- Exactly what did the employee say or do?
- What resulted that made you feel the interaction was *satisfying (dissatisfying)*?

Based on the above guidelines by Stauss (1993) and the example by Bitner *et al.* (1990), the very simple questionnaire given in Appendix J was developed. Being a questionnaire for the construction industry, where the participants are very busy, the Author had every incentive to make it simple. Therefore just two question were formulated as follows:

> Think of a time when, as a construction project participant (at the construction stage), you met with a particularly satisfactory (or unsatisfactory) incident of site co-ordination by the main contractor.
>
> 1. How exactly did the incident happen? *(Need not disclose the names of the site or companies or individuals involved. Use their designations only e.g., client, main contractor, project manager, site engineer, QS.)*
>
> 2. What actions in that incident exactly made you feel satisfied (or dissatisfied)?

For reasons given in Section 1.6.3 the present experiment was not focused on one particular site. Instead it was conducted on industry personnel who were willing to participate. Therefore, as evidenced by the first question above, the respondents were made to feel comfortable by allowing the critical incidents described to be unattributable. Nevertheless, it was necessary to establish the type of stakeholder responding to the survey. (In a survey of critical incidents of firsthand experience, a respondent describing the incident is invariably a stakeholder of the process). Therefore, a third question was asked as follows:

> In that site, what was your position? ...…………………………………… working for the Client/Consultant/Main Contractor/Other (please specify) ………………………….
> *(Delete inapplicable)*

The questionnaire was pilot tested on two construction personnel in Hong Kong. No problems arose in understanding/interpreting the questions and therefore the same version was used for the industry wide survey.

Where possible, the questions were asked face to face. Because the questions were simple, a mailed questionnaire was used when an interview was not possible. Therefore, as apparent from the covering letter given in Appendix J, the recipients were provided three options, i.e., either to grant an appointment to the Author to meet at a time convenient and record the information or use the two reply forms attached to write the response or write an e-mail. It was found, however, that recipients of the questionnaires were usually not happy to write descriptive answers.

Questionnaires were faxed to 112 clients, architects, consultants, project management and quantity surveying organisations in Hong Kong and were sent by mail to 119 similar organisations in Singapore. Further, questionnaires were mailed to:

- 157 construction contractors in the Hong Kong Works Branch tender list Group C and HKHA tender lists NW2 and NW1
- 120 construction contractors in lists G7 and G8 of CIDB, Singapore

In contractor organisations, targeted respondents were Directors (superiors of the construction project managers) and site engineers/agents (subordinates of construction project managers who assist in co-ordination). Therefore one set of questionnaires were despatched addressed to the Managing Directors and another set was mailed stating on the envelope that it contains a questionnaire and requesting to be forwarded to a site engineer/agent. Further, the questionnaire was e-mailed in the 'Text Only' format to members of the Co-operative Network for Building Researchers (CNBR). Additionally, requests were made to known personnel in the construction industries of Hong Kong and Singapore.

A total of 36 critical incidents were collected from 21 respondents because 5 respondents provided more than one critical incident. Four responses had to be discarded because the respondents failed to focus on co-ordination processes. From the remaining 32, 23 responses were selected primarily on the basis of the quality of the responses (Carroll and Johnson (1990) state that it is typical to focus analysis of qualitative data on the best responses where the respondents have verbalised well) and also to enable the analysis to be representative of the following:

- stories by a variety customers and stakeholders
- cases concerning the three levels of customer expectations, viz. implicit, explicit and latent
- stories focus on co-ordination processes, outputs and outcomes

Analysis of these data is presented in Sections 8.4 to 8.8 and a summary of the results is presented in Table 8.1.

8.3.1 Justification of the Research Methodology

As discussed in Sections 3.7 and 8.1, CIT is a powerful quality measurement tool. Especially, it allows customers to think about services the way they normally do and articulate the service experiences in their own terms and familiar language. The Hypothesis H2 would be true if such strengths persist despite the difficult characteristics of construction co-ordination processes: Informality, Intangibility, Low Repetition, Problem Solving Work, Co-production by Customers and Unsolicited Service. The way of verifying this is by applying CIT to construction co-ordination processes and testing its capability of generating information required to make measurements that satisfy the criteria given in Section 8.2.

The critical incident surveys were carried out using a questionnaire that involved two questioning steps as recommended by Stauss (1993). As explained in Section 1.6.3 and 1.6.4, this experiment was conducted with industry practitioners who would willingly contribute to the research, instead of attempting to focus on a selected construction site. For the reasons discussed in Section 1.5 and in the following paragraph, it was not attempted to conduct the survey on a statistical sample of the industry.

In testing Hypothesis H2 logic of probability is not used. It is entirely based on the descriptive data of critical incidents. Mason (1996) states that, “in qualitative research the logic of probability is rarely used” and alternative forms of logic based on arguments can be used. Therefore in the present analysis, the argument used is whether the Critical Incident Technique (CIT) is capable of providing the information required to make measurements that satisfy the criteria given in Section 8.2.

8.4 An Overview of the Analysis of Interview Results

As stated before in Section 3.7, the Critical Incident Technique (CIT) does not force the respondents to think in terms of our definition of quality or our model of quality. Instead, what is collected is an array of authentic descriptions of service encounters in customers' own words. The service provider has to analyse this collection of little stories to develop a measure of the service quality. In the following sections, the responses on critical incidents of construction co-ordination collected during the surveys are analysed to determine, based on the criteria laid in Section 8.2, the possibility of developing an understanding of the level of quality provided. For clarity, the analysis is divided into 4 sections based on the type of respondent (stakeholder): customer (such as client, architect, consultant, quantity surveyor, subcontractor and so on), owner (e.g., director of a construction contractor), employee (e.g., site engineer/agent – assisting the project manager in site co-ordination) and the society. A summary of the findings is provided in Table 8.1. Since the measurements thus obtained are qualitative, how they could be used to understand and compare incremental improvements in co-ordination processes is discussed in Section 8.11.

8.5 Responses by Customers of Project Manager

8.5.1 Responses by Clients

Seven Critical Incidents given by clients' site staff are analysed below, to understand their applicability as measures of the quality of co-ordination in the respective sites.

Critical Incident : 1
Responding Stakeholder : Project Manager (working for the Client)

I would expect the contractor's project manager to have a full picture of various trades/disciplines involved. Provide for all these things in terms of co-ordination.

Just before contractor wants to do a concrete pour, comes and tells "Hey! There is this big discrepancy between the mechanical drawings and the structural plans!" – where there should be a shaft, an opening or a vent – "… and we are just going to cast today!" As a competent Project Manager he should, sometime before the casting – may be a week before – he should have exhausted all material he has; it could be drawings, specifications, even specialist shop drawings. He should look through everything and satisfy himself that there are no major discrepancies technically as well as other things. If there is and he is unable to resolve them, he should come back to the consultant or the specialist and have a technical meeting to solve it. So, at least we would expect this to be done instead of at the last minute coming and telling "there is a discrepancy, our work is delayed, *you* do not have the details for me".

I have cases where contractors study even a few floors in advance before they go up to a certain level and they highlight problems leaving ample time to have all these things done – resolved – and some problems you may actually need to go back to some Government departments and get clearance and all that.

I am dissatisfied because there is no proactive project management here.

In the above critical incident, the Client's Project Manager expresses dissatisfaction because "there is no proactive project management" by the Contractor's Project Manager. Analysis of the incident enables observation of at least some of the reasons that led to this impression. The description of the incident reveals that the former implicitly expects the latter to:

- "have a full picture of various trades/disciplines involved and provide for all these things in terms of co-ordination".
- sometime before the casting, may be a week before, exhaust all material such as drawings, specifications, specialist shop drawings and so on to be satisfied that there are "no major discrepancies technically as well as other things".
- not come just before a scheduled concrete pour and say "There is this big discrepancy"

The above critical incident highlights the implicit expectations of the client. It also describes shortcomings in the present process and the outputs, that explain to some extent how these expectations are not being met.

- The Contractor's Project Manager either does not study the drawings and specifications or even having done so fails to identify discrepancies. Reasons may either be gross negligence or lack of cognitive competencies to identify problems or technical incompetence or lack of experience and so on. The service providers could identify such exact reasons by internally studying their co-ordination processes based on the directions received from the critical incident.
- The co-ordination output comes too late for the consultant to provide a solution to the discrepancy without delaying the scheduled concrete pour. This is a problem directly resulting from the shortcomings in the process, i.e., the discrepancies are not identified until they surface as problems onsite.

- The quotation by the respondent "… our work is delayed, *you* do not have the details for me" reflects the adversarial attitude the contractor has brought to the site. Firstly, it suggests how the contractor could improve the co-ordination outputs to create a cordial environment at the site. Secondly, it suggests possible vested interests the contractor's management has in not achieving co-ordination, in order to claim extra time to complete the works. If the latter is the case, the service provider (Contractor's Project Manager) may not be interested in improving the process. Nevertheless, the critical incident illustrates how the vested interest causes the relationship with the client and consultants to deteriorate.

Further, the statement by the respondent "I have cases where contractors study even a few floors in advance … highlight problems leaving ample time" hints how some other contractors have satisfied his expectations by identifying potential problems well in advance.

The above discussion illustrates how analysis of a critical incident description enabled the identification of:

- implicit expectations of the customer
- possible shortcomings in the process and the outputs that explain to some extent how the above expectations are not being met
- effects of possible vested interests the contractor's management has in not achieving co-ordination in order to claim extra time to complete the works

- the fact that other contractors have satisfied the Client's Project Manager's expectations in the past

Work by the Contractor's Project Manager in reading the drawings, specifications, specialist shop drawings, etc., and performing cognitive processes to identify discrepancies and potential problems is not a process tangible to other project participants. It is a problem solving process often carried out informally without explicit solicitation as pointed out in Section 7.6. Despite these characteristics of the process, the study of the Critical Incident enabled a measure of the process quality to be obtained and an understanding of many aspects useful for improvement of the process and the outputs.

Critical Incident : 2
Responding Stakeholder : Project Manager (working for the Client)

> Contractor's project manager must be able to bring his team together, he will have a lot of subcontractors, he must be in good control of the various trades that are going in. He should be able to plan his work well, such that work that really have to go first really go first. Not do without planning – just do everything he feels – this subcontractor comes in, just ask him to start work and there may be some abortive work.
>
> This guy [subcontractor] doing brickwork had come in – the Project Manager just let him put up all the brick walls and not co-ordinating the services and M&E work. So, those [latter] contractors came in and hacked here and there. There were areas where big services go. You can co-ordinate and leave those for later. Worst thing is in some of the RC walls coring needed to be done. A good project manager should be in good control and phase his work.

In Critical Incident 2, a Client's Project Manager is dissatisfied with the abortive work onsite that happen due to poor control and phasing of work. Achieving the correct sequence of work appears to be an implicit expectation of the Client's Project Manager. It could be judged by the statement "must be in good control of the various trades that are going in … plan his work well, such that work that really have to go first really go first". The Contractor's Project Manager fails to satisfy this implicit expectation. It is common experience that securing required labour for a construction project at the optimum time is a difficult task. The description of this critical incident reveals that the present problem is a result of the Contractor's Project Manager allowing whatever subcontractor coming in to start work without co-ordinating with the services and M&E work. Thus the respondent describes the shortcomings of the co-ordination process where the contractor's project manager fails to do the problem solving work expected of him, such as deciding which trade should go in first, identifying where the big services go and getting the bricklayers to leave such areas for later and so on to avoid abortive work. Hence this measurement indicates the quality of co-ordination and where the improvement efforts can be focused.

Critical Incident : 3
Responding Stakeholder : Client

> There are instances where the contractor has to make floor penetrations of sizes ranging as small as 50 – 75 mm to as big as 300 mm. The contractor will miss out – human beings – so end up needing coring. In some areas, if you miss out, coring will not be possible due to the structural concept – the structural engineer will say you cannot core within 600 mm of the column.
>
> Here [in that site] they missed a row of penetrations for rainwater down pipes. They were next to the columns and as a result they wanted to go through a point 600 mm away. If they were going through the original location they could have made a neat and small 150 mm box-out next to the column. Now they would need a huge box-out. I refused because the furniture will not fit in anyway and it is an utter waste of space – some 750 mm just for a rain water pipe! I wanted the rain water system to be redesigned and the architect came with a scheme that was not all that nice.
>
> I am dissatisfied because it was a terrible mistake. It is very difficult to correct. There are so many people out there [onsite] to check these things and co-ordinate.

Critical Incident 3 describes a situation where the client's explicit expectation of making penetrations through the concrete slab for rainwater down pipes was not satisfied. It suggests shortcomings in the processes such as the possibility of shortcomings in the cognitive processes carried out to identify what penetrations are required to be made in this particular concrete pour. Also it suggests shortcomings in the process outputs such as the possibility that the personnel responsible for the roof plumbing have not been informed/reminded of the forthcoming concrete pour. Further the statements by the respondent "… furniture will not fit in anyway and it is an utter waste of space – some 750 mm just for a rain water pipe! … it was a terrible mistake. It is very difficult to correct" indicate how seriously the incident has affected the outcomes for the client. For a person involved in the co-ordination of this site the above "story" provides many opportunities to understand the quality of service provided and possible improvements. Analysis of the critical incident provided such opportunities even though the processes concerned were intangible cognitive psychological processes.

The next four examples describe satisfactory incidents where the latent expectations of the clients were satisfied.

Critical Incident	**:**	**4**
Responding Stakeholder	:	Civil Engineer (working for the client)

This was a project of moving a huge quantity (few million cubic metres) of earth from one place to another on some very crowded public roads. Work included cutting earth, loading tippers and moving. The full cycle time is about 30 – 40 minutes. Contract period was 15 months and the section completion time was 9 months. The cut and fill sites were on opposite sides of an expressway, but to get from one side to the other you have to go through a number of traffic light controlled junctions. We [the Client] thought of a conveyor system, but it will take a long time to install. Therefore, we did not suggest it in the contract.

The contractor built one temporary bridge over the expressway thus totally eliminating the need to use the public roads, shortening the haulage distance, eliminating the waiting time at traffic lights, eliminating the inconvenience to public and eliminating the littering of roads. The contractor promoted this on their own. A creative way of doing it! With this arrangement, they could send 2 – 3 tippers per minute past a point. They finally completed the section on time.

We [the Client] were hard pressed to deliver the project (prepared land for the industrialists) on time. I knew from my experience that it was a very short schedule. I admire the commitment by the contractor to complete the project on time. They [the Contractor] had the foresight to judge that the initially very high expenditure and the time spent on building the bridge could be saved on the haulage.

In Critical Incident 4 it is clear that the client really wished to find a more efficient way to move the earth than using trucks on crowded public roads, but could not come up with a good idea to be suggested in the contract. Therefore his latent expectations appear to be:

- shortening the haulage distance
- total elimination of the need to use the public roads
- total elimination of the waiting time at traffic lights
- total elimination of the inconvenience to public and
- total elimination of the littering of roads

Although the completion date was an explicit requirement in the contract, the Client's Engineer "knew from [his] experience that it was a very short schedule". Hence, achieving it without claims for extension of time and other problems appears to have been a latent expectation. The Client's Engineer may have expected a very troublesome project in store for him.

The very innovative solution of a bridge over the expressway satisfied the above latent expectations thus *delighting* him. The description of the incident further indicates how the contractor managed the project risks with great foresight, judging "that the initially very high expenditure and the time spent on building the bridge could be saved on the haulage".

Processes such as innovation and risk management are not very tangible and involve a lot of problem solving work. Further, they are low in repetition. The contract has been in terms of using the public roads for hauling the earth and innovative solutions were not directly solicited. Nevertheless, the client has co-produced in the process by encouraging innovative solutions to the problem. Despite such process characteristics, studying the above critical incident enabled identifying the latent expectations of the client. Also, it identified good attributes of the contractor such as commitment to complete the project on time, innovation, foresight and judgment.

Critical Incident	**:**	**5**
Responding Stakeholder	:	Project Manager (working for the Client)

I had a hospital project where there was a substation within the building itself. Above that was a plaza and it is exposed to elements like rain and all that. So, what happened was that, clearly the drainage system that was provided there [in the design] could have some leakage into the substation. So, clearly that drainage scheme needed some refinement or needed to be modified to cater to some Government departments' requirements because there is going to be some electrical equipment and all kinds of sensitive things there. So, the consultants may have missed out certain things or may not have refined their details too much or overlooked such aspects.

As a contractor who has been working in the local context for a while, they looked at it and advised us. That is like value adding, there could be a potential problem, a flash point where there could be some trouble. These are the value added things we would expect from a contractor. Not just follow blindly or do things at the last minute or look just at one particular aspect of the things, not look at the big global picture. Looking at all the structural, architectural, M&E, specialist drawings – these are the technical related things, co-ordination, looking at it in advance, giving ample time for the consultants to react and resolve problems.

Critical Incident 5 presents how the client was happy when the contractor "who has been working in the local context for a while" looked at the design and advised on possible improvements. "That was like value adding" and avoided "potential problems". The contractor's action was an unsolicited process and as discussed in Section 7.6.2, the contractor has gone beyond the formal site management protocol to suggest improvements to the design. Such process depends on the co-production by the client and the consultant, by way of co-operating with the contractor and accommodating the suggestions. Further, such processes are not very repetitive. The contractor studying the design in depth involve cognitive psychological processes and proposing solutions is a problem solving process. Such activities are not very tangible to other project participants.

Although the respondent has stated, "These are the value added things we would expect from a contractor", overall it appears that the suggested improvements to the design have satisfied latent expectations thus causing delight. The statement: "Not just follow blindly or do things at the last minute or look just at one particular aspect of the things, not look at the big global picture" indicates attributes of the construction co-ordination process that are found important by this client. The statement: "looking at it in advance, giving ample time for the consultants to react and resolve problems" indicates the client's satisfaction of the timing of the co-ordination output, allowing sufficient time for the design improvement to be accommodated. In the absence of a critical incident, customer may not be able to articulate all these valuable aspects of the process because of the latent nature of the expectations. Therefore, analysis of such incidents provides opportunities to improve the co-ordination processes.

Both Critical Incidents 6 and 7 were given by one respondent. They show how the contractor has satisfied the latent expectations of the client.

Critical Incident : 6
Responding Stakeholder : Executive Engineer (working for the client)

In certain locations for lifting facilities, we were concerned about overloading of tower cranes – for instance tower cranes trying to pick up loads greater than what they can.

Contractor had certain areas on the ground drawn up and placards indicating to the supervisors the maximum loads.

So, these are initiatives taken by the contractor, which we did not need to tell them, which I think is good.

Critical Incident : 7
Responding Stakeholder : Executive Engineer (working for the client)

Because we are working close to an MRT [Railway (Singapore)] reserved line there are certain load restrictions that are imposed at certain locations of the construction site. Initially, there were some overloading issues where they stockpiled too much debris at certain sensitive areas. Having informed them on this and requested to enforce stricter control, some initiative the contractor took was to, besides just imposing the controls, put up flag lines, printed and put up placards indicating certain demarcation zones, at certain locations defining clearly what the loading requirements are.

These are the initiatives contractors took though we did not really expect. I think these are good controls.

Both the above incidents are similar and have occurred at the same site. Overloading tower cranes and excessive stockpiling close to an Railway reserved line were two possible problems on this site. The contractor's attempts to co-ordinate the site supervisors to avoid these possible problems have caused the satisfaction of the latent expectations of the Client's Executive Engineer. This is evident from his statements:

So, these are initiatives taken by the contractor, which we did not need to tell them …

These are the initiatives contractors took though we did not really expect.

It is interesting to observe that the two co-ordination process and the outputs were between the contractor's senior management and the supervisory staff. Nevertheless, the superior quality of the outputs to the supervisory staff (as indicated by the two quotations given below) caused satisfaction to the Client, who was a third party to the two processes.

… certain areas on the ground drawn up and placards indicating to the supervisors …

> … besides just imposing the controls, put up flag lines, printed and put up placards indicating certain demarcation zones …

Therefore, study of the two critical incidents enabled the understanding of indirect effects of the co-ordination processes. It illustrated how good co-ordination between the Contractor's Project Manager and Supervisors could cause satisfaction of latent expectations the Client's Executive Engineer; a secondary effect. In the absence of a critical incident, the respondents will not be able articulate such complex aspects of the processes.

The analysis of critical incidents carried out so far illustrated how the Critical Incident Technique (CIT) enables to assess the quality of co-ordination processes from the perspective of the Client. As summarised in Table 8.1, it was possible to identify the implicit, explicit and latent expectations of the client. The measurements could focus on processes, outputs and outcomes too.

8.5.2 Responses by Architects

This section presents analysis of two critical incidents (one satisfying and one dissatisfying) given by another stakeholder: Architects. The objective is to understand their applicability as measures of co-ordination quality.

Critical Incident : 8
Responding Stakeholder : Architect

> In our contract we called for veneer laminate for service doors. The contractor has come out with a few samples where the interior designers and the architects have subsequently approved one. The contractor then said to us, "I am offering you these [another] laminate, I can offer you a good price, the reason being I have purchased these laminate for another project where it was found to be not complying with the fire regulations and the architects in other project have subsequently rejected it. But I am still claiming them because it is not our problem, the architect made a mistake in specifying them to two areas where the fire door cannot receive this laminate. So, I could offer you a good price". So, I looked at the material, studied the technical

> performance, to find that it is equivalent to what we have specified and I accepted it. We have a cost saving and they are giving us a thicker laminate – our contract specify 1.3 mm and they are giving us 1.6 mm! Everyone is happy!!
>
> Two months down the track the contractor comes back to me to tells that the quantity of this laminate they had ex-stock is insufficient to meet the requirement of this project, we have to buy some more. Of course my reply was "So, then buy some more!" Then he says, "That was an old range and the production is no longer making that colour! This is the new colour chart – can you please choose the short quantities based on this?" By that time the contractor has cut most of the old range laminate and installed over 10% of the doors onsite!
>
> See the mess! How can I tell the client? OK, I too had increased the number of doors by just a few. Still they did not have sufficient material to cover even the initial tender quantity! The Client will say, "You must check the quantities first, before proposing this material to me!" I was most dissatisfied because the contractor did not check with the suppliers whether if they [contractor] want to order extra, can they [supplier] produce?

Presented above is a terribly dissatisfying incident due to poor co-ordination of material supplies. When proposing to use a material already purchased for another site, the Contractor failed to check whether the short quantity is still available in the same colour. It has been an implicit expectation of the Architect that the Contractor should check such things. The critical incident thus describes a shortcoming in the co-ordination process.

A co-ordination process such as the above where the co-ordinator has to identify a potential problem (e.g., Will the short quantity still be available in the same colour?) and check with the relevant parties (possibly the suppliers or the subcontractor) requires critical thinking and cognitive psychological processes. As illustrated by the critical incident, it is an unsolicited process and as pointed out in Section 7.6, they are not processes tangible to other project participants. Further, the Contractor proposing to use a material already purchased for another site is not a commonly occurring situation. Therefore, this is not a highly repetitive situation that was dealt by the co-ordinator. Despite such difficult characteristics of the process, the analysis of the critical incident enabled assessing the quality of the process and identifying possibilities of improvement.

> **Critical Incident : 9**
> Responding Stakeholder : Architect
>
> Installation of a rather complex roof structure was simplified by the manner in which the work was set out onsite.
>
> The roof slopes in two directions and the heights along the wall were calculated and specified and in the drawings. A scale model of the building was done and handed over to the builders so that the roof carpenters could study the overall form and the features of the design.
>
> The contractor when setting out onsite lined up the entire roof using strings and further covered it with plastic film so that the total interrelationship of the roof with other elements (other roofs) could be evaluated by us.
>
> I was very satisfied with the contractor for assisting to assure the actual situation onsite before starting the construction.

Contractors often perceive that architects like to design something fancy but difficult to build. Critical Incident 9 describes an incident where the Contractor made a big effort to understand a complex design and assure to the Architect the actual situation onsite before starting the construction. By doing so, the contractor has satisfied latent expectations of the Architect thus causing satisfaction. Possibly the contractor too had gained from this effort by addressing many of the buidability problems and educating their roof carpenters of the details of the end product expected. This was an unsolicited service and was an informal process where the contractor has gone beyond contractual obligations to clarify the details of the design. Still, the analysis of this critical incident revealed that “assisting to assure the actual situation onsite before starting the construction” is a latent expectation of the Architect. Further, it enabled evaluating the co-ordinator’s performance and focusing on possible developmental activities.

8.5.3 Responses by Consultants

Below in this section, four critical incidents related by consultants are analysed. The analysis will follow a format similar to Sections 8.5.1 and 8.5.2 above.

Critical Incident : 10
Responding Stakeholder : Consultant

> Curtain wall, in theory, you are supposed to erect floor by floor. Because that will make sure that the alignment is perfect. But the construction always requires a passenger hoist for any number of stories above 8 floors. So, certain location must be allocated for the passenger hoist and the curtain wall cannot be closed there. Toilet partitions, paint cans, ceiling boards, some trunking, wiring, can use the passenger hoist because they are not bulky. However, all those are the tail end finishes and can use the service lift. Near the tail end, your service lift may be in working order thus relieving the passenger hoist. But this contractor did not have the service lift ready until it was too late.
>
> On each floor, a temporary platform is fixed to receive bulky items such as bricks, sand, cement and air-handling units. A platform was at the 9th floor ready to receive the air-handling units. The air-handling units never came. It was a 7-floor construction cycle. So, this platform can remain here just one day or at most 2 days. It needs to be jacked up to the next floor. If the air-handling unit come late, that is a problem on site.
>
> This is a contractor's co-ordination problem. The co-ordination problem may eventually affect the quality. That is what made me dissatisfied. The curtain wall must be installed as much as possible on each floor and it also must be installed in sequence so that the male and female parts may interlock from one frame to another. There may be a situation where there is a broken gap and which later has to call for top slot done. But in your heart you are not so confident whether this will not cause any water leakage because it is not strictly according to the correct sequence.

In the above critical incident the contractor did not have the service lift operational early enough to relieve the passenger hoist that needs to be dismantled to enable the curtain wall to be erected. Further, the supply of the air-handling units was not properly co-ordinated that resulted in the inability to remove the temporary platform at the 9th floor. Thus the Consultant's implicit expectations of co-ordination have not been met, resulting in dissatisfaction. The Contractor's Project Manager may have mismanaged these matters possibly due to gross negligence or technical incompetence/lack cognitive competencies/lack of experience to identify that delay in commissioning of the service lift and the arrival of the air-handling units can cause problems in curtain wall erection and so on. As discussed in Section 7.6, such co-ordination processes involving cognitive process and reflective thinking are internalised in the co-ordinator, intangible and involve problem solving work. Curtain wall subcontractor often may not check with the Project Manager when the air-handling units will arrive or why the service lift is not yet operational; thus making the co-ordination of the temporary platform and the service lift unsolicited processes. However, the analysis of the critical incident provided an opportunity to understand the above implicit expectations of the consultant and understand possible improvements to the co-ordination processes.

Critical Incident : 11
Responding Stakeholder : Consultant

In some areas such as the computer rooms, the contract required 250 mm raised floors – raised floors required the subspace to be anti-dust coated simply because the computer cabling required certain amount of clean room environment. So, the sequence of contractors who moved in to the areas where the anti-dust coating was completed caused the problem.

The contractor cleaned the area good enough to receive the anti-dust coating and applied the three coats as specified, to our satisfaction.

Then you find lots of subsequent trades coming in – pedestals coming in, cable trays coming in – doing the cable trays, they inevitably have to hook down and inevitably this process will damage the anti-dust coating. But we cannot help that. However, at that time, the ceiling had not been erected, ductwork is still running, people walk-in with safety shoes, tools being dropped unintentionally, material for the cable trays were stored there for a couple of days before they finally installed. Absolutely there is no need for those areas to store equipment. The contractor very well knows that this area had an anti-dust coating. You should not put any alien material into that area – alien in the sense that that material does not go into that room, it goes to some other rooms. Then, the alien material was not stored in a proper manner – not on some platform or planks, but just on the concrete. The ladders they could have wrapped around the legs to make it less sharp. Where you can put the [working] platform on rollers to minimise the damage on the anti-dust coating, they just put a [working] platform that the workers just push. So, all these damaged the anti dust coating. But, the process of identifying which areas the anti-dust coating has been damaged is not easy because this anti-dust coating is a clear liquid. When you apply to the bear concrete, it is very hard to say that this area has been damaged. So, there will be arguments if we say “reapply all” because the contractor has to spend on material, labour and it takes time. Also now with the trunking on, it is very difficult to apply again. These are the unsatisfactory instances where the contractor has on his own set out the problems. The consultant is

> faced with the problem either you accept or reject. If you accept, you know that anti dust coating is damaged in some areas.
>
> Of course it boils down to something very abstract, very intangible – proper co-ordination. You could have done the ceiling first – you could have minimised the number of people going in and out of theses rooms, where unnecessary workmen stepping on this area can be stopped. You can barricade the area, you can divert the workers' traffic route. But the workers' mentality is, if this is an easier route, if this is an area through which I can take equipment, if there is sufficient width, if the alternate routes are longer, or difficult to manoeuvre the equipment, I have to go through this way. It is difficult to stop them. Furthermore, in Singapore, the construction phase is also subjected to fire requirement. You cannot simply barricade the areas.
>
> So, the remedy is what we told the contractor: you make sufficient protection and you co-ordinate your sequence. You try to get the ceiling in, you try to get the pedestals in, you get the trunking in, then you apply the anti-dust coat and do the raised floor. But you get not so accommodating contractors. But if I take a very confrontational attitude, they will say, "When did you approve the ceiling samples? The time that you approved the ceiling samples and when we placed the order, I cannot afford to have the ceiling constructed first. I have to go a bit off our sequence. I have to do the raised floor first. Only then my ceiling comes". True, the ceiling in that area was a subsequent requirement by the client. Earlier it was soffit plaster. Therefore, the light fittings and AC grills too had to change. Then these are the things the contractor should have discussed with us beforehand. According to their programme, I have to confirm the ceiling material, ceiling pattern, working points, etc. first. But how rigorously can we follow the construction sequence?
>
> I was dissatisfied because the contractor failed to give sufficient protection to the anti-dust coat and co-ordinate the sequence of work. They did not discuss with us the implications of the subsequent requirement by the client for a ceiling.

Critical Incident 11 describes a dissatisfying incident caused by not satisfying:

1. the explicit expectation that the contractor would give sufficient protection to the anti-dust coat and co-ordinate the sequence of work accordingly

2. the implicit expectation that the contractor would discuss with the consultant all the implications of the "subsequent requirement" by the client for a ceiling

The lengthy description given by the consultant illustrates many shortcomings of the contractor's co-ordination process such as the following:

- failing to discuss the implications of the late request for the ceiling and the delivery time for the ceiling material

- not minimising the trades that worked in that area subsequent to applying the anti-dust coat; not achieving the explicitly requested sequence "try to get the ceiling in, try to get the pedestals in, get the trunking in, then apply the anti-dust coat and do the raised floor"
- allowing storage of material in that area; at times even alien material
- failing to effectively divert the workers' traffic through other routes
- failing to take other possible measures for care of the anti-dust coating: material not stored on some platforms or planks but just on the concrete, the ladders not wrapped around the legs to make them less sharp, working platform not on rollers to minimise the damage and so on.

From the description of the incident it could be observed that the contractor cannot be blamed for everything. Nevertheless, a few simple measures such as:

- keeping the consultant informed of all the implications of the subsequent requirement by the client for a ceiling
- taking a few possible measures for care of the anti-dust coating

could have mitigated the dissatisfaction of the consultant.

Analysing the implications of the subsequent requirement by the client for a ceiling is not a process that is visible or tangible to the other participants of the project; it is a problem solving process internalised in the co-ordinator. As evident from this incident, the consultant may not explicitly solicit such service.

Nevertheless, studying the critical incident shed light on many tacit details of the process that are valuable for developmental purposes.

Critical Incident : 12
Responding Stakeholder : Consultant

The size of this beam is to be 800 mm and the ceiling height specified in this area is 2.6 m. As the contractor, you must co-ordinate given the ceiling height required, given the slab to slab height and whether the beam at certain locations is deeper than usual, you must check whether the gap allows all the mechanical and electrical services to go through or you need to do coring into the beam. This is a co-ordination under the main contract required for the main contractor to do. But the construction sequence ran like this. RC structure all up now. Contractor was coming in with the co-ordination drawings. By the time the co-ordination drawings are done the structure is already built and the formwork all removed. They come to me [the architect] to say "We cannot achieve the 2.6 m clearance because there is a central vacuum cleaning tube going through, there is a duct work of this size going in and this I cannot cross, there is a water pipe going here, there is a gas pipe going here and the water cannot run above the electrical trunking and so on and I cannot give you the 2.6 m clearance!"

This is a case of purely the lack of co-ordination by the contractor.

According to the above Consultant, co-ordinating structural works and the services is an explicit requirement under the contract. The contractor failed to satisfy this expectation because of the delay in preparing co-ordination drawings. By the time they analysed the clearances required for the big services and other technicalities such as "the water [pipe] cannot run above the electrical trunking" and so on, the concrete structure was already done. Hence the timing of the co-ordination process was poor. This incident illustrates shortcomings of the co-ordinator's process where s/he has to solve the problems of interfaces of the concrete structure with different services.

Critical Incident : 13
Responding Stakeholder : Consultant – Structural Engineer

This was a site erecting a prefabricated steel portal framed structure under a design and build contract. I was the Structural Engineer. The contractor was casting the concrete footings for the steel columns. There were many other concrete footings being cast for process machines and material conveyors and also for the lampposts around the premises. The contractor began to cast the bases from one end of the building and proceeded and the steel structure erection was to follow starting from the same end. The weather was bad and the concreting could not follow the schedule exactly.

> Therefore the progress was irregular and the contractor was getting under time pressure to complete the work. Further this contractor was not very good at keeping records. This made me concerned whether the steel structure would be erected on some of the footings before they are adequately cured. To avoid such errors, the contractor's site manager marked the casting dates of the final lifts of the column footings by lightly scribing on the top surfaces of the concrete before they set.
>
> This made it very easy to co-ordinate the steel erectors. Despite they being behind the schedule, I see it as a genuine attempt by the site manager to ensure that all concrete footings are properly cured before erecting the steel structures. That made me very confident and happy with their approach to work.

The above critical incident describes how the Consulting Structural Engineer initially became concerned over:

- The contractor not being very good at keeping records.
- The weather being bad and the concreting not following the schedule exactly.
- The progress being irregular and the contractor getting under time pressure to complete the work.
- In such circumstances whether the steel structure would be erected on some of the footings before they were adequately cured.

The Site Manager's idea of marking the casting dates on the concrete footings was a very reliable co-ordination output that made it very easy to co-ordinate the steel erectors. This alleviated the above concerns and reflected a genuine attempt to ensure that all concrete footings are properly cured before erecting the steel structures, and delighting the consultant. The initially negative perception of a customer was changed to positive by "a genuine attempt" by the service provider. Thus the study of the critical incident enabled an understanding of how a 'hidden expectation' (please see Section 2.5), where the customer was wishing for some remedy for the initial shortcomings, was satisfied thus causing recovery from the initial dissatisfaction and becoming satisfactory overall. Such focusing on tacit details of the process was possible even though the act of marking the casting dates on the concrete footings was an unsolicited service carried out informally.

8.5.4 Responses by Quantity Surveyors

This section presents two dissatisfying critical incidents related by Quantity Surveyors analysed in a format similar to that followed in the previous sections.

Critical Incident : 14
Responding Stakeholder : Quantity Surveyor

> Our contract was not very clear on the type of toilet partitions. This is a Government contract and we are unable to state any brand names in the specifications. So the contractor will came with a few brands and the consultants selected the type of system and the colours and approved the price. But the contractor did this exercise too late was in a rush, they could not find ex-stock, the type of system we needed. So, they unilaterally took another system that was very, very similar and to be fair by them I must say it was superior. In this case, this alternate system was about 5% higher [in price] than the one we approved. But because of the time frame the contractor chose this system that was in stock. Later they tried to claim for that extra 5%. This 5% for the entire project was some S$ 25,000.
>
> I was dissatisfied because the contractor did not co-ordinate their material supplies and asked the client to pay for it.

It has been an implicit expectation that the contractor will co-ordinate their material supplies. The above critical incident occurred apparently when the contractor made a delayed application for the approval of the type of toilet partitions. Therefore, it illustrates a shortcoming of the process of co-ordinating material supplies.

Dissatisfaction of the customer occurred when the contractor tried to claim from the client the extra cost incurred due to shortcoming of the co-ordination process. The critical incident enabled identification of many details of the co-ordination process that led to it. Such process requires cognitive processes of finding what needs to be approved at each stage of the project, finding out other requirements such as needs of finding ex-stock availability and/or delivery times. Further, calculating logistics of material delivery is often a complex process where many aspects of the procurement process such as the following (described by another respondent to this study) need to be considered:

> Does it need approval? How long does it take to get the approval - how long to submit, resubmit, … finally get the approval? How long does it take to procure the material? How long does it take to manufacture in the shop and then deliver? How does it come packaged? How long is it going to take to install? How many pieces? What is the cutting list? What is the shop-drawing list? What is the delivery? Is it shipped? Is it air freighted? … and so on.

Such analysis is not tangible to other project participants. Nevertheless, the study of the critical incident enabled evaluating the quality of co-ordination, identifying what caused dissatisfaction of the customer and identifying possible improvements to the process.

Critical Incident : 15
Responding Stakeholder : Quantity Surveyor

> It was a measure and pay contract and a huge site where they were constructing many buildings, concrete aprons, services, roads and so on. Contractor was laying external water and sewage mains. Usually they will excavate a trench of sufficient length for laying 3 or 4 six-metre lengths of pipe. Then, they lay the pipe and backfill with a minimum sand cover of 150 mm. Backfilling is done immediately after the laying of the pipe to avoid the danger of the PVC pipe getting displaced if it rains and the trench gets flooded. However, this process takes around a day, during which my staff take the measurements. The problem happened when the contractor had to do a 100 mm water supply branch line to a remote corner of the site. The length of the branch was nearly 100 m long – a job that would have taken may be three days at their normal pace. However, the ground was found to be extremely sandy and starting the work after lunch one day, they had excavated the entire length of the branch in may be couple of hours. The specification was that the minimum width of a trench was to be 600 mm. However, because of the very sandy conditions and because of the absence of rocks or any foreign matter, the consultant had not insisted on the sand cover and allowed them to lay the pipe in a just 300 – 400 mm wide trench and use some of the excavated material itself in the cover. Being just a 100 mm pipe, they had very easily fitted it and the whole job was over by the end of that day. Being a very large site my staff have not been aware of this rapid progress and were not there to take the measurement. Nobody cared to inform us to take the measurements. Usually they did not have to inform us because our staff take all these measurements on our regular rounds.

> When the interim valuation came, it was prepared as if the work went as per specification – 600 mm trench, supplied sand cover and so on. Together with the consultant we disputed this.
>
> I was dissatisfied because we were not informed before backfilling the trench and the contractor tried to use the situation to claim for more than what was actually done.

Being a measure and pay contract, it may have been an explicit requirement that the Client's Quantity Surveyors should be informed before covering any work that gets buried underground or embedded in concrete or masonry. From the description of the critical incident it can be observed that this requirement usually did not arise onsite because the Quantity Surveyors took all these measurements on their regular rounds. Therefore, the informal environment that prevailed at the site was to assume that the Quantity Surveyors normally would make themselves available to take measurements by observing the progress. Such assumptions were a result of the manner in which Quantity Surveyors have co-produced in the co-ordination process at that site. However, contractor had failed to liaise with the Quantity Surveyors of the unusually high progress on the water supply branch line and co-ordinate their availability for taking measurements. When there was an unusually high progress the contractor failed to identify whose else's work gets affected and co-ordinate accordingly. Therefore, it is possible to identify shortcomings in the process and its outputs. The dissatisfaction of the Quantity Surveyor has exacerbated when the contractor used the situation to claim for more than what was done. The statement "Together with the consultant we disputed this" illustrates possible further reasons for dissatisfaction because the Quantity Surveyor had to depend on the consultant to challenge the measurements. It is an outcome of the failure in co-ordination. This example further illustrates how studying critical incidents enable evaluating the quality and understanding complex and tacit details of the co-ordination processes outputs and outcomes.

8.5.5 Responses by Subcontractors

Another type of customer of a project manager is the subcontractor. In this section, three critical incidents presented by subcontractors are analysed.

> **Critical Incident : 16**
> Responding Stakeholder : Site Engineer of the Fire Protection System Subcontractor
>
> This was a hotel refurbishment project. We were doing the fire protection system installation as a subcontractor. There was a consultant for the project overlooking the entire operation. They request as usual for the shop drawings before carrying out any work. For our work we forwarded these and got the approval to go ahead.
>
> We carried out our pipe work inside the toilet ceilings of the guest rooms, reported completion and testing at site meetings as requested. There were some air-conditioning ducting that had to be done by another subcontractor, which was delayed due to their not submitting the shop drawings and designs to the consultant for approval.
>
> At a later stage, the Site Manager wanted us to bring down a part of the pipeline in several rooms for the other subcontractor to install this ducting. I explained to him that this will cause a lot of hardship in re-routing the pipelines as by that time most of the other services like wiring were also completed. Although he understood this, he did not show much mercy, because he was under fire and pressure.
>
> So I told him that we will look at alternatives and asked him to send his air-conditioning duct designer and the draughtsmen. These people were not too keen in changing their design as it means they have to re-design and re-draw and get approval again. But I insisted that we should look at the alternative and since I did understand fluid mechanics and flow calculations. I crept inside the ceiling to show them and convinced them that it could be done, without dismantling the Water Supply and Fire Lines. I showed how we could achieve many things with co-operation, co-ordination, understanding and appreciation of mutual needs/problems when working as a team.
>
> I felt dissatisfied the way the Consultants and the Site Manager handled the project. They are there to do this kind of co-ordination between various installers. They should have had co-ordination drawings and more understanding of the entire project as a whole.

Critical Incident 16 describes a very poorly managed site. Due priority has not been given to get the shop drawings finalised for large and less manoeuvrable services such as air-conditioning ducts. Co-ordination drawings too have not been prepared and the Consultant and the Site Manager did not have an "understanding of the entire project as a whole". From the description of the critical incident, it is evident that the Site Engineer of the Fire Protection System Subcontractor implicitly expected the site manager to attend to all these aspects. Reasons for failure may be either gross negligence or lack of critical thinking skills or cognitive competencies or technical incompetence or lack of experience or so on to identify that large and less manoeuvrable services need priority. When the air-conditioning subcontractor was finding it difficult to install the ducts the Site Manager tried to disrupt the already installed services without working hands-on to try and generate a solution. Such inelegant co-ordination output apparently has caused much distress to the respondent. The statement "how we could achieve many things with co-operation, co-ordination, understanding and appreciation of mutual needs/problems when working as a team" illustrates many desired attributes of a co-ordinator which were apparently lacking in the Site Manager concerned.

Identifying large and less manoeuvrable services that require priority involve cognitive psychological processes and problem solving work. Such processes are internalised in the Site Manager and less tangible to other project participants. It is apparent from the description of the incident that other parties who may get affected, such as the Fire Protection System Subcontractor, did not solicit the service. The demand for re-routing the pipelines and the Site Manager not showing much mercy illustrate the informal environment and the internal politics that prevailed in that site. The air-conditioning duct designer and the draughtsmen not being too keen and respondent Site Engineer creeping inside the ceiling to show them and convince them illustrate how co-production by each party to the issue changed the co-ordination process. However, despite such difficult characteristics of the process, analysis of the critical incident enabled evaluating the quality and learning much valuable information that can be used for improvement.

Critical Incident : 17
Responding Stakeholder : Labour Subcontractor

We had to carry out the underground Fire Ring Main installation. As per requirements the pipeline was in GI and buried about 1.5 m underground. The soil condition was muddy. We were expected to compact the trench base and give a compaction test report before laying pipes. With the condition of the soil this was an impossible task to achieve. We also did not realise this till we started compacting with the tampers. Tampers got stuck in the mud and we had a time coping with this problem. Therefore, our progress of work was not that good and we were behind schedule.

The main contractor's engineers insisted on compacting and finding a solution to the problem ourselves. Finally, we had to bring in an external consultant engineer to prove that this soil is incompactable and the solution given was to put a layer of sand on the trench base and not to compact.

We were not satisfied the way the main contractor treated us at a time of crisis. They could have helped us in finding a technical solution liaising with the consultant. Ultimately the project could not be completed on time.

In the above critical incident the labour subcontractor had encountered a difficult ground condition. He had an explicit expectation that the Main Contractor would liaise with the consultants and provide a solution. Failure to do so, "the way the main contractor treated [them] at a time of crisis", has caused dissatisfaction. The liaison process had to change because of the manner in which the consultant apparently had reacted to the requirement to review the specification. The subcontractor had to go beyond the formal arrangement to bring in an external consultant engineer to prove that the soil is incompactable and to propose a solution. Nevertheless, the critical incident illustrated how the deficient liaison process caused dissatisfaction to the customer.

Critical Incident : 18
Responding Stakeholder : Manager of the Specialist Sub-Contractor (Electrical)

> We were carrying out the electrical installation for a shopping complex of six stories. The project was behind schedule due to delays from the client, consultant and building contractor's sides. The electrical works were also behind schedule but not due to our fault.
>
> When the work was about 80% completed the client gave an ultimatum to all the contractors that they should complete the work within about 1 month. Since the main contractor was behind schedule he commenced working round the clock to avoid penalties.
>
> As the Electrical contractor we could have objected to this because as per our agreement we had given a schedule of work program that required a minimum amount of time for our works. But as the manager of the Electrical Division I took the stance that we also should somehow achieve this target so that we could satisfy the client and the consultant. (This was a job that we grabbed from the regular Electrical contractor to the customer. Also, we wanted to convince and satisfy the consultant for future jobs). At that point we sat together with the Main Contractor and other specialist contractors to formulate the crash program.
>
> One area was the conduiting in the floor render. Where the main contractor was starting rendering the floor from the top floors down. The main contractor agreed to do this during the night so that other sub-contractors could do their work during the daytime. This operation went on very smoothly and we achieved our target without any hick-ups.
>
> The most satisfying action in this instance was the collective decisions and actions we took in co-ordination with the main contractor and others to achieve a goal.

In the above critical incident, the main contractor and other specialist contractors sitting together and formulating the crash program and the collective decisions and actions taken in co-ordination with the main contractor and others to achieve a goal have satisfied the latent expectations of the subcontractor. Therefore this description of the critical incident enables understanding how subcontractors value a main contractor co-ordinating a challenging situation.

Nevertheless, the statements such as:

> … we could have objected to this because as per our agreement we had given a schedule of work program that required a minimum amount of time for our works. But as the manager of the Electrical Division I took the stance that we also should somehow achieve this target …

illustrate the informal environment that prevailed. The delays were not due to this Specialist Sub-Contractor and contractually they were under no obligation to crash programme. Further, the statements:

> … we sat together with the Main Contractor and other specialist contractors to formulate the crash program.

> … the collective decisions and actions we took in co-ordination with the main contractor and others to achieve a goal.

illustrate how the process depended a lot on the co-production by project participants. Still it was possible to evaluate the main contractor's co-ordination process and understand possibilities of carrying out improvements.

Section 8.5 presented an array of critical incidents related by a variety of customers of the construction project manager: client, architect, consultant, quantity surveyor and subcontractor.

8.6 Responses by Owners of Construction Contractors

This section presents two critical incidents (one satisfying and one dissatisfying) related by a different type of stakeholders of the process: the Owners of Construction Contractors or the superiors of construction project managers.

Critical Incident : 19
Responding Stakeholder : Director of a Construction Contractor

We were constructing a factory building on a green field site overseas. The Client was a large multinational conglomerate. Our contract included building work and mechanical and electrical services. There were lots of materials such as structural steel, ironmongery, pipes and fittings, air-conditioning plant, cables, busbars and electrical fittings to be sourced from overseas thus having long delivery times.

The Client was enjoying certain import duty concessions from that Government. Therefore, based on our requirements, they were supposed to establish direct orders for all materials sourced from overseas. So, the procedure was that shop drawings have to

> be completed and approved first. Then the material requirements have to be taken off from that and given to the client to be ordered. Later, at the time of clearing the goods, the shop drawings and the material schedules approved by a professional engineer have to be submitted to the customs to get the concession on duty.
>
> The Consultants were very ineffective and the designs provided at the tender stage were very rough. Even after the award of the contract, they kept changing a lot and we had a difficult time finalising the shop drawings and the material schedules and getting their [the Consultants'] approval. And, the Client would not establish the orders for material without the Consultants' approval.
>
> The problem was our Project Manager wasted time trying to finalise the material schedules before requesting the client to establish orders [for material]. I expected him to arrange to order at least 70% of the material requirement immediately. There was this problem of the Consultants approving our shop drawings and material schedules. But if he [Project Manager] spoke to the Client, they would have agreed to order 70% of a provisionally calculated quantity based on an available design. The Project Manager failed to identify his priorities and convince the Client and the Consultants that, this delay in ordering the material would be disastrous to the project and ordering 70% of the material requirement would not be a waste. The cost of any redundant or excess material [due to subsequent design changes] will be very small compared to other losses to the Client due to delay of the project. Alternatively, that would have been an incentive for them to freeze the design! The Client's process machinery were already on order. The installation teams from the respective manufacturers were scheduled to arrive. The client was in no way ready to accept a delay by us. We were not tying our capital because the client was ready to establish letters of credit to our suppliers. By the time the goods arrived at the port, we could have had the shop drawings and the material schedules finalised and approved. Any short quantities could be reordered later and if anything [short quantities] was too small to directly order, we could have easily collected them here in Singapore and despatched.
>
> Because of this problem our material were delayed and some had to be purchased locally in a rush without enjoying the import duty concessions, hence at extra cost to us. Our completion of the project was delayed. We argued that the designs kept changing. Finally they did not impose liquidated damages but the client was extremely unhappy.
>
> That was not all – we were to do the lightening protection system also. However, the insurance company refused to accept the design done by the consultant. By then the client was unhappy with the consultant and us and decided to give that contract to a local specialist contractor, introduced by the insurance broker, to design and install the lightening protection system. But if we had ordered the material, the client would be reluctant to do that, or if they still do, we have at least sold the material to the client.

In the above critical incident, the designs provided at the tender stage were very rough and even after the award of the contract they kept changing a lot. The Director's implicit expectations were that the Project Manager would convince the Client and the Consultants that, delay in ordering the material would be disastrous to the project and ordering 70% of the material requirement would not be a waste. Instead, the Project Manager wasted time trying to finalise the material schedules. The problem may have possibly occurred because of lack of professional competence/experience or lack critical thinking and problem solving capability on the part of the Project Manager. Thus, focusing on the critical incident enables a person involved in the process to understand the shortcomings of the process that resulted in the Director's implicit expectations not being met.

The description of the critical incident also enabled understanding the adverse outcomes to the stakeholder such as the following:

> … some [material] had to be purchased locally in a rush without enjoying the import duty concessions, hence at extra cost to us
>
> … they did not impose liquidated damages but the client was extremely unhappy
>
> … the client was unhappy … and decided to give [the lightening protection system] contract to a local specialist contractor … if we had ordered the material, the client would be reluctant to do that, or if they still do, we have at least sold the material to the client

In the absence of a critical incident, it will be difficult to focus on the co-ordination process as demonstrated above because application of professional competence/experience, critical thinking and problem solving are internalised in the co-ordinator and intangible to the other project participants. Further, the process depended on co-production by the Client as evident from the statement:

> There was this problem of the Consultants approving our shop drawings and material schedules. But if he [Project Manager] spoke to the Client, they would have agreed to order 70% of a provisionally calculated quantity based on an available design. The Project Manager failed to identify his priorities and convince the Client and the Consultants …

Thus the process varies depending on how well the Client would react to the Contractor's reasoning/argument. There was a formally accepted procedure to order material through the Client but it was not possible to be followed without causing delay to the project, apparently because of the shortcomings of the design and design management by the consultants. The critical incident reveals that the problem was caused by the Project Manager's failure to adopt a suitable informal approach to address the needs of the situation.

Critical Incident : 20
Responding Stakeholder : Director of a Construction Contractor

We carried out a contract overseas to lay water and sewage mains within another larger project site where a large governmental facility was being expanded. They had one big consultant firm to design and supervise all the contracts. We sent in our staff and some of the best craftsmen we had. Then we recruited some more direct labour available locally and trained them on the job to suit us.

However, within the first few months it was realised that the main building contractor who had been awarded the construction of three large buildings had under quoted and was not mobilising enough resources to do a decent job. We were to lay a number of ring mains around these buildings to service them and many facilities around. Within the first three months, we found that the foundation works were getting terribly delayed. As a result of this, we could not lay our ring mains around the buildings. We were in a terrible situation where we were getting delayed by others. We were employing direct labour and we have to pay them and the staff; our plant and machinery were there.

Well, we had a good case, but what is the good in arguing with the Client? What is the maximum we could expect to be compensated? – No point! Instead, the Project Manager immediately requested permission to change our programme and lay all the smaller diameter branch lines away from the main buildings. Then the Client got more ideas of improving the facility and we got extra work to lay many additional branch lines and connections to buildings replacing some of the existing pipelines.

The planning and designing [by the Consultant] was poor. After we laid some of the new lines, they changed some of the road layouts and even the positions of some smaller buildings. We had to relocate the pipelines or lay additional lengths. So, we were paid for all that.

Initially, it was a 1½-year contract but we were delayed by 6 months. The initial contract sum was S$ 28 million, but our final sum was S$ 39 million. Naturally I am pleased with the Project Manager! The moment we realised that we are being delayed, he got the permission to lay all the pipes wherever we are not affected by others. Then he always offered to do extra work that compensated for the overheads we kept incurring due to delay by others. We did not claim any extra on overheads due to delays but earned that. Our work was of good quality and overall the Client was very happy with us.

In the above critical incident when the Contractor's Project Manager realised that the delay by another contractor was going to affect his contract, he accepted the fact that there is not much benefit in claiming 'extra on overheads' from the Client. Thus a very sound strategy for co-ordinating the project was adopted wherein all the branch lines were laid and additional work was solicited from the Client. The results exceeded the latent expectations of the Director, possibly by generating a good financial return for the overall contract period, thus delighting him. Further, the statements:

> Initially, it was a 1½-year contract but we were delayed by 6 months. The initial contract sum was S$ 28 million, but our final sum was S$ 39 million.
>
> We did not claim any extra on overheads due to delays but earned that. Our work was of good quality and overall the Client was very happy with us.

illustrate the favourable outcomes for the respondent stakeholder that caused satisfaction.

The co-ordination process depended heavily on co-production by the Client and the Consultants where they allowed a change in the programme to “lay all the pipes wherever [work is] not affected by others” and also entrusted additional work to the contractor. Further, the Client was able to provide the required funds for such extra work. The Contractor’s Project Manager’s analysis of the situation to decide on this strategy is a problem solving process that is internalised in him. Such problem solving processes involving the application of a strategy to manoeuvre the situation are not tangible to the other project participants. Nevertheless, focusing on this critical incident enabled evaluation of the Project Managers co-ordination capabilities and the understanding of many aspects useful for improving construction project co-ordination.

8.7 Responses by Contractors' Site Engineers

This section presents two responses, one dissatisfying and one satisfying, related by Contractors' Site Engineers.

Critical Incident : 21
Responding Stakeholder : Site Engineer

> In this [building] site we have a chaotic situation. The electrical subcontractor was to lay the conduits. It had been sub-sublet and we had lots of problems. Initially, the material did not come on time, enough men were not brought in … We had to bring in their senior personnel and make a lot of fuss to get them moving. Still there was a lot of shoddy work and abortive work. Now, this affected many trades starting from concreting, masonry to finishes … I can say everybody was delayed. The Project Manager should have called everyone and said, "OK we now have a problem lets see the schedule", try to readjust, refocus where we need to focus, get everyone to say how they will adjust their schedule and then check where they clash and readjust and say, "Well, yeah we are stuck and this is the problem this is where we are going". Instead he just kept on asking the people "When can we finish this? – When can we finish that?" Now, the whole site does not have a focus, you do not know where you are going and many of us lost interest. Now this fellow wants to do this [work], that fellow wants to do that [work] and when they clash both argue that they are delayed and cannot wait for the other's work. So, I will put the problem to the Project Manager. He takes instant decisions to let one fellow override the other. That made many of them angry.
>
> The site is moving at a much lower rate than compared to good support from higher management plus a lot of people are frustrated though staying on this site, I want to request to be transferred out.

In the above critical incident, many trades were affected due to the delay and abortive work by the electrical contractor. The Project Manager did not obtain feedback from all affected parties on how they intend to adjust their schedules, analyse such feedback and bring them all together to resolve possible clashes and so on. From the statement "Instead he just kept on asking the people "When can we finish this? – When can we finish that?"" it is apparent that the Project Manager was merely exhorting various parties to complete their work quickly. Various tradesmen/women were pressurised to work without co-ordinating them and focusing their efforts. When there were clashes of work, instant decisions were given resulting in deterioration of relationships at the site.

Adverse outcomes to the respondent stakeholder can be observed from statements such as the following:

> … you do not know where you are going and many of us lost interest.
>
> … a lot of people are frustrated though staying on this site, I want to request to be transferred out.

Analysing proposed changes to schedules and resolving clashes are problem solving processes that are internalised in the Project Manager and intangible to the other project participants. Said processes depend on co-production by the other project participants by providing feedback, reacting to decisions where proposed schedules clash and so on. Further, it is apparent from the description of the critical incident that while the site lost focus due to lack of co-ordination, the project participants did not solicit co-ordination service from the Project Manager; co-ordinating various trades was and implicit expectation. Despite such difficult characteristics, focusing on the critical incident enabled the Site Engineer to articulate deficiencies in the co-ordination process, thus providing opportunities to make improvements.

Critical Incident : 22
Responding Stakeholder : Site Engineer

One morning the Consultant demanded that a particular job of work be given priority over the other work and insisted that people be mobilised now – immediately – quickly – and finished that day itself. The Project Manager asked me to put in some of my workmen on that job. We were working on it, the Consultant kept coming to gauge the progress and began to demand that the progress is insufficient and more workmen must be mobilised. The Project Manager very nicely reassured to him [Consultant] that the work would be finished tonight. He carefully explained why he could judge that the work will finish, why any more men put in that area will not help and the Consultant was satisfied and did not come again till the evening. I was left alone to do my work and therefore I finished it by the evening. If somebody was continuously pushing and just demanding more, we will not be able to concentrate, the morale would be low and it will be very difficult.

I was very satisfied with the manner in which my Project Manager used his judgment on the progress of the work and reassured to the Consultant describing why he [Project Manager] is satisfied that the work can be finished by that evening.

In this critical incident the Site Engineer had done his own job of co-ordination to ensure that the work would finish by the end of that day. The Project Manager's excellent support to his subordinate satisfied his latent expectations. Apparently, the Project Manager was able to judge for himself that the Site Engineer was progressing in such a manner that he could finish the work by the end of the day. Further, he could understand "why any more men put in that area will not help". Then, he was capable of articulating his judgement and expressing them to the consultant in a convincing manner. Possibly the Project manager has very good interpersonal skills too. Thus the analysis of the critical incident enabled identification of the stakeholder's latent expectations, evaluating the liaison process and the outputs. Further, the statement:

> I was left alone to do my work and therefore I finished it by the evening. If somebody was continuously pushing and just demanding more, we will not be able to concentrate, the morale would be low and it will be very difficult

illustrates the favourable outcomes to the stakeholder that resulted from the process. The Site Engineer was able to articulate such valuable aspects of the liaison process because he focused on a critical incident.

The Project Manager's judgement of the work progress, reflecting on that judgement and articulating it in a convincing manner involves problem solving work and it is an intangible process. The entire incident, starting with the Consultant demanding a particular job of work be given priority, that people be mobilised immediately and finished that day itself, reflects the informal environment that prevailed at the site. The liaison process of the Project Manager also depended much on co-production by the Consultant. The Critical Incident Technique enabled the study of the process despite such difficult characteristics.

8.8 A Response by a Resident Living Near a Site

A person who had lived near a construction site related the following incident to the Author during a conversation. It is a simple example how a shortfall in the Contractor's co-ordination caused a problem to the residents nearby.

Critical Incident	**:**	**23**
Responding Stakeholder	:	Resident living near the site

A large water tank was being constructed near our place. There is a main road and a byroad off that leading to our housing development *[shows the arrangement with his hands]*. On the right-hand side of the byroad is our housing development and on the left-hand side was the site [where the water tank was being constructed]. In the morning during the rush hours the main road is very congested and also there are many vehicles coming up the byroad to take the main road to the City. Possibly they [the Contractor] have arranged a huge pour of concrete for this tank and they [the Contractor] had decided to start very early. That morning I was driving to work as usual and found that the byroad leading to the main road was fully blocked. I could see at least 3 or 4 concrete trucks on the byroad. They could not enter the site because the narrow byroad was blocked by morning traffic and another concrete truck was unable to leave the site. There were many vehicles stuck on the byroad unable to reach the main road because there were more concrete trucks restricting the flow of traffic at the junction. It took me at least 20 – 25 minutes to get to the main road. During that time, from what I saw, may be only one truck entered the site. So I think, it would have been beneficial to everyone if the contractor avoided the morning rush hours. Later I learnt that trucks continued to come almost one after the other until the late afternoon.

Of course I was dissatisfied. I was late to work and my schedule for the day was messed up. Later some of us complained to the engineer there [at the site] and requested not to repeat it. It boils down to proper co-ordination; they should have planned for the rush hour.

The respondent had implicitly expected that the Contractor's Project Manager would plan for the rush hours when arranging a concrete pour. This expectation was not satisfied possibly because the latter failed to identify the importance of checking the traffic conditions during the morning rush hours before ordering the concrete to be supplied very early in the morning.

The processes by which a project manager identifies the importance of checking and then performs the checks are cognitive psychological processes internalised within the project manager and hence intangible to other project participants. Further, the study of the co-ordination process was possible despite the process of checking traffic conditions possibly not being a formal contractual requirement. Neither the client nor the residents in the neighbouring development solicit such co-ordination processes.

Nevertheless, focusing on the critical incident enabled the stakeholder to articulate the shortfall in the co-ordination process: "it would have been beneficial to everyone if the contractor avoided the morning rush hours". Further, the stakeholder was able to articulate the resultant undesirable outcomes of it such as: "byroad leading to the main road was fully blocked … took me at least 20 – 25 minutes to get to the main road. During that time, from what I saw, may be only one truck entered the site … I was late to work and my schedule for the day was messed up".

8.9 Summary of the Analysis

Sections 8.5 to 8.8 present the analysis of an array of critical incidents related by a variety of stakeholders of construction co-ordination processes. A summary of the analysis is presented in tabular form in Table 8.1. It serves to establish that the Critical Incident Technique (CIT) could identify implicit, explicit and latent expectations of stakeholders and evaluate the quality of co-ordination processes, outputs and outcomes and provide information useful for process improvement. Further, the analysis illustrated the possibility of doing so despite the characteristics of co-ordination processes: Informality, Intangibility, Co-production, Low Repetition, Unsolicited Service and Problem Solving Work.

Table 8.1: Summary of the Analysis of the Critical Incident Examples

Critical Incident No.	Brief Statement of the Critical Incident Example	Respondent Stakeholder								Stakeholder Expectation			The Focus of the Measurement			Process Characteristics Encountered						Useful Information that can be Utilised by the Contractor for Process Improvement
		Client	Architect	Consultant	Quantity Surveyor	Subcontractor	Owner	Subordinate	Society	Implicit	Explicit	Latent/Hidden	Process	Output	Outcome	Informality	Intangibility	Co-production	Low Repetition	Unsolicited Service	Problem Solving	
	Responses by Customers																					
1	Just before contractor wants to do a concrete pour, comes and tells that there is a discrepancy.	●								●			●	●		●	●			●	●	Project Manager either does not study the relevant material or fails to identify discrepancies. The co-ordination output comes too late for the consultant to provide a solution and the Contractor adopts an adversarial approach with the consultants.
2	Contractor failing to achieve the correct sequence of work and co-ordinate with the services and M&E work.	●								●			●								●	Project Manager fails to do the problem solving work expected of him, such as identifying where the big services go and getting the bricklayers to leave such areas for later in order to avoid abortive work.
3	Contractor missed a line of penetrations for rainwater down pipes.	●									●		●	●	●		●					Possible shortcomings in the cognitive processes carried out to identify the required penetrations and in the process outputs where the personnel responsible for roof plumbing not being informed of the forthcoming concrete pour.
4	Contractor building a temporary bridge over the expressway enabling efficient haulage of earth.	●										●	●				●		●	●	●	Commitment by the contractor to complete the project on time. Innovation. Management of project risks.
5	Contractor having studied the design advised the client and the consultant on possible improvements to it.	●										●	●	●		●	●	●	●	●	●	Suggested improvement was like value adding and avoided potential problems. The contractor did not just follow the design blindly. They neither did things at the last minute nor looked just at one particular aspect of the things, but look at the big global picture, looked at the design in advance, giving ample time for the consultants to react and resolve problems.

Table 8.1 continued …………

Critical Incident No.	Brief Statement of the Critical Incident Example	Respondent Stakeholder								Stakeholder Expectation			The Focus of the Measurement			Process Characteristics Encountered						Useful Information that can be Utilised by the Contractor for Process Improvement
		Client	Architect	Consultant	Quantity Surveyor	Subcontractor	Owner	Subordinate	Society	Implicit	Explicit	Latent/Hidden	Process	Output	Outcome	Informality	Intangibility	Co-production	Low Repetition	Unsolicited Service	Problem Solving	
6	Contractor put up placards indicating the maximum loads for tower cranes.	●										●		●						●		Superior quality of co-ordination outputs where the contractor had certain areas on the ground drawn up and placards indicating to the supervisors the maximum loads.
7	Contractor put up flag lines and placards indicating certain demarcation zones and defining clearly the loading requirements.	●										●		●						●		Superior quality of co-ordination outputs where the contractor besides just imposing the controls, put up flag lines, printed and put up placards indicating certain demarcation zones, at certain locations defining clearly what the loading requirements are.
8	The Contractor proposed to use a material already purchased for another site.		●							●			●				●		●	●	●	The Contractor failed to check whether the short quantity is still available in the same colour.
9	The contractor when setting out onsite lined up the entire roof using strings and further covered it with plastic film.		●									●		●	●	●				●		The Contractor assisting the Architect to assure the actual situation onsite before starting the construction.
10	The contractor did not have the service lift operational early enough to relieve the passenger hoist and the supply of the air-handling units was not properly co-ordinated resulting in the inability to remove the temporary platform thus affecting the erection of the curtain wall.			●						●			●				●			●	●	Possibly due to gross negligence or technical incompetence/lack cognitive competencies/lack of experience to identify that delay in commissioning of the service lift and the arrival of the air-handling units can cause problem in curtain wall erection
11	The Contractor not sufficiently provide protection to the anti-dust coat.			●						●	●		●				●			●	●	Failing to discuss the implications of the late request for the ceiling and the delivery time for the ceiling material; not minimising the trades that worked in that area subsequent to applying the anti-dust coat and failing to take other possible measures of care.

Table 8.1 continued …………

Critical Incident No.	Brief Statement of the Critical Incident Example	Respondent Stakeholder								Stakeholder Expectation			The Focus of the Measurement			Process Characteristics Encountered						Useful Information that can be Utilised by the Contractor for Process Improvement
		Client	Architect	Consultant	Quantity Surveyor	Subcontractor	Owner	Subordinate	Society	Implicit	Explicit	Latent/Hidden	Process	Output	Outcome	Informality	Intangibility	Co-production	Low Repetition	Unsolicited Service	Problem Solving	
12	By the time the co-ordination drawings are done the RC structure is already built.			●							●		●								●	The contractor failed to co-ordinate structural works and the services because of the delay in preparing co-ordination drawings. By the time they analysed the clearances required for the big services and technicalities such as "the water [pipe] cannot run above the electrical trunking" and so on, the concrete structure was already done.
13	The contractor's site manager marked the casting dates of the final lifts of the column footings			●								●		●		●				●		The genuine attempt by the site manager to ensure that all concrete footings are properly cured before erecting the steel structures satisfied the consultant.
14	The contractor unilaterally selected another system of toilet partitions that was very similar but superior and more expensive.				●					●			●				●				●	The contractor applied for the material approval too late and could not find the material ex-stock. They had to settle for an alternate system that cost 5% more. Later they tried to claim that extra cost causing dissatisfaction.
15	The Quantity Surveyor was not informed before backfilling the trench and the contractor claimed for more than what was actually done.				●						●		●	●	●	●		●				When there was an unusually high progress the contractor failed to identify who else's work gets affected and co-ordinate accordingly. The dissatisfaction exacerbated when the contractor used the situation to claim for more than what was done.
16	Air-conditioning subcontractor delayed submitting the shop drawings and designs. By then other services were installed making it impossible to follow their design.					●				●			●	●		●	●	●		●	●	The Project Manager is there to co-ordinate between various installers. He should have had co-ordination drawings and a better understanding of the entire project.

Table 8.1 continued …………

Critical Incident No.	Brief Statement of the Critical Incident Example	Respondent Stakeholder								Stakeholder Expectation			The Focus of the Measurement			Process Characteristics Encountered						Useful Information that can be Utilised by the Contractor for Process Improvement
		Client	Architect	Consultant	Quantity Surveyor	Subcontractor	Owner	Subordinate	Society	Implicit	Explicit	Latent/Hidden	Process	Output	Outcome	Informality	Intangibility	Co-production	Low Repetition	Unsolicited Service	Problem Solving	
17	The soil cond ition made it impossible to compact the trench base to achieve the expected compaction. Main contr actor ins isted on compacting and the subcon tractor had to bring an external consultant engineer to prove that the soil is incompactable and propose a solution.					●					●		●			●		●				The subcontr actor was dissatis fied with the way the m ain contractor treated them at a time of cris is. The main contractor could have h elped them in findi ng a techn ical solution, liaising with the consultant
18	The cl ient g ave an ultim atum to all the contractors to finish th e project, thus requiring them to crash programme.					●						●	●			●		●				The main contractor and other specialist contractors sat together to formulate the crash program. The m ain contractor agreed to render the f loor during th e nig ht so that oth er sub-contractors could do their work during the da ytime. Th e m ain contra ctor and others took collective decisions and acti ons in co-ordination to achieve a goal.
	<u>Responses by Owners</u>																					
19	The Projec t Manager tri ed to finalise t he material schedules without arranging to order at least 70% of the material requirement immediately.						●			●			●	●	●	●	●	●			●	The Project Manager wasted time trying to fin alise the material schedules. He f ailed to convin ce the Client and the Consultants that d elay in or dering th e material would b e d isastrous to the project and ordering 70% of the material requirement would not be a waste. The cost of any redundant or excess material [due to subsequent design changes] will be very small compared to other losses due to delay of the project.
20	The m oment the P roject M anager rea lised th at they ar e being d elayed, obtain ed permission to lay pipes wherever not affected by others. Then he always offered to do extra work.						●					●	●		●		●	●			●	The work continued wherev er not aff ected b y others . Th e Project Manager offered to do extra work th at compensated for the overheads due to delay by others. Thus no claim for extra on overheads due to delays was made but the contractor earned that.

Table 8.1 continued …………

Critical Incident No.	Brief Statement of the Critical Incident Example	Respondent Stakeholder								Stakeholder Expectation			The Focus of the Measurement			Process Characteristics Encountered						Useful Information that can be Utilised by the Contractor for Process Improvement
		Client	Architect	Consultant	Quantity Surveyor	Subcontractor	Owner	Subordinate	Society	Implicit	Explicit	Latent/Hidden	Process	Output	Outcome	Informality	Intangibility	Co-production	Low Repetition	Unsolicited Service	Problem Solving	
	<u>Responses by Subordinates</u>																					
21	The electr ical subcontractor delay ed lay ing the conduits and did a lot of shodd y work and abortive work. Consequently everybody w as delayed.							●		●			●		●		●	●		●	●	The Project Manager did not call ever yone and try to readjust, refocus, get everyone to s ay how they will adjust their s chedule and then check where the y clash and read just. Ins tead he jus t kept on asking the people “When can we finish this ? – When can we finish that?”
22	One morning th e Consultan t demanded that a particular job o f work be giv en priority and finished that day itself. He kept coming to gauge the progr ess and began to demand that more workmen must be mobilised.							●				●	●	●	●	●	●	●			●	The Project Manager very nicely reassured to the Consultant that the work would be finished tonight. He carefully explained why he could judge t hat the work will finish, wh y any more men put in that ar ea will not help. Th e Site Eng ineer had his own bit of co-ordination d one and the Project Manag er supported his subordinate.
	<u>Responses from the Society</u>																					
23	The Contractor ordering concrete to be supplied during the morning rush hours.								●	●			●		●	●	●			●	●	The Contr actor failed to check the tr affic cond itions during th e morning rush hours before ord ering the concr ete to be supplied commencing very early in the morning.

8.10 Accepting Hypothesis H2

Analysis of Critical Incidents 1 to 23 (presented in Sections 8.5 to 8.8 and summarised in Table 8.1) demonstrate that, when using the Critical Incident Technique (CIT) it is possible to identify implicit, explicit and latent expectations of the customers and other stakeholders. The technique was successfully applied to a variety of stakeholders, viz. Clients, Architects, Consultants, Quantity Surveyors, Subcontractors, Directors, Site Engineers, and the Society. As summarised in the last column of Table 8.1 it was also possible to develop an understanding of many aspects useful for quality improvement. Further, how it could enable evaluation of the quality of the co-ordination processes and outputs was demonstrated. Utilising such qualitative measurements to understand and compare incremental improvements to co-ordination processes is further discussed in Section 8.11.

Additionally, the analysis illustrates three special cases that further demonstrate the strengths of this tool:

- Critical Incident 1 identified a situation where the contractor's management possibly had vested interests in not achieving co-ordination in order to claim extra time to complete the works. The critical incident illustrated how the vested interest caused the relationship with the client and consultants to deteriorate.

- Critical Incidents 6 & 7 were based on two cases concerning co-ordination processes and outputs between the contractor's senior management and the supervisory staff. Nevertheless, the superior quality of the outputs to the supervisory staff caused satisfaction of the latent expectations of the Client, who was a third party to the two processes. This technique, therefore, enabled the identification of the expectations of a variety of stakeholders, thus, providing an understanding of the indirect effects of the co-ordination processes.

- Critical Incident 13 describes how the Consulting Structural Engineer's initially negative perception of the Contractor's capabilities became positive because of a genuine attempt by the Project Manager to achieve co-ordination. The study of the critical incident therefore enabled the development of an understanding as to how a 'hidden expectation', where the customer was wishing for some remedy to initial shortcomings, can be satisfied thus causing a recovery from the initial dissatisfaction and overall satisfaction to be achieved.

Such valuable aspects that enable process improvement to be carried out could be studied using the Critical Incident Technique (CIT) despite the co-ordination process characteristics of Informality, Intangibility, Co-production, Low Repetition, Unsolicited Service and Problem Solving Work.

Therefore, based on the above demonstrated strengths of the Critical Incident Technique (CIT), Hypothesis H2, that "the Critical Incident Technique (CIT) is a practical method for measuring the quality of construction co-ordination processes", was accepted.

8.11 Using CIT Measurements for Incremental Improvement of Construction Co-ordination Processes

The scope of this study is limited to the testing of Hypothesis H2. Because the measurements obtained in the above critical incident examples are qualitative, it is considered useful to discuss how such measures can be used to compare the levels of quality delivered. In Sections 8.11.1 to 8.11.4, the reader will be introduced to a 7-step process of how this may be done.

8.11.1 Conducting Co-ordination Measurement Surveys on a Routine Basis

Step 1: Conduct critical incident surveys

To measure the co-ordination processes on a routine basis, the main contractor's project management could conduct 'Critical Incident Surveys' regularly, perhaps weekly or monthly. Such surveys should be conducted by those who carryout co-ordination e.g., Project Manager, Asst. Project Manager, Co-ordinator, Site Engineers. The focus of the surveys could be any site or division or company wide. The questionnaire used in these surveys will have just 3 questions:

Q1. How exactly did the critical incident happen?

Q2. What actions in that incident exactly made you feel satisfied (or dissatisfied)?

Q3. In that site, what was your position?

Please find an example of this questionnaire in the Appendix J. As described in this Chapter, such surveys should be conducted on all stakeholders of the co-ordination processes, e.g., client, consultants, and subcontractors. Clear transcripts will be prepared on each incident description and a serial number will be assigned to each. The results of such surveys would serve two purposes:

1. Initially use CIT survey results to develop a 'Co-ordination Maturity Grid' similar to the 'Quality Management Maturity Grids' presented in Tables 3.1 and 3.2.

2. Once the maturity grid is done, CIT survey results can be used to:
   a) rank the present operation against the maturity grid
   b) update and continuously improve the maturity grid

8.11.2 Analysis of Survey Results

Step 2: Classify the critical incidents collected

The critical incident responses would first need to be classified before they could be meaningfully analysed. Therefore it is proposed to:

a) firstly classify under different co-ordination processes. The 68 co-ordination processes listed in Tables 6.3 and 6.4 is one possible classification that may be used. (Because it is a long list of processes, attention could initially be focused only on the more important and time consuming processes identified therein).

b) secondly classify under the type of stakeholder responding, e.g., client, consultants, and subcontractors

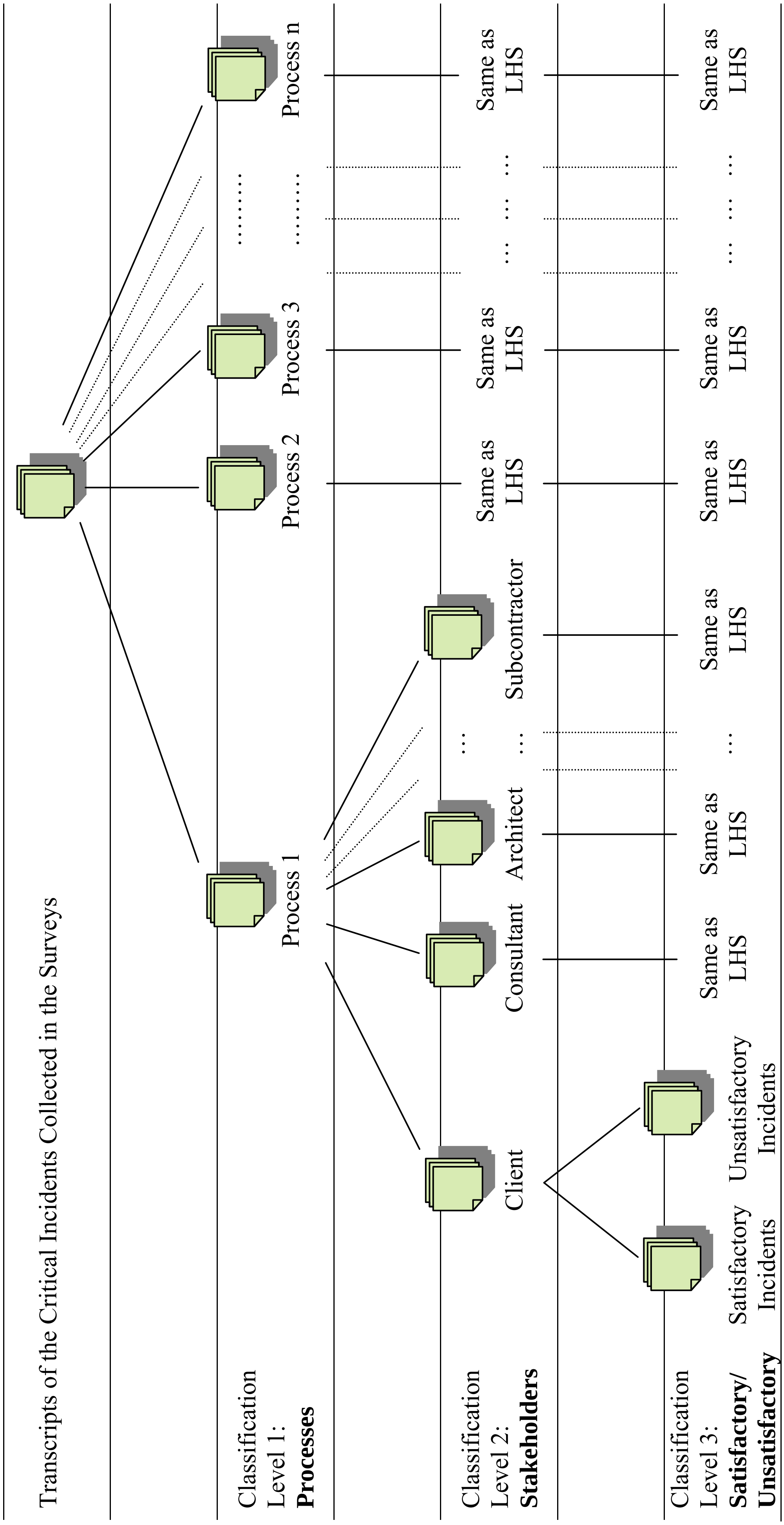


Figure 8.1: The Structure for Classification of Critical Incident Responses

c) thirdly classify into further two subgroups of satisfactory and unsatisfactory incidents.

The above structure for classification is graphically depicted in Figure 8.1.

Step 3: Analyse the critical incidents

This step requires carefully reading and analysis of each critical incident classified above to elicit the following information.

Read and analyse the unsatisfactory critical incidents to assemble the following information in the format shown in Table 8.2:

(i) the implicit and explicit expectations of each customer/stakeholder that were not met (thus causing dissatisfaction)

(ii) the shortcomings of the processes and the outputs that caused the above failure to meet implicit and explicit expectations

(iii) how such shortcomings yield unfavourable outcomes to the customers/stakeholders

Read and analyse the satisfactory critical incidents to assemble the following information in the format shown in Table 8.3:

(i) the latent expectations of each customer/stakeholder that were met (thus causing satisfaction)

Table 8.2: The Format for Analysis of Unfavourable Critical Incidents

Summary of Information on Unfavourable Critical Incidents for the Co-ordination Process …………				
Customer/ Stakeholder	**CI No.**	**Implicit and Explicit Expectations that were not Met**	**Shortcomings of the Processes and the Outputs that Caused the Failure to Meet the Expectations**	**How Such Shortcomings Yield Unfavourable Outcomes to the Customers/Stakeholders**
⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮

Table 8.3: The Format for Analysis of Favourable Critical Incidents

Summary of Information on Favourable Critical Incidents for the Co-ordination Process …………				
Customer/ Stakeholder	**CI No.**	**Latent Expectations that were Met**	**Virtues of the Processes and the Outputs that Enabled Meeting the Expectations**	**How Such Virtues Yield Favourable Outcomes to the Customers/Stakeholders**
⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮

(ii) the virtues of the processes and the outputs that enabled meeting the latent expectations identified above

(iii) how such virtues yield unfavourable outcomes to the customers/stakeholders

8.11.3 Developing a 'Co-ordination Maturity Grid'

Step 4: Develop performance descriptions

The information in Tables 8.2 and 8.3 will be examined to identify matching contexts that could be integrated into groups. Such groups of information on matching contexts will be further analysed to thoroughly understand the co-ordination processes involved and to distil the bulky information to enable:

1. Based on the information pertaining to satisfactory incidents, assembled in Table 8.3, develop a description of the best level of performance that can be envisaged for the particular co-ordination process. (Best level of performance is basically where all latent expectations identified are being met)

2. Based on the information pertaining to unsatisfactory incidents, assembled in Table 8.2, for the particular co-ordination process, develop a description of:

   a) the average level of performance that can be envisaged (average level of performance is basically where merely the implicit and explicit expectations are met)

b) the worst level of performance that can be envisaged (at the worst level of performance even the implicit and explicit expectations are not met)

Then, enter as shown in Table 8.4, the above performance descriptions pertaining to the three levels of performances, i.e., best, average and worst. Table 8.4 will be developed into the 'Co-ordination Maturity Grid, in the steps to follow. In Table 8.4, for simplicity, only one column is allocated to each co-ordination process. In reality, the research will develop an understanding of many aspects pertaining to each co-ordination process. Hence, multiple columns will be allocated to each process to enable presentation of all such valuable details.

Table 8.4: Initial form of the Co-ordination Maturity Grid

Performance Level	Co-ordination Process 1	Co-ordination Process 2	Co-ordination Process 3
Best performance visualised	Description of the expected performance	Description of the expected performance	Description of the expected performance
Average performance visualised	Description of the expected performance	Description of the expected performance	Description of the expected performance
Worst performance visualised	Description of the expected performance	Description of the expected performance	Description of the expected performance

Next, fill in the intermediate rows by deriving performance descriptions for intermediate performance levels. This needs to be achieved by the way of an interpolation process between the performance levels already established. This stage of matrix development is illustrated in Table 8.5.

Table 8.5: Performance descriptions for intermediate performance levels entered

Performance Level	Co-ordination Process 1	Co-ordination Process 2	Co-ordination Process 3
Best performance visualised	Description of the expected performance	Description of the expected performance	Description of the expected performance
Intermediate performance Level	Description of the expected performance	Description of the expected performance	Description of the expected performance
Average performance visualised	Description of the expected performance	Description of the expected performance	Description of the expected performance
Intermediate performance Level	Description of the expected performance	Description of the expected performance	Description of the expected performance
Worst performance visualised	Description of the expected performance	Description of the expected performance	Description of the expected performance

Step 5: Decide on the Rankings

Table 8.6: Completed Co-ordination Maturity Grid with Rankings for Performance Levels

Performance Level*	Co-ordination Process 1	Co-ordination Process 2	Co-ordination Process 3
80 — 100%	Description of the best envisaged performance	Description of the best envisaged performance	Description of the best envisaged performance
60 — 80%	Description of the 60-80% level of performance	Description of the 60-80% level of performance	Description of the 60-80% level of performance
40 — 60%	Description of the 40-60% level of performance	Description of the 40-60% level of performance	Description of the 40-60% level of performance
20 — 40%	Description of the 20-40% level of performance	Description of the 20-40% level of performance	Description of the 20-40% level of performance
0 — 20%	Description of the worst envisaged performance	Description of the worst envisaged performance	Description of the worst envisaged performance

* Linear rankings are shown here for simplicity. None linear scales too can be used.

Decide on a set of rankings similar to that in column 1 of Table 8.6. In Table 8.6, for simplicity, a linear scale is shown where a 20% range (e.g., 60 – 80%) is assigned for each performance level. This need not be so. By examining the performance descriptions derived, a more appropriate scale (possibly non-linear) will be assigned (e.g. Table 3.2, Malcolm Baldrige Award – Scoring Guidelines). Else, the performance levels could just be given names as done by Crosby (1979).

This step concludes the development of the Matrices. The next two steps demonstrate how this 'Co-ordination Maturity Grid' could be used to measure the quality of construction co-ordination.

8.11.4 Using the 'Co-ordination Maturity Grid' to Measure the Quality of Construction Co-ordination

Step 6: Use the 'Co-ordination Maturity Grid' to continuously measure performance

To use this 'Co-ordination Maturity Grid' to continuously measure the quality of construction co-ordination, repeat above Steps 1 to 3 on a regular basis (perhaps weekly or monthly as suggested in Step 1). Based on the information that Step 3 would yield in the formats given in Table 8.2 and 8.3:

(i) Identify which level of descriptions in the 'Co-ordination Maturity Grid' would best describe the present co-ordination performance.

(ii) Assign the relevant ranking given in column 1 (of 'Co-ordination Maturity Grid') to the present level of performance.

(iii) Then, most importantly, identify how the present performance could improve up to the next level in the matrix.

Completing this step enables construction co-ordinators to assess and compare the levels of co-ordination quality delivered and to continuously improve the co-ordination processes.

Step 7: Continuously improving and updating the 'Co-ordination Maturity Grid'

As discussed in Sections 2.5 and 2.7, customer expectations never remain static and they can change very quickly. Hence, it is necessary to regularly update the performance descriptions given in the 'Co-ordination Maturity Grid'. Also, the continuing influx of critical incident responses gives an opportunity to continuously improve the performance descriptions and process classifications used in the grid. Therefore, based on the information that Step 3 would yield in the formats given in Table 8.2 and 8.3, identify any improvements/changes required to the performance descriptions and process classifications to suit the changing levels of expectations and other conditions, to be used in the next round of survey.

Chapter 9

CONCLUSIONS AND OTHER REMARKS

9.1 Reflections on the Research Experiments

This study included four experiments:

Experiment 1**:** Finding whether the PASS and CONQUAS, both being attributes based quality measurement systems, have contributed to better customer focus and continuous improvement of construction processes and products.

Experiment 2**:** Identifying what constitutes the construction co-ordination function and what are the more important and time consuming of these.

Experiment 3**:** Testing Hypothesis H1: "Attributes based quality measurement tools are not applicable to the construction co-ordination processes".

Experiment 4**:** Testing Hypothesis H2: "The Critical Incident Technique (CIT) is a practical method for measuring the quality of construction co-ordination processes".

Before summarising the conclusions it is useful to briefly reflect on the rationale for each experiment and the objectives.

It was observed that the construction co-ordination function had received little quality improvement attention in the recent past. It may be that the Informality, Intangibility, Co-production by Customers, Low Repetition, Unsolicited Service and Problem Solving Work of construction co-ordination processes have made it very difficult for practitioners to align this most important function with the 'classic' quality improvement models of Total Quality. Therefore by testing Hypotheses H1 and H2, the present research endeavoured to shed light on possible ways of managing the quality of a difficult process such as construction co-ordination.

In testing Hypothesis H1, it was beneficial to learn from the present experiences of implementing the multi-attribute quality measurement systems of PASS and CONQUAS, in the construction industries of Hong Kong and Singapore. Specifically to know:

1. What could be learnt from the quality measurement experiences of PASS and CONQUAS?

2. Could PASS and CONQUAS models be used in some way in this research to test Hypothesis H1?

Experiment 1 (presented in Chapter 4), therefore, was performed to evaluate the suitability and effectiveness of PASS and CONQUAS in achieving better satisfied customers and continuous improvement of products and processes. The conclusions from this experiment are summarised in Section 9.2.1.

It was observed that very little research and discussion is available on construction co-ordination. One of the major implications for this research is that no ready definition exists of what is construction co-ordination and how it is achieved. That made it not possible to readily identify important co-ordination processes on which to test the attributes based quality measurement model. Experiment 2 (presented in Chapter 6), therefore, was conducted to identify what constitutes the construction co-ordination function, what are the more important activities and what are the more time consuming. The conclusions from this experiment are summarised in Section 9.2.2.

Experiments 3 and 4 (presented in Chapters 7 and 8) were conducted respectively to test the Hypotheses H1 and H2. The conclusions that led to the acceptance of the two hypotheses are summarised in Sections 9.2.3 and 9.2.4 respectively.

9.2 Conclusions from the Study

9.2.1 PASS and CONQUAS Could Not Contribute to the Promotion of Customer Focus and Continuous Improvement

Experiment 1 demonstrated that the usefulness of PASS and CONQUAS as a quality improvement tool is flawed due to the following factors:

Problems in the systems:

- Measures being based on conformance to specifications instead of achieving customer satisfaction

- Focus only on the outputs and not on the construction processes
- The tests are not in "statistical control", thus they are unable to furnish "statistical evidence of quality"
- Could not measure quality against explicit, implicit and latent expectations of customers
- Could not identify changes in expectations of customers

Problems in the implementation:

- Mandatory enforcement on the contractors
- Measurement systems developed and administered by people other than those involved in the processes
- Scores being used for judgemental purposes

In this context, there was very little effort to use PASS and CONQUAS scores for developmental purposes. PASS and CONQUAS scores that have been improving since the inception, seem to have reached a plateau in the past few years above which it appears to be difficult to improve. The results suggest that initial improvement was possibly due to the removal of special causes of defects because of sheer pressure by the clients. Further control of construction workers and site staff, checking of material and documenting to get evidence of conformance, may not improve the quality of construction products. If the quality is to further develop common causes of defects have to be removed by adopting meaningful management practises based on the Total Quality philosophy.

The above conclusions had an implication for the next step of this study. Although PASS and CONQUAS are multi-attribute methods that are presently employed to measure the quality of construction products, in view of the shortcomings identified above it was concluded that these two systems cannot be used as examples to check the applicability of multi-attribute quality measurement methods to construction co-ordination processes. Therefore another generic multi-attribute quality measurement model (described in Chapter 5) was adapted to the construction co-ordination context in order to test Hypothesis H1.

9.2.2 Construction Co-ordination Issues – Their Importance and Time Consumed

The net result of Experiment 2 was that the respondents identified the following as the six most important co-ordination activities:

- Identifying strategic activities and potential delays
- Ensuring the timeliness of all work carried out
- Maintaining records of all drawings, information, directives, verbal instructions and documents received from the Consultants and the Client
- Maintaining proper relationships with client, consultants and the contractor

- Managing the quality of all work carried out
- Liaison with the Client and the Consultants

The following six appear to consume most of the Construction Project Co-ordinators' time:

- Conducting regular meetings and project reviews
- Analysing the project performance, detecting variances and dealing with their effects
- Identifying/gathering information on requirements of all parties and consolidate for use in planning
- Interpreting all contractual commitments and documents
- Resolving differences/conflicts/confusions among participants
- Liaison with the Client and the Consultants

This led to the focusing of the next experiment for testing Hypothesis H1 on the three co-ordination processes: (1) Identifying strategic activities and potential delays, (2) Ensuring the timeliness of all work carried out and (3) Liaison with the client and consultants.

9.2.3 Acceptance of Hypothesis H1

Experiment 3 revealed that the three co-ordination processes concerned:

1. Identifying strategic activities and potential delays
2. Ensuring the timeliness of all work carried out
3. Liaison with the Client and Consultants

are carried out through regular co-ordination meetings, making direct observations at the site and proactively bringing up various problems into discussion and so on. In such a context it was possible to identify characteristics of:

- informality
- intangibility
- low repetition
- co-production by customers
- unsolicited service
- problem solving work

among the co-ordination processes that make it difficult to identify a predictable flow of processes, the personnel involved, the customers and other stakeholders, the interactions or inputs and outputs between these parties, expectations of these parties and so on.

Further analysis revealed how these characteristics cause difficulties in applying Steps A to H:

Step A. State the construction co-ordination process to be measured.

Step B. Identify the customers of the process

Step C. Identify the other stakeholders of the process

Step D. Identify (with the help of a service quality model) those performance characteristics required by the customers and other stakeholders.

Step E. Translate each characteristic desired by customers and other stakeholders into corresponding specifications for the process and the outputs.

Step F. Flowchart (or otherwise document) the process

Step G. List the measures internal to the process that control the performance of the process outputs against the requirements and specifications identified above. List the salient features of the process as practised now.

Step H. Determine how satisfied customers are with performance at the current level and the relative importance customers place on changing the level of each characteristic.

of the multi-attribute quality measurement systems to the three co-ordination processes concerned. It could be also be observed from the results that the process characteristics:

- 'Co-production by Customers' often cause difficulties in applying Steps A, D, E, F and G
- 'Informality' often cause difficulties in applying Steps A, F and G
- 'Intangibility' often cause difficulties in applying Steps D, E, G and H
- 'Low Repetition' often cause difficulties in applying Steps B, D, E, G and H

- 'Problem Solving Work' often cause difficulties in applying Steps A, F, G and H
- 'Unsolicited Process' often cause difficulties in applying Steps B, D, E, G and H

It was also argued that, above Steps A to H are the most basic and essential steps required in applying any multi-attribute quality measurement model to any process. Difficulties in applying these basic and essential Steps A to H to construction co-ordination context signify difficulties in applying any multi-attribute quality measurement model to that context.

On the strength of these arguments, Hypothesis H1, that "Attributes based quality measurement tools are not applicable to the construction co-ordination processes", was accepted.

9.2.4 Acceptance of Hypothesis H2

The 23 Critical Incidents analysed in this experiment demonstrated that by using the Critical Incident Technique (CIT) it is possible to identify implicit, explicit and latent expectations of the customers and other stakeholders. The technique was successfully applied to a variety of stakeholders, viz. Clients, Architects, Consultants, Quantity Surveyors, Subcontractors, Directors, Site Engineers, and the Society. Further, all 23 incidents analysed demonstrated how they could enable the evaluation of the quality of co-ordination processes and outputs and generate information useful for quality improvement.

Additionally, the analysis illustrated the three noteworthy cases of:

- How the vested interests causes a deteriorating relationship with the client and consultants.

- The superior quality of the co-ordinator's outputs to the supervisory staff satisfied the latent expectations of the Client, who was a third party to the processes. Thus this technique enabled the identification of the expectations of a variety of stakeholders. Therefore, it provided an understanding greater than merely the direct effects of the co-ordination processes.

- How a customer's initially negative perception of the Contractor's capabilities was changed to a positive one by a genuine attempt of the Project Manager to achieve co-ordination. It gave an understanding of how a 'hidden expectation' was satisfied, causing a recovery from the initial dissatisfaction to one of overall satisfaction.

Such valuable aspects that enable process improvement to be carried out could be studied using the Critical Incident Technique (CIT) despite the inherent characteristics of the co-ordination processes of Informality, Intangibility, Co-production, Low Repetition, Unsolicited Service and Problem Solving Work.

Therefore, based on the above demonstrated strengths of the Critical Incident Technique (CIT), Hypothesis H2, that "the Critical Incident Technique (CIT) is a practical method for measuring the quality of construction co-ordination processes", was accepted.

9.3 Concluding Remarks and Recommendation

Multi-attribute methods are popularly employed in quality management in many industrial and service organisations. However, as pointed out in this study, they require the service providers to identify the process flow, the customers and prepare lists of relevant quality attributes of the process. The customers have to evaluate and weight the attributes during the surveys conducted by the service providers. Such methods are possible to be applied on more tangible, visible, formal and predictable flow processes. The research study presented in this thesis demonstrated that it is not possible to apply these models on processes such as construction co-ordination that are characterised by Informality, Intangibility, Co-production, Low Repetition, Unsolicited Service and Problem Solving Work. As a result, industry practitioners have usually neglected such difficult processes.

As an alternative, this study demonstrated that, with minimum preparation, the Critical Incident Technique (CIT) could gather the required critical incident information related to co-ordination processes from customers and a variety of stakeholders. The flexibility afforded by this technique allowed respondents to easily articulate their perceptions of the processes and the outputs. The most important result was the in-depth information collected that is valuable for process improvement. Hitherto, there are no records of this technique being applied in the construction industry and this research suggests construction industry practitioners should view quality measurement from a new perspective.

It was observed during this study that present day understanding of the co-ordination function is poor. Much of the available knowledge is informal and intuitive, internalised in individual co-ordinators and other stakeholders of the process. It is envisaged that application of the Critical Incident Technique on construction co-ordination processes over a period of time, cataloguing a large number of critical incidents and classifying them on various aspects of the co-ordination processes and the expectations of the stakeholders, as discussed in Section 8.11, would eventually generate a body of knowledge that helps us to understand formally:

- What is good co-ordination?

- What is poor co-ordination?

Based on such formal knowledge, the Author recommends that a management maturity grid (please see the examples provided in Tables 3.1 and 3.2) be developed as briefly discussed in Section 8.11. That could provide guidance to future project managers in improving the quality of co-ordination.

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Appendix A

A CRITICAL ANALYSIS OF THE EFFECTS OF PASS AND CONQUAS

A.1 Construction Quality Assessment System (CONQUAS)

"Singapore's Construction Industry Development Board (CIDB) began in 1988 to work on a quality development strategy for the construction industry. In 1989, CIDB started by setting up a measurement system to assess the quality of constructed works. The Construction Quality Assessment System, or CONQUAS, was developed with the inputs of several construction-related government bodies. In 1990, a year after CONQUAS was introduced, a tendering advantage (a preferential margin) of up to 5% in public sector building tenders was given to contractors who consistently achieved good quality work as reflected through high CONQUAS scores. Called the Premium Scheme, it quickly became an incentive that was widely received by the industry" (Lam *et al.* 1994).

CONQUAS has three objectives (CIDB 1995 and 1998):

- To have a standard quality assessment scheme for construction projects
- To make quality assessment objective by:
  - measuring constructed work against workmanship standards and specifications.
  - using a sampling approach to suitably represent the whole project
- To enable quality assessment to be carried out systematically within a reasonable cost and time

The scope of CONQUAS, as given in CIDB (1995), is to set out the standards for the various aspects of construction work and to award points for work that meets the standards. CONQUAS covers most aspects of building work and the assessment consists of three parts, i.e., structural work, architectural work and external work (CIDB 1995). "In the fifth edition, CONQUAS 21, a number of new features have been introduced to make CONQUAS scoring more comprehensive and customer-oriented. These include a component for the assessment of 'Mechanical and Electrical (M&E) Works', the world's first field external water-tightness test that simulates the local rain and wind condition, a 'Pull-Off Test' for adhesion of internal wall tiles and non-destructive tests for durability of concrete. … 'M&E Works' has replaced the 'External Works' component. The latter is now reduced in weighting and incorporated under 'Architectural Works' for condominiums and public housing" (CIDB 1998).

Nevertheless the Author observes that, though there is a comprehensive arrangement to measure the said 'hard' or tangible aspects of the construction work, there is no attempt to measure the 'soft' aspects such as customer focus, co-ordination, teamwork, employee motivation, et cetera. In February 1998, when the Author interviewed a Senior Development Officer of Quality Assessment Unit, Technical Development Division, CIDB, he was told that they have no intention of expanding the system in the near future to measure such soft aspects of the construction work.

A.2 Performance Assessment Scoring System (PASS)

Once the Hong Kong Housing Authority started to maintain its own list of contractors, it developed a measurement system for quality at the construction stage (HKHA 1994). The system is called the Performance Assessment Scoring System (PASS) and was developed with reference to CONQUAS that had been successfully in operation for a few years in Singapore. It used to rate a contractor's level of achievement under the headings of materials, structure, labour, progress, safety, etc. The system, focusing on quality, scores performance against predetermined standards and tolerance levels (HKHA 1991).

Today, the system has expanded to measure further aspects of the construction process as follows (HKHA 1997a and 1997b):

- Structural Works
- Architectural Works
- Other Obligations (safety, health and cleanliness)
- Input Assessment (contractor's site management and progress)
- Maintenance Period Assessment

Under 'Input Assessment' contractor's site management and progress is measured under the following headings.

- Management and Organisation of Works

- Resources Management
- Co-ordination and Control
- Documentation
- Programming and Progress

All the issues measured under 'Co-ordination and Control' are listed in Appendix AA. It appears to be a very impressive list of aspects.

A.3 Multi-attribute Nature of PASS and CONQUAS

The PASS and CONQUAS manuals (respectively HKHA 1997a and CIDB 1998) identify specific attributes of construction products to be measured. The measurements are carried out by assessing the quality of these attributes against standards specified in the manuals. For example, in PASS, measurement of 'Co-ordination of Physical Deployment of Works' is made on the following attributes (HKHA 1997a):

> Take leading role and necessary action to co-ordinate physical deployment of works among all relevant parties such as but not restricted to:
>
> (a) checking all drawings and submitted requirements for conflict between all services, works and services,
>
> (b) reporting on ambiguity, discrepancy or conflict,
>
> (c) giving details of the method of construction including all dimensions and necessary information to ensure correct work execution and materials/goods supply, and
>
> (d) resolving conflicts onsite or drawing the attention of CM/CMR for instruction before any such work [that cause conflict] is due to be executed.

The measurements on these attributes are made as follows (HKHA 1997a):

Grading	**Standard**
A	**No non-compliance**
B	*Not defined/awarded*
C	**Minor non-compliance** Any case/instance of failure to comply with the assessment standards and: (i) not involve re-execution of work; and (ii) no adverse effect on quality/standard of works/materials; and (iii) no adverse effect on progress of works; and (iv) not induce difficulties to other trade(s) or parties; and (v) not functional deficiency; and (vi) not involve urgent case (safety hazard, structural stability, site security, risk of injury, physical damage or inconvenience to users or public); and (vii) not affect handing over of works to estate management or maintenance arrangement; and (viii) not cause delay to issuance of Maintenance Certificate; and (ix) not cause delay in settling final account of the Contract.
D	**Major non-compliance** Any case/instance of failure to comply with the assessment standards which (i) may cause (or has caused) re-execution of work; or (ii) may cause (or has caused) adverse effect on quality/standard of works/materials; or (iii) may cause (or has caused) adverse effect on progress of works; or (iv) may induce (or has induced) difficulties to other trades(s) or parties; or (v) may necessitate seeking concessionary acceptance of the product from the Client; or (vi) may involve functional deficiency; or (vii) may involve an urgent case (safety hazard, structural stability, site security', risk of injury, physical damage or inconvenience to users or public); or (viii) may affect handing over of works to estate management or maintenance arrangement; or (ix) may cause delay to issuance of Maintenance Certificate; or (x) may cause delay in settling final account of the Contract.

However, the Author observes that the focus is on either compliance or non-compliance with the generalised standards defined by the HKHA (Client). It does not, as proposed by Deming (1986), focus on maximizing Client satisfaction on the particular project or on statistical evidence of quality or on understanding the procedures the contractor uses to achieve a reduced number of defects.

A.4 Results of the Study Conducted in HK and Singapore

A.4.1 Overall Opinion of PASS and CONQUAS

In the questionnaire (given in Appendix AC) utilised to solicit wider opinion, a number of general questions were asked to find out on the whole how satisfied are the participants of PASS and CONQUAS. The summary of the responses is given in Table A.1. A majority of the respondents stated that PASS/CONQUAS is good and that they are happy and satisfied with it. It is also evident that a bigger percentage of construction contractors in Singapore held a positive overall opinion on CONQUAS than those in Hong Kong held on PASS. Still the results of in-depth interview surveys presented below indicate that PASS and CONQUAS has not meaningfully motivated the contractors to achieve higher quality by focusing on customer needs and continuously improving the processes. Based on the measurement theory discussed in Chapter 2, and the results of in-depth interviews conducted, the following discussion attempts to analyse some of the reasons for these problems.

Table A.1: Overall opinion of PASS/CONQUAS

	PASS (Hong Kong)	CONQUAS (Singapore)
Total Number of Responses	10	26
What is your overall opinion of PASS/CONQUAS?		
Excellent	0%	15%
Good	60%	73%
Fair	40%	12%
Poor	0%	0%
Are you happy with PASS/CONQUAS?		
Yes	50%	73%
No	30%	4%
Not sure	10%	23%
Did not answer the question*	10%	–
Are you satisfied with PASS/CONQUAS?		
Yes	60%	81%
No	30%	4%
Not sure	10%	15%

Being measurement systems developed for industry wide implementation, HKHA and CIDB may have had practical difficulties in sufficiently harnessing the participation of the parties being measured in the development of the systems. Further, the measurement or the assessment is carried out by the personnel of the client (HKHA) resident at the site in the case of PASS or by a panel of independent assessors from the CIDB in the case of CONQUAS. The result is that the personnel of the construction contractors being measured do not have any feeling of ownership towards PASS and CONQUAS. Following is a comment by a quality manager of a construction contractor that had in fact scored very high (in the upper quartile of the league) in PASS:

> PASS is actually designed by the Client. It serves the Client more. It is not really partnering although HKHA has recently adapted a policy of partnering.

Quality measurement systems should be developed with the involvement of those who will be measured (Davidow and Uttal, 1989). The resulting ownership of

* May be because they encountered some difficulties in answering, some respondents had skipped a question or two in the questionnaire. Wherever this happened, it is indicated in this manner in Tables 4.1 to 4.9.

the quality measurement system among the process participants is vital for acceptance of its results and its eventual success. PASS and CONQUAS scoring is not carried out by the personnel doing the construction for their own desire to better understand their construction process as suggested by Total Quality pioneer Deming (1986). Both PASS and CONQUAS are in fact merit ratings and they are supposed to benefit the better performers by giving better opportunities to secure future jobs (HKHA 1997a, CIDB 1995). The contractors thus compete for better tendering opportunities. In the case of CONQUAS 21 a monetary bonus payment is made under a scheme called 'Bonus Scheme for Construction Quality (BSCQ)' (CIDB 1998). This is different to the proposal by Deming (1986) for the finding of vendors that can furnish their own statistical evidence of quality and for clients to work with them to understand the procedures they use to achieve reduced number of defects. As described in Chapter 2, Deming (1986) had reiterated that use of performance measures for judgemental purposes and monetary incentives would result in poor quality.

The belief in the construction industry has often been that a third party can come into the site and monitor to ensure the quality of the product. Kam and Tang (1997) point out that the vision of HKHA has been, "Under tight surveillance from both the certification bodies and internal auditors, the quality of works can be guaranteed. The preferential tendering eligibility system can effectively bar the poor [quality performance] contractors and prevent them from obtaining contracts with a low tender price". Ahmed, Ahmad and De Saram (1998) pointed out that this vision does not relate to reality and demonstrated the need for Hong Kong construction industry (contractors, consultants and clients alike) to adopt more meaningful 'Total Quality' approaches. In this context, it is not surprising that construction personnel do not consider PASS and CONQUAS very favourable or useful, though they were happy and satisfied that these systems were better than nothing and something to begin with. The positive responses to the interview surveys received from Hong Kong are as follows.

Though the respondent below, a Senior Quality Manager of a very large contractor, had some reasons why he is not happy with PASS, he also stated that PASS has maintained the momentum of a quality circle they conduct. This was the only response on PASS that says the score is meaningfully used, i.e., to run "a quality improvement group which is a little like a quality circle".

> Certainly I think we are better off with it [PASS] rather than without it. I think it is a good start but it is a very very complicated system. I mean overall it has made a very positive contribution to the industry in Hong Kong. … Well, I am not happy in view of the fact that I don't think it is objective. Same applies to the question whether I am satisfied with PASS. … The other reason I am not happy with it is that it relies a lot on the clerk of works and his perception of the contractor. He becomes a very powerful person on that job site. … We do have certain elements that may be seen as Total Quality Management, e.g., we have in our building group a quality improvement group which is a little like a quality circle. We had it running for something like 5 years now and that had been quite productive. In some respects that has been actually focused on the works we do for the HKHA where we had the monthly PASS assessment and that gives us a form of measure which we can focus the quality improvement group on. We tried using this [a quality improvement group] in other parts of our organisation, in what we called our Commercial Building area. However, we found that we could not keep the momentum of the impetus of that quality improvement group going because we did not get data fed to us such that we could look at identification of particular problems that we could focus the group's attention on. So, that was one of the positive things that we have used from The Hong Kong Housing Department's PASS. *[However, this contractor had not scored very high in PASS relative to the other respondents to this survey and was not within the upper quartile of the league either].*

Another respondent from Hong Kong spoke how PASS promotes improvements at the site.

> PASS score is an average. Some items are high and some are low. So, cannot say. However, low PASS score means you have to change your working system, have special meetings et cetera. PASS does promote improvements at the site.

> If the PASS score this month is lower than last month, we may open the score sheet and compare that with the scores we received in the past three months of so to see the problem.

However, the improvements referred to do not appear to be continuous and incremental as would be carried out in a Total Quality environment. To open score sheets and have special meetings when the score is low, is in the nature of fire fighting.

The following respondents gave negative responses that were more typical of the opinion of Hong Kong construction contractors.

> I think PASS does something to make quality a little bit better and monitor the performance of the contractor. It is actually better than nothing.

> PASS is simply a scoring system to control the contractor on contractual obligations. It will give a useful assessment of the contractors quality capabilities provided more effort is put in by the people who implement it.

The latter statement “more effort is put in by the people who implement it” meant that the assessors do not give a proper assessment. This aspect will be discussed in detail later in this Chapter.

A Senior Quality Manager responded as follows stating that they have to comply with too many controls and checks on a construction site. He also points out, by contrast, that an improved construction method has without doubt upgraded the quality. Improving construction methods and processes is a better approach than increasing controls and checks.

> A lot of housing jobs are now prefabricated and precast. Just because of that, the quality is without doubt a lot better than it was many years ago and by imposition of PASS we do not feel that it [PASS] is going to increase that [customer] satisfaction any more than what exists now. Also, coupled with that is the normal project controls (certification of the main contractor, certification of other subcontractors, need for the approval of those specialist contractors on the job and selection of those contractors from various lists, particularly everyone - the materials, the design, all people on the

> job are all better qualified) and one begs a question "Why do we need PASS on top of all that?". I do not think there is anything there that is going to increase the satisfaction of the future residents. There is very little deviation in the materials, specification permitted to the contractor. So, he has to follow it fully, rigorously. If he gets it wrong, he got to put it right. So, that [PASS] is not going to impact the future residents.

Another respondent, a Quality Manager of a contractor that had scored very high (in the upper quartile of the league) in PASS said:

> [In this company] site management treats PASS score like a window dressing. Deep down in their hearts there is no intention to improve the quality unless somebody pushes it. That is the culture in Hong Kong [construction industry]. Like the culture of some students trying to get a higher mark [at the examination] and not the knowledge.

While the responses we received on PASS from Hong Kong contractors were mostly negative, more positive responses on CONQUAS were however received from Singapore contractors.

> This is better than nothing. I give credit to the CIDB for making some quantification. Somehow they managed to make the people become strict. If no guidelines and only market forces to manage the quality, it will not be OK.

> We are given a common assessment ground to compare with other contractors how well we have done for that finished product. If we score well, it is a good advertisement for the company. Recently under the new scheme [CONQUAS 21] they have given incentives in present time. If you perform above the national average they pay you a percentage above the contract sum as a bonus. What happened previously was that after you have performed, based on the CONQUAS score, you have a preferential margin above the rest of the tenderers [at the next tender]. That preferential margin was from the past project and does not reflect the present project. Now they are applying the scheme to the present project in present time.

The above two respondents however appreciate CONQUAS as a merit rating and as a financial incentive scheme. The following respondent, a Senior Project Co-ordinator, speaks of how CONQUAS has helped in making a change of attitude within his company.

> CONQUAS helps to accelerate the change in the mentality towards work – in terms of quality consciousness. We are always feeling cost is our first priority. Subsequently, our goal is between time and quality. So, cost is still the main criteria and time is number two, but we are beginning to treat quality as number two. There will be a time

> when quality is treated as number one! It is not something we would not have done without CONQUAS but certainly it would not have been as fast as with CONQUAS.

Although the above responses indicated a positive impact of CONQUAS, what appears to lack is emphasis on better focus on customer needs and continuous improvement of construction processes. However, one contractor responded as follows:

> Definitely yes, if you score high, it helps you to go a long way. Previously we were mainly doing private jobs. The developer also uses CONQUAS score to gauge our performance as far as quality workmanship is concerned. So, it is useful. On one of the condominiums our score was 79, which was above the National Average. So, it has given us something to improve on. It is definitely a very useful assessment.

A Japanese construction contractor operating in Singapore and practising Total Quality stated as follows:

> As you could see *[showing the manifesto displayed in the conference room]*, we have adopted CONQUAS as our managerial objective for our quality management system, i.e., "0.5 points higher than the National Average for the applicable type of building". … We adopted because it is a measurable, quantifiable yardstick used for assessment. There is no point saying that I have done a good job; what is a good job?

What is more evident from the discussion so far is that PASS and CONQUAS are serving the function of a merit rating of contractors rather than motivating them to achieve better quality. This observation will be further substantiated as we proceed with this discussion. Deming (1986) stressed that choosing a supplier based on merit rating creates short-term thinking and deflects effort away from long-term improvement. Supplier evaluation should focus on maximizing Client satisfaction, statistical evidence of quality, understanding the procedures they use to achieve reduced number of defects and so on. A merit rating approach is management downstream; managing the outcome; managing too late. However is popularly used because it is so much easier than providing leadership on improvement. A better way would be to enquire on advancement during the past year along the Total Quality philosophy path (Deming 1986).

A.4.2 Faith in the PASS and CONQUAS Assessments

As Deming (1986) stated, merit ratings could even become barriers to pride of workmanship. There could be doubts about acceptable workmanship, inspectors not sure about what is right, what cannot be measured, problems with inspection and so on (Deming 1986). Using very elaborate manuals (HKHA 1997a and 1997b, CIDB 1998) both PASS and CONQUAS specify in great detail what to measure and how to measure. Nevertheless, as seen in Table A.2 and the following discussion, respondents to the surveys had reasons to doubt the validity of the measurements.

At the time of the pilot survey, the question on accuracy of the PASS assessment was originally formulated as (please see Appendix AB) “Does PASS give fair and accurate assessment of the quality capability of the contractor?”. It was then formulated as given in Table A.2 (also please see Appendix AC) when all four respondents to the pilot survey complained of the assessors’ tendency to give an average score. In Table A.2, please note that the options “just give you a high score” and “just give you a low score” did not receive any responses.

Table A.2: Faith in the PASS/CONQUAS assessment

	PASS (Hong Kong)	CONQUAS (Singapore)
Total Number of Responses	10	26
Do you feel that PASS/CONQUAS assessors try to:		
give you a very correct and accurate assessment?	20%	77%
just give you an average score?	60%	23%
just give you a high score?	0%	0%
just give you a low score?	0%	0%
Did not answer the question	20%	–
Does PASS/CONQUAS give a *fair* assessment of contractor's capabilities?		
Yes	40%	73%
No	20%	8%
Not sure	40%	15%
Did not answer the question	–	4%
Does PASS/CONQUAS give a *useful* assessment of contractor's capabilities?		
Yes	60%	73%
No	10%	8%
Not sure	30%	15%
Did not answer the question	–	4%
Does a high PASS/CONQUAS score mean a higher quality of work?		
Always	30%	46%
Never	10%	0%
Sometimes	60%	50%
Did not answer the question	–	4%

60% respondents in Hong Kong stated that assessors give an average score while it was about the opposite in Singapore. Only 40% of the respondents from Hong Kong felt that PASS gives a fair assessment of the contractor's capabilities and only 30% felt that a high PASS score would mean higher quality of work. From these results it is evident that contractors in Singapore had more faith in CONQUAS than Hong Kong contractors on the PASS. However even in Singapore, 50% of respondents were not sure whether a high CONQUAS score would mean higher quality of work. During the in-depth interview surveys conducted, it was realised that one of the major reasons for the better opinion on CONQUAS was that independent assessors from outside the project team were brought in to assess the work. They were hence independent of the politics and obligations within the project organisation. Hong Kong contractors expressed concern over HKHA personnel resident at the site assessing the work. Following are some of the comments:

> HKHA's CPRC (Contractor Performance Review Committee) will base on the PASS score to make decision on the tendering eligibility of the contractor. Contractors with high PASS score will be given more tendering opportunities. For projects with extremely high or low PASS scores, the CPRC will arrange to conduct site visits to ascertain the reasons and obtain explanations from the project teams. So, the project teams are usually reluctant to give high or low scores. However, as the PASS score is a combination of marks obtained in monthly inspections and routine checks conducted by the Housing Department site staff, I would agree it can give a fair assessment of the contractor. Nevertheless most contractors, due to limited resources, will assign workers to tidy up the sites only on the day of PASS assessment. Also, they rectify the defects once they receive the notification of the "locations" where the assessment will be conducted. If you have a good relationship with the client's staff, you can get the locations early. *[This contractor had scored low in PASS and was in the lower quartile of the league]*.

The above respondent describes why there is a tendency to give an average score; if the assessors make a discriminating decision they may have to explain it. Deming (1986) states, "no explanation is required of a man in the management for doing nothing". The comment "If you have a good relationship with the client's staff, you can get the locations early" was confirmed by another respondent as follows. He further stated how it has become a game to get a high score at the merit rating.

> Our company puts lots of effort each time PASS assessment is done. There is a special team in each housing project to handle the preparation and verification to get the higher mark. They also work hard to get beforehand the locations the assessors will look at. Some people in the site management now know the loopholes and can play the game to get a high score. To prevent this I think the system and the content should be revised every two years. *[This response was from a contractor who had scored very high in PASS and in the upper quartile of the league]*. … We get a very high score over 80% even the mean score is very high over 80%.

When interviewed, more respondents confirmed their responses that assessors try to give an average score:

> Assessors try to give us an average score and take the no questions asked approach. I cannot give you hard evidence but that is a feeling we have, yes it happens.

> Some of the HKHA personnel themselves think the system is tedious. They just give the contractor average marks, not too high and not too low. A too high score brings extra attention of the Audits and more visits by other personnel of the Client; which they do not like. If the score is too low, the contractor may be penalised, but it is a problem to the Client's Engineer too. So they give an average score. The system is quite fair as it is in the shape of a detailed written document but under the control of human beings. If an extra special audit team or other HKHA personnel do the assessment/audit it will be fair.
>
> PASS depends on the people who implement it. If a site receives a low score, the Architect/Engineer has to explain by a report. Also there may be warning letters to the Architect/Engineer. Therefore, most Architects/Engineers do not like to give a low score. Hence, now there are third parties to counter check the scoring which is a good system.

On this, officers of the PASS Control Unit HKHA said when interviewed,

> We are looking into developing the system for the future to remove the idea of grading A, B, C, D and E and to make the assessment items of PASS more of a package. The contractor will either comply with that package fully or if he does not comply with a part of the package then he will basically get a non-conformance score for that, i.e. zero score. One of the ideas of that is we will push the assessors into a more black and white assessment of achievement. It is a hard-line approach and our first discussion with the industry on this, seems to indicate that the industry is not too concerned about the fact that it is a more hard-line approach is being that it is fair to everybody.

As given in Table A.2, some respondents from Singapore also had stated that the CONQUAS assessors give average scores. When interviewed, they confirmed it as follows.

> Yes I stated [in response to the questionnaire] that they [assessors] just give an average score. They do it basically to please everyone. If you give a very high score, there might be a tendency to think that he [assessor] is slacking in his work and did not check properly. If the score is too low, the contractor may not be happy.
>
> The assessors are also of different opinions; they are not 100% objective. Some will have the feeling that "If I did not find anything wrong with you, I have not done my job" and then they will say "I have never given anything [score] so high before". They may tell you "For an industrial building it is very easy to achieve all our requirements like the flatness of the wall and flatness of the floor". "Because in an industrial building like warehouse there is no finish we cannot check". No! This is not true. If there is no finish, then my structural finish is the finish. If you want to check the alignment, plumb, flatness, etc., you check whatever surface I finish. So, these things happen because he does not want to be questioned "Why did you give such a high score to a certain project?" So, they tend to stick to the average they know. So, it [CONQUAS score] becomes sometimes not a real reflection of what your quality is. CIDB, I must say is very responsible in their management of the CONQUAS. If there is any extremely high or extremely low score, they may (and they did in some circumstances) do a recheck. They will come for another inspection just to confirm whether the score is reasonable. So, there is a problem, but if like I say an assessor sticks to an average, no question will be asked. We cannot rule out any subjective

> assessment in any assessment other than laboratory kind of test. There is still a very high degree of subjective opinion. I won't say that all of them are like that, but the tendency is there. *[This response is from a Japanese contactor operating in Singapore and practising Total Quality].*

> I think, when the assessors go to the site to assess the quality of work, the tendency is to give an average score. Because if he gives a very bad assessment or if he gives a very good assessment he may end up drawing lots of attention. Unless he can show that a particular project has produced a good quality work or he is dead sure that in a project the standard is very low, the tendency is that they give an average score. That is the reason why most of the scores are average. You very seldom see a contractor scoring very high or very low. I mean it is practical and I am not saying that this is right or wrong, but this is the situation.

The respondents also expressed concern that PASS is not objective and depended on the assessor and his/er judgement.

> It [PASS] covers all the major items but the PASS scores depend on HKHA personnel. – Depends on who the architect onsite is. – PASS Manual gives the requirements in detail but some follow it while others do not. Therefore it is not fair. A high PASS score does not really mean a higher quality of work.

> PASS is simply a scoring system to control the contractor on contractual obligations. It will give a useful assessment of the contractors quality capabilities provided more effort is put in by the people who implement it.

> It definitely gives you a useful assessment but I doubt that it will give you a fair assessment because it depends on the assessor; on the level of his competence to assess the work, his mentality and his skill. If they all have the requirements of a trained auditor/trained assessor it is OK.

> What I would like to say about the system is that they should formalise the system by having a central audit team that will apply the same criteria to all projects. At present, the acceptance criteria varies. *[This response is from a contractor usually scoring very high in PASS and carrying a reputation as a company with great initiative to improve its quality capability].*

> I think it [PASS] is not totally objective. There has been consideration to have an independent PASS assessment group established and that group to assess all the sites. Today the problem is that personnel at one site might mark tougher and vice versa in another. I mean it [PASS] is not totally subjective but if you went out and see how it is done, you could say things are not terribly objective. Higher PASS score does not necessarily mean higher quality.

May be the proposed hard-line, black and white assessment described by the HKHA officials will help reduce this problem also. However, this problem was found to exist even in Singapore where CONQUAS assessments are scored as a cross or a tick depending on whether the contractor has complied with the requirements or not. Respondents from Singapore who were dissatisfied with subjectivity of CONQUAS scoring stated:

> CONQUAS is a quantification. Under the guidelines the assessor can give you a correct mark, but still depends on the assessor because, within the guidelines the subjective judgement of the assessor matters.
>
> As I said, it [CONQUAS] is very subjective and depends on the assessors and sometimes the human relationships will come in to play. I mean there are many factors involved.

HKHA has future plans to improve on these aspects as stated below by the officials of the PASS Control Unit. Such approaches that focus on the processes could yield positive results:

> We are also going to take the critical trades and establish methodologies similar to Singapore whereby before, say, the concreter starts his work on the site, there will be a demonstration on the site to achieve certain benchmark standards of work processes. Not necessarily it is going to guarantee quality but at least will give some assurance that the contractor will understand what he is doing. Therefore he should be able to produce the final workmanship that we require because his trade procedure is correct and preparation is correct, he is using the right kind of methodology to achieve it.

"There is obviously something wrong when a measured characteristic barely inside [the limits of] a specification is declared to be conforming; outside [the limits] it is declared to be nonconforming. The supposition that everything is all right inside the specifications and all wrong outside does not correspond to this world. A better description of the world is the Taguchi loss function in which there is minimum loss at the nominal value and ever-increasing loss with departure either way from the nominal value" (Deming 1986).

Deming (1986) further states, "the only communicable meaning of any word, prescription, instruction, specification, measure, attribute is not what the writer thereof had in mind, but is instead, the result of application. How does it work in practise? What happens? … The man in business or in government cannot afford to be superficial in his understanding of specifications for performance of products or human effort. … Meaning starts with the concept, which is in somebody's mind and only there: it is ineffable. An operational definition puts communicable meaning into a concept. An operational meaning is one that people can do business with. Operational definitions provide a basis of communication between the inspectors and operators. … Adjectives like good, reliable, uniform, round, safe, unsafe have no communicable meaning until they are expressed in operational terms of sampling, test and criterion". For example, in PASS measurement of 'Co-ordination of Physical Deployment of Works', there are statements such as the following that require operational definitions to make their meaning precise. Please note the underlined words that require further definition.

> giving <u>details</u> of method of construction including <u>all</u> dimensions and <u>necessary</u> information to ensure <u>correct</u> work execution
>
> may cause (or has caused) <u>adverse</u> effect on quality/standard of works/materials
>
> may cause (or has caused) <u>adverse</u> effect on progress of works

Deming (1986) states, "it may be cruel supervision. Who declares an item to be defective? Would it have been declared defective yesterday?" He further asks "Are your tests of the final product in statistical control? If not they will mislead you" (Deming 1986). These problems need to be seriously addressed if PASS and CONQUAS are to be made more meaningful.

In this context, some respondents spoke of how human relations also matter in PASS and CONQUAS scoring.

> The other reason I am not happy with it is that it relies a lot on the clerk of works and his perception of the contractor. He becomes a very powerful person on that job site and I am not sure whether this in fact is the way it should be; it should be the architect, I mean the architect is the client's representative. Thus, clerks of works can start wielding a great deal of power based on PASS. So I think that is the game, we are all human and, I mean, if there is a particular (even a personality) clash, our score could get affected. If you have some particular problems with the client in the previous month or previous three months, you will find that the score will be generally down.

> PASS is an additional burden to all those things we have to carryout in a day. You may find that on some projects the relationship issues with clerk of works onsite are very very significant. Clerk of works may not like what you are doing and he may not be adopting a judgement from contractor's perspective although you may be absolutely right by the book. Consequently you may find that lots of resources were put into satisfying clerk of works' various comments. On some jobs clerk of works may be very useful, constructive, proactive and it will be a team approach to finish the job and in another job it may be an adversarial approach.

> As I said, it [CONQUAS] is very subjective and depends on the assessors and sometimes the human relationships will come in to play. I mean there are many factors involved.

> Generally, it [CONQUAS] is a good idea, I mean it is somewhere to start. If there is no system, you will have nothing. However, it depends on the mood of the person who is going to inspect and how you treat him onsite, because after all it is the human perception of what is quality and what is not quality. It happened in one of our sites where the assessors informed that they will be there by 9.00 a.m. but came late at around 9.30 a.m. to find that my staff had left the site for a while. When he [staff] came back, the assessors were waiting and were not happy and the score that day was very low. It is very subjective. Then there are people [assessors] who really do help the system in a way; they will advise you that there are better ways to do this and that.

The following respondent described how high CONQUAS scores are at times achieved after rework.

> During the structural stage, before we pour concrete we will contact the CIDB to have the work assessed. They will come to the site, check and ask us to rectify this and that; for example, level is wrong, you fix it, like this, like that. So, after rectification what is the problem? Really, you are supposed to check yourself before the [CIDB] officer comes. So, in structural works everyone normally score very high and it does not tell which contractor is good and which is not very good. For finishing, CIDB will check after you finish. They will check surface roughness, hollowness, dimensions, flatness and so on. On the finishes, yes, we can say there is some fair assessment because they check after you finish. That is why I have answered [in response to the questionnaire] that I am not sure whether CONQUAS gives a fair assessment.

The latter response was further confirmed by the following statement by another respondent.

> For structural works there is a total of 4 inspections; before casting and after casting in 2 different sets. Scoring is normally very high (90+) before casting and after casting the scores tend to be on the lower side (in the range of 70s). So it averages out to around 80+. Finishes are in the range of 70s and at times as low as 60s.

In Hong Kong also, the following was stated by a Senior Quality Manager (of a contractor usually scoring very high in PASS and carrying a reputation as a company with great initiative to improve its quality capability).

> At the beginning of the project during the structural works, the score is higher. Architectural works, it is less.

Therefore, some aspects of the structural works, where it is easier to rework than in the finishes, can get a higher score.

Still, apparently because of the very independent assessment body well separated from contractual obligations and other politics within the construction project, CONQUAS received the following very positive responses on its credibility. Such positive responses on PASS were not received even from the contractors who had scored high at HKHA contracts.

> … All things are specified. So, standards have been set. There is no argument and also the assessors are from the CIDB. So, I do not see any problem. Sometimes you can still see that a certain assessor's assessment is slightly different. One assessor will say this is good while the other may feel not so good. That is human judgement but overall to me it is fair. If you feel that you should not get this low mark, you could ask for reassessment. … The assessment is done by quite an independent body. So, you get a second opinion. However, [referring to what he heard from the interviewer on Hong Kong situation*] if you are the supervising engineer and you yourself set the standard and give assessment to the contractor, you will pitch on what we call the common interest. So, you should have an independent assessment.

* When the respondent spoke very positively on credibility of CONQUAS, the interviewer described the situation in Hong Kong and asked the respondent whether he had any such concern.

> For CONQUAS, I would say the percentage of subjectivity is very high. That means they actually assess the things they see. On the score sheet there are just too many things to take care of in one single assessment. So, unless he [assessor] has something in mind such as "I am going to give you 20% less than national average" – which I do not think so – they are basically there to mark cross or tick what they see. End of the day, they consciously do not know how many they have ticked or crossed. They just go along and check [the score] subsequently. They do not know whether you are scoring above the national average or below. Content of objectivity is there but he has to assess based on subjective gut feelings, he actually subjects his assessment to what he sees and what he hears like the sound when he checks the hollowness. So, I believe the subjectivity is very high. I do not think they are influenced by having to answer for giving high or low marks.

> I think it [CONQUAS] can give a correct and accurate score because the test itself is basically carried out onsite with all the people around. Though the test cannot be 100% representative of the entire site (because it is a sampling test), within the sample it is correct and accurate.

> The assessors are not resident at the site. They just visit and beforehand they do not know what site they will visit. They [CIDB] have a pool of assessors and send any two assessors to the site; never one. So, anything we are not comfortable with, we can ask for reassessment. Over a period of 2 years, we may see the whole pool of assessors and every time there is a new pair. They are very careful about these things because they have to be very very independent.

However, two respondents had spoken as follows on the CONQUAS scoring. Still, based on the numerous responses presented above, the Author doubts the validity of such extremely positive statements. The respondents were Quality Managers of the companies and it was not clear whether they actually witness the assessments carried out at the construction sites or did not want to give the actual position.

> In Singapore, the scores are very absolute, correct and accurate. As you [interviewer] suggest, there is no human judgement involved. Depending whether you have a tick or a cross you have corresponding points, it is not a judgement in a range where you can have high and low values.

> It gives a good indication – high CONQUAS score means good construction quality. Government officers are very rigid. Normally there is no human factor. It is very rigid assessment. Generally the trend is that the scores are improving, as there is an incentive. High score brings good reputation.

The last two sentences by the latter respondent suggest that he is motivated to get a high score and improve the company's prospects.

Table A.3: Is PASS/CONQUAS another burden on the contractor?

	PASS (Hong Kong)	CONQUAS (Singapore)
Total Number of Responses	10	26
Do you consider PASS/CONQUAS as another burden on the contractor?		
Yes	60%	12%
No	30%	73%
Not sure	10%	15%

According to the discussion so far it will not be surprising to note that many respondents from Hong Kong considered PASS as a burden on them while majority of respondents from Singapore did not think so about CONQUAS (please see Table A.3). In this context, it is also noticeable that the scores are not used for developmental purposes, i.e., focus on customer requirements, improve construction processes and so on. The common objective among the contractors is to get a score as high as possible thus satisfy the requirements enforced by the governmental bodies. This tendency is evident from the following responses.

> We quite honestly believe that there is a technique to achieve a high PASS score; which does not necessarily mean that the contractor was capable of doing a better job than the other contractor. We try to benchmark our performance against other contractors and quite frankly we cannot understand how it is that we are down the scale, in the middle of the scale. We would like to be on the top of the scale but we feel we do not have the experience or the technique to achieve a high PASS score result. We feel we are going to take more time before we come round to it, even though there may not be any change in the quality of the work or may be a few changes. … We feel there is a technique with which a contractor can score high. Yes, and that technique is something else other than doing everything perfectly. For that reason we do not think it [PASS] is entirely fair and it is useful. There might be one factor in the score that might knock it down significantly. It does not give credit for the things you have done extremely well, it only penalises you for the things you have not done well and because of that the usefulness of the actual score is very questionable.

> Our company puts lots of effort each time PASS assessment is done. There is a special team in each housing project to handle the preparation and verification to get the higher mark. They also work hard to get beforehand the locations the assessors will look at. Some people in the site management now know the loopholes and can play the game to get a high score. To prevent this I think the system and the content should be revised every two years. *[This response was from a contractor who had scored very high in PASS and in the upper quartile of the league]*. … We get a very high score over 80% even the mean score is very high over 80%.

> It [PASS] takes a fair bit of time. I question whether or not we should do it monthly. It does take a lot of time of our staff, time wise it is a burden on the contractor. I think

> monthly is a bit too often. *[This response is from the Senior Quality Manager of a large contractor in Hong Kong that had a quality circle – described in a response presented before]*.
>
> I think it is a good system. However, they [personnel at the site] achieve the score only on two days a month. Reason is that the PASS requirements are higher than the contract requirements and hence the contractor has to spend more money if he needs to achieve the quality that PASS needs.
>
> Nevertheless most contractors, due to limited resources, will assign workers to tidy up the sites only on the day of PASS assessment. Also, they rectify the defects once they receive the notification of the "locations" where the assessment will be conducted. If you have a good relationship with the client's staff, you can get the locations early.
>
> The culture here is, when it comes to quality it frightens people; it is considered as a burden. That is the problem here. We can implement many systems ISO 9000, TQM, CONQUAS, but most of these are purely bureaucratic.

However, another contractor responded as follows:

> We maintain a clean site all the time. Not just before their [the assessors'] visit. We always do it.

A General Manager from a Japanese contractor in Singapore practising Total Quality stated as follows:

> You should get all your supervisors and engineers to pay attention to all these assessment points, which means that you are ready when they come to check, everything is correct and you get the high score. The other thing is to a certain extent it can be controlled; sort of regulated by yourself because you have to call the assessors to say that you are ready, come and check. So, you can get everything correct, pay attention to all those things they are going to check and then ask them to come and check.

A.4.3 Do Capable and Competent Contractors Get More Jobs?

To the question "Do you think PASS/CONQUAS has succeeded in ensuring that capable and competent contractors get more jobs?", as it could be seen from the quantitative results presented in Table A.4, even the respondents from Singapore however appeared to be less convinced.

Table A.4: Has PASS/CONQUAS succeeded in ensuring that capable and competent contractors get more jobs?

	PASS (Hong Kong)	CONQUAS (Singapore)
Total Number of Responses	10	26
Do you think PASS/CONQUAS has succeeded in ensuring that capable and competent contractors get more jobs?		
Yes	20%	46%
No	50%	23%
Not sure	30%	31%

A respondent from Hong Kong stated:

> At the end of the day, it is the price that gets you the job. A low PASS score will reduce your opportunities to tender and above average score will make an open plain for you. There are also quite a lot of contractors after the same jobs. The ones that are more capable and competent and other ones with cheaper prices, and that is it. Some of them make mistakes in their pricing while some make them more competent or capable. I suppose the theory is you should weed out some of those who are less competent. Well, I am not sure, it [PASS] improves the chances that more capable and competent contractors will get the work, but does not, I do not think, that it succeeded in ensuring that competent and capable contractors will get more jobs. So, there is a difference.

Another respondent, this time from Singapore, stressed that some contractors submit low bids by not properly studying the content of work involved and eventually have the job awarded to them:

> I don't think CONQUAS has succeeded in ensuring that capable and competent contractors get more jobs. On the contrary you will get less jobs as you will be more professional in tendering/planning – you will remember everything, keep everything in mind when preparing the bid – whereas an average contractor, based on my past experience, does not go into details of how to plan.

The following responses also state that clients really do not care much for the quality capability of the contractor.

> No, it [award of jobs] mainly depend upon the price. If the price difference is very small, then people will look at whether your company is reputable and reliable. I am not sure whether CONQUAS score will help much. *[This Japanese contractor once had got the highest CONQUAS score for a project in Singapore]*.

> Contractors in Singapore got pre-qualified or selected not really based on how much CONQUAS score you got in the past. Nobody has really asked us or used it as a

> condition. So far we have not seen any pre-qualification or selection of tenderers based on CONQUAS score. CONQUAS 21 is going to have a bonus point system. That is what it is leading to. They would put CONQUAS in the contract as a part of a requirement and they would also have some bonus or penalty attached to it.
>
> Even if you have a score of 80+, in my opinion, it all comes down to money – your tender sum. CONQUAS score is a much secondary factor. During the tender stage, the tender sum is the one that really counts and in Singapore if you tender for public projects it [the awarding] is always based on the lowest tender. So they do not really bother about your CONQUAS score. It may help in private projects but in the current situation (economic downturn) I doubt so.

It appears from the above response that during the economic downturn even the private clients focus on the price tag. However, the following response suggests that the reduced markups during the economic downturn have made the 5% preferential margin* significant. During the boom time, a 5% tendering advantage has not been sufficient to secure a job.

> Depends on the type of client, e.g. public project – they are quite clear – when you have a certain score they will give a certain margin. However, in open tender they will almost always award to the lowest tenderer. All depends upon the market conditions; right now everybody is hungry for jobs, so 5% is a lot. If you are talking of now [economic downturn], the preferential margin* of 5% they used to give would have been good enough, however not much during the boom time.

A.4.4 Use of PASS and CONQUAS for Improvement

A question was asked whether higher PASS/CONQUAS scores mean less problems at site. As evident from the quantitative results summarised in Table A.5, a majority of the respondents did not feel so or they were not sure. Following are some comments we received during the follow-up interviews, which may explain the above results.

* Due to WTO requirements, Singapore Governmental clients have stopped the previous practice of giving a preferential margin. Instead they have commenced to pay a bonus of up to 5% over the contract sum.

Table A.5: Higher PASS/CONQUAS score means less problems at site?

	PASS (Hong Kong)	CONQUAS (Singapore)
Total Number of Responses	10	26
Do you think that a higher PASS/CONQUAS score means less problems at site?		
Yes	30%	31%
No	20%	42%
Not sure	50%	23%
Did not answer the question	–	4%

Some respondents stated that the score depends on the construction methods and material used. If easier methods and material are used, there will be less problems and consequently the score will be higher. Therefore, PASS and CONQUAS could motivate contractors to seek better methods, processes, material and so on thus improving the construction work.

> A lot of housing jobs are now prefabricated and precast. Just because of that, the quality is without doubt a lot better than it was many years ago and by imposition of PASS we do not feel that it [PASS] is going to increase that [customer] satisfaction any more than what exists now.

> Tendency is that if you use more precast methods, your CONQUAS score will be higher because there is less finishing work in the precast methods.

> It [CONQUAS score] depends on the material you use. If you use granite, surely it gives you a much good finish, a straight finish compared to plastering.

There were other reasons given for lack of such relationship between the score and the problems at the site, especially that assessment is subjective.

> No! This is because, sometimes the higher PASS score means that you have been marked softly in that particular month and there have been problems in the areas which have not been looked at.

Perhaps that respondent did not feel that the sample assessed under PASS could represent the entire site. Another respondent stated, as quoted below, how PASS score being an average makes it difficult to correlate with different aspects of site problems. Also, the PASS score relates to your previous project and because of the high turnover of personnel in this industry it may not guarantee a similar score in the present project.

> There is a little bit of problem with this relationship. The way they do the score is they will have some checklist to check ... but when they compile the score, they compile all the techniques together and make a cumulative evaluation. So it is difficult to correlate with the intensity of problems. However, if you have a high PASS score, you have completed within budget and on time. Otherwise you won't get a high PASS score. Your PASS score comes from your previous work. That does not necessarily mean that you will get a high PASS score in this project because the people change; they are not using the same subcontractors.

Others had not attempted to identify or check whether there is a correlation between PASS/CONQUAS score and problems at site.

> Somewhat related ... more disputes will mean lower PASS score and on time/budget completion will mean higher PASS score. Similarly, delay and not within budget will surely get a lower PASS score. I cannot see a major correlation with intensity of complaints and number of site instructions and variation orders.

> Yes it is highly related to the number of site instructions and variation orders. On-time within budget completion will mean higher PASS score. I agree that high score will mean less problems. However, we do not use the scores for our own monitoring. We manage by exception.

> We have never tried to correlate like that.

However, another respondent stated as follows:

> If you are scoring low in the finishing stage, it means that lots of places need to be rectified. This is also during the maintenance stage; you need to deploy three or four staff to rectify the problems. So, if your score is high, this means less rectification problems.

Others spoke on the inability of these measurement systems to focus on the processes. As described in Chapter 2, Davidow and Uttal (1989) and Tenner and DeToro (1992) emphasised the need to measure at three levels: Process, Output and Outcome. The following respondents speak of two relevant aspects:

1) contractors achieving quality after lots of rework

2) PASS and CONQUAS not focusing on problems of construction processes and management processes

> Emphasis of CONQUAS is on the finished product. So, from the contractor's point of view, it does not mean less problems. You get to that fine finished product after lots of rework. Quality is carrying it out right the first time; not rework to get quality!

> During the structural stage, before we pour concrete we will contact the CIDB to have the work assessed. They will come to the site, check and ask us to rectify this and that; for example, level is wrong, you fix it, like this, like that. So, after rectification what is the problem? Really, you are supposed to check yourself before the [CIDB] officer comes.

> CONQUAS looks mainly at quality of works. There are so many problems at the site. Quality is only a very small part of it. You solve this problem does not mean that your other problems will be solved. What I mean is that you should have good project management to run the job smoothly. Then only you can concentrate on achieving higher quality.

> You get thousands of problems at the site. Problems we deal with on a daily basis have no direct relationship with the CONQUAS score. High CONQUAS score means strict/high quality control.

> There are so many types of problems. Human management is a big problem. Another thing is that we have a time frame to complete the works. So, quality and project management has to go together. High CONQUAS score does not mean that other problems are solved.

A Japanese contractor operating in Singapore stated as follows:

> Yes we do practise Total Quality. Total Quality for us is coupled with ISO 9000, as you know all the G8 contractors must be ISO 9000 certified. Therefore, in running a quality management system, there is no other way than Total Quality system. Which means you start from the beginning all the way from business development right down to the handover and services to the client, you have to be good in every step. Not just by CONQUAS score, not just by ISO 9000 audit, best way to ensure getting yourself in the good range is to practise Total Quality.

Table A.6: Use of PASS/CONQUAS scores for continuous improvement

	PASS (Hong Kong)	CONQUAS (Singapore)
Total Number of Responses	10	26
Do you use the PASS/CONQUAS scores to check whether your improvements to the construction process have been effective and suitable?		
Always	20%	38%
Never	0%	4%
Sometimes	80%	54%
Did not answer the question	–	4%

As apparent from the results presented in Table A.6, many respondents stated that they use PASS/CONQUAS scores to check whether their improvements to the construction process have been effective and suitable. However, when interviewed, it was revealed that there is no systematic use of the scores for such evaluation. Many had ticked on the options "Always" or "Sometimes" because they used the scores at least to casually judge how they are doing.

As seen from the interview structure in Appendix AB and the questionnaire in Appendix AC, it was queried whether the respondents measure the quality of customer satisfaction, responsiveness to complaints, level of employee involvement and degree of motivation. The interview survey revealed that these exercises are limited to casual assessments at the annual reviews.

Only one instance was found where a quality circle was run using the PASS score as a measure to focus the quality improvement group on.

> We do have certain elements that may be seen as Total Quality Management, e.g., we have in our building group a quality improvement group which is a little like a quality circle. We had it running for something like 5 years now and that had been quite productive. In some respects that has been actually focused on the works we do for the HKHA where we had the monthly PASS assessment and that gives us a form of measure which we can focus the quality improvement group on. We tried using this (a quality improvement group) in other parts of our organisation, in what we called our Commercial Building area. However, we found that we could not keep the momentum of the impetus of that quality improvement group going because we did not get data fed to us such that we could look at identification of particular problems that we could focus the group's attention on. So, that was one of the positive things that we have used from The Hong Kong Housing Department's PASS. *[However, this contractor had not scored very high in PASS relative to the other respondents to this survey and was not within the upper quartile of the league either]*.

Also, there were two other responses where it was stated that PASS and CONQUAS scores are used in the improvement of construction processes:

> As you could see *[showing the manifesto displayed in the conference room]*, we have adopted CONQUAS as our managerial objective for our quality management system,

> i.e., "0.5 points higher than the National Average for the applicable type of building". … We adopted because it is a measurable, quantifiable yardstick used for assessment. There is no point saying that I have done a good job; what is a good job?

The above respondent further described at length how they practise very comprehensive quality management practises where they spend lots of effort to bring together the personnel of their construction teams, get them to discuss problems pertaining to each trade in the ongoing job, get them to work as a well co-ordinated team understanding each other's requirement to build a superior product. Another respondent stated as follows:

> PASS score is an average. Some items are high and some are low. So, cannot say. However, low PASS score means you have to change your working system, have special meetings et cetera. PASS does promote improvements at the site.
>
> If the PASS score this month is lower than last month, we may open the score sheet and compare that with the scores we received in the past three months of so to see the problem.

As stated before, opening the score sheets and having special meetings when the score is low, is in the nature of fire fighting. It is different to continuous and incremental improvements as carried out in a Total Quality environment. Another respondent stated that they use other information for development work:

> In our company, we don't use the PASS score to check out our improvement or whether the improvement has been effective or suitable. We send a questionnaire to the Client once in a while, particularly when we finish the job, to ensure that Client is satisfied with our job. We would ask the Client to give us some feedback.

Following responses were typically the attitude of the other respondents though some may have "ticked" in the questionnaire that they "Always" or "Sometimes" use PASS/CONQUAS scores to check whether their improvements to the construction process have been effective and suitable. Therein, the reader may be able to observe following aspects.

1) merely targeting the surveillance audit

2) not using PASS/CONQUAS score as a benchmark

3) no emphasis to improve the processes but reactive management (instead of being proactive) and exhortation of subcontractors

> The culture here is, when it comes to quality it frightens people; it is considered as a burden. That is the problem here. We can implement many systems ISO 9000, TQM, CONQUAS, but most of these are purely bureaucratic.

> The system in Singapore is everyone targets the surveillance audit. Once it passes, everything slackens.

> In this company I have never seen PASS score being used as a benchmark. Site management treats PASS score like a window dressing. Deep down in their hearts there is no intention to improve the quality unless somebody pushes it. That is the culture in Hong Kong [construction industry]. Like the culture of some students trying to get a higher mark [at the examination] and not the knowledge. *[This response is from a quality manager of a contractor who had scored very high in PASS].*

> Construction processes are the same but with the CONQUAS scheme, the contractors will put in more effort to achieve good quality.

> You have to show that your company is capable of delivering high quality projects. So, contractors will try to score high; above National Average.

> I manage by exception. As a quality manager of a contractor, what I don't like to see is complaints and adverse reports by Clients. We try to manage towards minimising them. So, measure of quality may be, to some extent, to minimise complaints and adverse reports. If the PASS score this month is lower than last month, we may open the score sheet and compare that with the scores we received in the past three months of so to see the problem.

> We use the PASS score to compel our subcontractors to achieve the requirements of the Client. I will not use the PASS score to assess the change or the effectiveness of the change. PASS score is not fair. Instead we see the cost and the difference in progress in terms of time to compare the previous methods with the new.

On the lack of initiative to use PASS scores as developmental tools, the officials of the PASS control unit of the HKHA commented as follows, identifying further shortcomings of the present system and how they intend to improve.

> I think that Housing Department itself has not – maybe – given as much information to the contractor as they might need to carryout proper benchmarking. In other words, what a contractor gets is his own scores. But he gets it historically late – after the work

> has been done. And he gets the quartile scores for the whole score league but he cannot actually benchmark himself directly against another project or another contractor. And to be honest with you, the information comes to him so late that it is already gone past the time when he can improve those elements in many cases where he is not scoring well in. One of the things which we want to try to do with the new PASS [PASS 2000] is to be able to give out information on more real-time basis, in fact at the end of a quarterly period the contractor will get all the information from that quarter. We are also intending to seek the approval of the Client to be more transparent with the scoring, putting it on the Internet website so that the contractors could more directly benchmark themselves. Also, rather than highlight poor performance in that kind of transparency, what we would try to do is to highlight more best performances and best practises – so that a contractor could actually go to see a particular site where there is a best practise from the Client's perspective.

In fact a respondent from Hong Kong commented as follows on their inability to use the PASS score as a benchmark:

> When you are getting a high PASS score, probably indicates you are getting a high quality building. I am not sure because I do not know how our sites compare with the others.

The PASS control unit officials further commented on the trend of PASS scores:

> If you had been running a trend analysis on PASS scores over the last years, there has been a flattening of the upward trend in the PASS graph across the board – which tends to suggest to me that, contractor given the price we pay for the work and given all other parameters that they have to comply with, like safety, accident reports, environmental standards, PASS, various other types – HKQAA audit etc., I think they have reached a plateau above which they have found it difficult to improve unless one of the other dynamics changes. You know, either we have to lower specification and make it more representative of what Hong Kong construction industry and skill levels can achieve or we may increase the remuneration in what we pay for tenders. So, they are the dynamics I think we have to alter.

However, the Author feels that there are possibilities that the above phenomenon of reaching a plateau could have other reasons. Deming (1986) pointed out that "a fault in the interpretation of observations, seen everywhere, is to suppose that every event (defect, mistake, accident) is attributable to someone (usually the nearest one at hand), or is related to some special event. The fact is that most troubles with service and production lie in the system. Sometimes the fault is indeed local, attributable to someone on the job or not on the job when he should be". He calls the faults of the system as common causes and faults from fleeting events as special causes. It is the management's responsibility to correct the common causes that lie in the system. In 94% of defect cases, mistakes or accidents can be attributed to common causes, leaving only 6% attributable to special causes (Deming 1986). Deming then explains a "typical path of frustration in improving quality". "A programme of [quality] improvement sets off with enthusiasm, exhortations, revival meetings, posters, pledges. … Quality as measured by results of inspection at the final audit shows at first dramatic improvement, better and better by the month (please see Figure A.1). Everyone expects the path of improvement to continue along the dotted line. Instead, success grinds to a halt. At best the curve levels off. It may even turn upward. … What happened? The rapid encouraging improvement seen at first came from removal of special causes, detected by horse sense. All this was fairly simple. But as obvious sources of improvement dried-up, the curve of improvement levelled off and became stable at an unacceptable level" (Deming 1986). He further states that improvement will continue if the management will take the lead and remove common causes from the system.

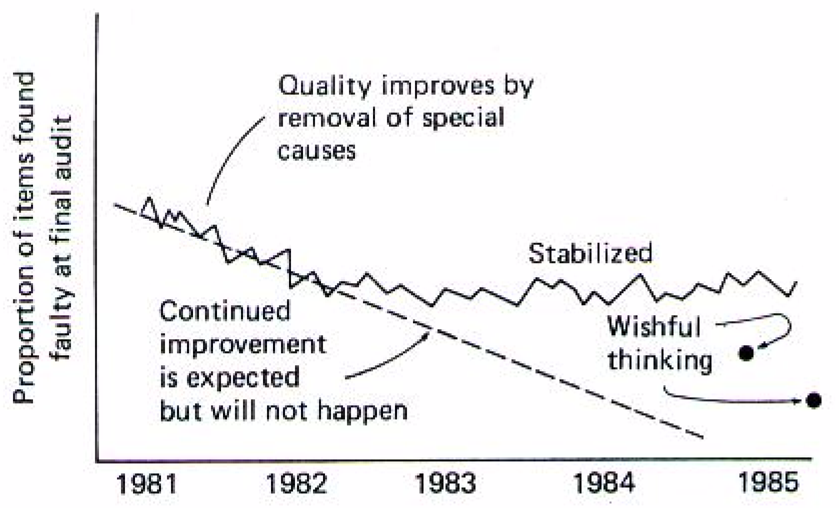

Figure A.1: Typical Path of Frustration

Source: Deming (1986)

HKHA has been pressurising its contractors to improve quality. In the absence of proper endeavours to continuously improve, simple attempts to comply with demands by the client may have resulted in the removal of 'special causes' of defects (detected by horse sense (Deming 1986)) thus resulting in some improvement in quality. However, as such obvious opportunities for improvement have dried-up, the industry has apparently reached a plateau at an unacceptable level.

Even in Singapore, there appears to be a levelling off of the quality improvement curve, similar to what was stated by the officials at the PASS Control Unit, HKHA. The following two comments were picked from the survey responses received from Singapore:

> The system [CONQUAS] applied here is stuck in the [score of] 70s. Similar with the ISO 9000 system.
>
> Construction processes are the same but with the CONQUAS scheme, the contractors will put in more effort to achieve good quality.

Especially the latter comment vindicates the argument that there is no improvement in the construction processes but a possible removal of 'special causes' of defects. Low *et al.* (1999) made the following two observations on four ISO 9000 certified companies studied:

(1) After achieving certification to ISO 9000 standards, there was an initial increase in CONQUAS scores. Subsequently these CONQUAS scores did not increase nor was their status quo maintained. The scores actually decreased.

(2) After achieving certification to ISO 9000 standards, there was a decrease in the initial CONQUAS scores. Subsequently, these CONQUAS scores fluctuated inconsistently.

Further control of construction workers and site staff, checking of material, documenting to get evidence of conformance, may not further improve the quality of construction products. To achieve further improvement, the management has to take the leadership and improve construction contracts, organisation, resources, processes and so on. Such improvement effort has to be carried out systematically, for example, by following the Shewhart and Deming Cycle (see Figure 2.1) backed by proper leadership by the senior management and not by just tightening the control on the end product. Improvement has to begin at the top rung of the project organisation, i.e., the client who could control the entire *system* from the very preconstruction processes such as the project brief, design, tender, preparing and awarding contracts and so on.

Table A.7: Are PASS/CONQUAS scores utilised in a way that will benefit the Client/Contractor?

		PASS (Hong Kong)	CONQUAS (Singapore)
Total Number of Responses		10	26
As a construction industry practitioner, do you think that PASS/CONQUAS scores are utilised in a way that will benefit:			
the Client			
	Yes	50%	77%
	No	0%	8%
	Sometimes	50%	15%
the Contractor			
	Yes	30%	73%
	No	20%	4%
	Sometimes	50%	23%

From the results presented in Table A.7, it can be observed that only 30% of respondents from Hong Kong felt that PASS scores are utilised in a way that will benefit the contractor. Further at least 50% of them were not sure whether it is used in a manner beneficial to the client either. However, more than 70% of the respondents from Singapore feel that CONQUAS scores are used in a manner beneficial to both client and the contractor.

As discussed in more detail before, one instance was found where a quality circle was run using the PASS score as a measure to focus the quality improvement group on.

> The way we use PASS score in this improvement of quality (using a quality improvement group similar to a quality circle), does benefit both (Client and Contractor) equally; because what we are trying to do is to improve our finished product. *[However, this contractor had not scored very high in PASS relative to the other respondents to this survey and was not within the upper quartile of the league either]*.

Also, one contractor from Singapore was using CONQUAS scores in their very comprehensive quality management programme:

> As you could see *[showing the manifesto displayed in the conference room]*, we have adopted CONQUAS as our managerial objective for our quality management system, i.e., "0.5 points higher than the National Average for the applicable type of building". … We adopted because it is a measurable, quantifiable yardstick used for assessment. There is no point saying that I have done a good job; what is a good job?

Another contractor from Singapore responded as follows

> For jobs like condominium/hotel, we do reduce maintenance period cost by reducing defects. We try to achieve a high score in condominiums because the emphasis is on finishes. If it [finish] is good, there will be less complaints. So, it [CONQUAS] is definitely a very useful assessment.

However, responses such as given below are typical of the construction industry's attitude to these measurement systems. The following responses suggest that PASS and CONQUAS are serving a function of pushing the contractors rather than motivating them. As discussed before, the contractors have reached the plateau within their capabilities. If they are to improve further and be relieved from the present frustration, help may have to come from the clients; perhaps by more meaningful and comprehensive management of construction projects; especially the tender processes and construction contracts.

> I believe what local [Singapore] contractors need is a push every now and then. The system [CONQUAS] applied here is stuck in the [score of] 70s. Similar with the ISO 9000 system. If the [Singapore] Government had not come up with the regulation that ISO 9000 certification is a mandatory requirement for public jobs, nobody would have adopted it. Because it would not benefit them financially. It basically comes down to money. What ever helps a company financially, they will do it. So, it is the reason why CONQUAS is serving only the financial point.
>
> Major benefit of this system is of course that if you score high you get some monetary benefit. The other important benefit is that end of the day you have less defects. That is more important to us. No doubt we know how to do good finishes. We do not pay attention to defects because nobody reminds us about defects at every stage of the work. We just complete one stage of works and carryon. With this [CONQUAS] system come in, we learn from it, we need to employ professional people, people who could check the work at every stage and reduce defects. With this continuous checking of works at every stage we end up with less defects which we can take care of easily, rather than spending more money rectifying defects. That is the biggest benefit.
>
> In the long term it [PASS] will benefit the contractor, but in the short term it may not be ... actually it [PASS] is very costly. Obligation of the contractor is to conform to specification. HKHA has benefited as any defect can be rectified at an early stage.
>
> Client can know what happens at the site and take remedial measures if something goes wrong. Contractor gets an external third party to monitor or supervise the staff working on the site.
>
> In the Client's point of view, you have some kind of formal assessment system ... so you know the experience, safety performance, quality performance of the contractor. From the Contractor's point of view, you can demonstrate that you can do it. For a contractor who gets a high score, probability of getting another tender is higher.
>
> For Client, better quality. PASS can make the contractor's product better than no PASS, but not too much.

A.4.5 Has PASS and CONQUAS Contributed Towards Achieving Better Customer Focus?

Table A.8: PASS/CONQUAS score vs. customer satisfaction

	PASS (Hong Kong)	CONQUAS (Singapore)
Total Number of Responses	10	26
Do you feel a high PASS/CONQUAS score will mean:		
Higher satisfaction of HKHA/Client personnel?		
Yes	60%	54%
No	0%	0%
Not sure	20%	8%
Did not answer the question	20%	38%
Higher satisfaction of future residents?		
Yes	20%	35%
No	10%	12%
Not sure	40%	12%
Did not answer the question	30%	42%
both (HKHA/Client personnel & future residents)?		
Yes	40%	65%
No	10%	5%
Not sure	40%	15%
Did not answer the question	10%	15%

The results of the questionnaire survey presented in Table A.8 convey that 60% of respondents from Hong Kong feel that a high PASS score will mean higher satisfaction of HKHA personnel. Similarly, 54% of respondents from Singapore felt that a high CONQUAS score would mean higher satisfaction of Client. It is noteworthy that none of the respondents selected the option “No”! Based on the discussion so far in this Chapter, a number of reasons could be attributed for 20% and 8% of respondents respectively from Hong Kong and from Singapore selecting the option “Not sure”. However, only 20% of respondents from Hong Kong and 35% of respondents from Singapore were positive that a high PASS/CONQUAS score would mean higher satisfaction of future residents too. This indicates that construction personnel in Singapore also do not have much faith in CONQUAS similar to their counterparts from Hong Kong do on PASS.

Following is an interesting response from Singapore indicating the failure of CONQUAS to understand the customer expectations.

> We have a project here that finished with a very high score; overall score is above 80 and not many buildings in Singapore have got this score. Unfortunately in that project we also have got lots of complaints and defects rectification was required from us. I think that clients' expectations and acceptance standards are quite independent of CONQUAS score. They do not really care whether your wall is flat or column is straight, but they look at things that are very minor! Like why your tiling joints are not even (though they are within the applicable tolerance limit). We do a lot of quality work like we make sure that in tiling, wall floor and ceiling joints meet; we try to make sure that joints in skirting will meet the floor tiling joints. For that, in-house we produce a lot of Co-ordination Drawings (Fitting-up Drawings). However, the clients do not really appreciate that. They will look at very small things and will say "There is a dent on the top frame". Now that sort of a thing could have been by somebody else or by themselves; but they want you to come and patch it up. So, they are looking at things that are totally not in line with the CONQUAS assessment.

It may be that the type of specifications and standards laid down in CONQUAS were customer expectations way back in late 1980s. For example, Low (1994) states "for a long time the Singapore construction industries had a bad image of low professionalism, poor quality and a high level of risk. However, over the years professional and government bodies have put substantial effort into attempting to change the public's unfavourable perception". May be due to such efforts and possibly with a contribution from CONQUAS itself, these customer expectations that were 'Explicit' or 'Level 2' expectations (please see Chapter 2) have become 'Implicit' or 'Level 1' expectations. Today, the residents/users of constructed facilities have become more demanding. For them, as the above respondents stated for example, joints in skirting meeting the floor tiling joints is something taken for granted; it is an implicit expectation from a responsible contractor. Today they will look at very small things for example, as the above respondents stated, a dent on the top frame; things that are totally not in line with the CONQUAS assessment.

Further, the following response indicates how customer expectations change due to external factors such as economic situations and market trends.

> Singapore has got a funny situation; a year ago when the property market was on the upward trend, everybody buys a house and they are not complaining because they know what they have committed is more expensive now. So, in that sense they are getting value for money. Whether you have a very high score or a very low score, the complains are very minimum. Since the beginning of last year when the property markets have started going down, the reverse happens. By the time they move in to the house, they feel they have been cheated because they know that if they bought it one year later it would have been cheaper. Now they want to make their moneys worth! They will start looking at every detail; the whole family comes in and can you imagine they look at the top of the door whether it is plained smooth and painted?

As discussed in Chapter 2, relative importance of each quality characteristic or attribute of a service will vary in relation to specific expectations of the customer at any particular time. No universal prescription has been developed and it is not wise to prioritise them on a global basis (Tenner and DeToro 1992). Hence, the relative ratings of importance of performance characteristics should be determined with customers for each product and service and then updated frequently because customers change the priorities very quickly due to changing situations. Tenner and DeToro (1992) state that, building of understanding of how customers rank relative importance of quality characteristics is not a simple task. "A growing number of companies are finding out that giving customers what they want is not nearly as hard as finding out what it is that they want" (Bennett 1990).

The Author could also observe that instead of customer satisfaction, construction industry practitioners put lots of emphasis on conforming to specifications and standards, possibly laid down contractually or by a third party. It could be resulting from emphasis on "meeting contractual requirements" and quality assurance systems where focus is on conformance to specifications (Ahmed, Lee and De Saram 1998 and Tang *et al.* 1998). The following responses from both Hong Kong and Singapore, for example, illustrate this tendency:

> PASS is good because it can actually promote the contractor's intentions to do certain things according to specification.

> The result of this scheme is that contractors are more conscious of quality and to what extent we have performed on the basis of quality. Before, we had no standard to measure or compare. Now we have this scheme – it is the first one – definitely it is not 100% representative of all the tests on quality. However, it is O.K. and that is why CONQUAS is accepted.

> Obviously we know the standard now. In the past we did not know what the standard is. So now we know what standards to achieve. When it comes to an argument, it is easy – we can say this is the standard – so there is no argument. Because sometimes it can be very subjective – architect or client sometimes say "No! This is not what I want!" – so now there is a national standard – at least some national standard to follow or expect. Otherwise very difficult to say – lots of arguments.

Table A.9: What does quality in construction mean to you?

	Hong Kong	Singapore
Total Number of Responses	10	26
What does quality in construction mean to you? Does it mean:		
conformance to specifications	60%	85%
satisfaction of the client's team	50%	31%
satisfaction of the ultimate users of the building	40%	42%
any other …………	10%	19%

NOTE: - Percentages given in this table add up to more than 100% because some respondents selected more than one option when answering this question.

Table A.9 present the summary of responses received to the question "What does quality in construction mean to you?" in the questionnaire survey. It is apparent that "conformance to specifications" received the largest percentage of responses, viz. 60% and 85% respectively from Hong Kong and Singapore. The option "satisfaction of the client's team" also received many responses especially 50% from Hong Kong and 31% from Singapore. In the follow-up interviews conducted, responses such as the following further illustrate this perspective:

> Conformance to specification. For an engineer like me or a manager like me, this is what is important. ... Satisfaction of Client (HKHA team) is a by-product. What the client does not want is non-conformance to specifications. I think contractors usually

> do not target the satisfaction of the ultimate users of the building. This will be the Client's (HKHA) interest.
>
> I think conformance to specifications and satisfaction of Client (HKHA team) are both important. Satisfaction of the ultimate users of the building we would like to aim at, but that would be difficult. Relationship we have is with HKHA. The Client of the Builder is HKHA. We do not know the ultimate user's expectations. So, as a builder, it is difficult to satisfy the ultimate users of the building.

The latter respondent mentioned his inability to know the ultimate user's expectations and difficulty to satisfy them. The following responses elaborate the difficulties in targeting the ultimate user, caused by the way construction contracts are let out. Therein, the reader may be able to observe following aspects.

1) in a traditional contract the contractor has no control over the design.
2) in the construction project organisation, the contractor is the lowest of the low
3) economic pressure due to hard dollar contracting system and cut-throat nature of the business

> I am still unable to find a contracting system that can make me target satisfaction of the client. Satisfaction of the client depends on external environment, which I do not think anyone could control, not even the Government.
>
> If the construction industry adopts design and build contract system or management contract system, we could implement Total Quality. Otherwise in the present system, everybody have their own skins to save. So, how to implement Total Quality? I also think they should implement "mid range tendering" system.
>
> How reasonable or how correct the expectation or yardstick of the client satisfaction and acceptance of quality? Take a normal contract for example; the specifications and designs are by others, given to you to build. You can solve everything accordingly not forgetting that there is that economic factor that is to price everything at a competitive rate. Otherwise you can only talk about quality but no chance of doing it. So, with that in mind, with the contract, design and specification given you do exactly what is required, nothing less and perhaps nothing very more. The client acceptance now comes in and like I said is it reasonable or not? It is very hard to decide. Sometimes you will find the architect will say yes, but the client is still complaining "This is no good because functional wise, usage wise it is not convenient", because that was not catered for in the design! So, why do you come to me? It was not my fault, it was not

> in the design and you should have corrected it in the design. So, sometimes the client's acceptance or perceptions of what is good and what is not are not known.
>
> Certainly the hard dollar or the cut-throat system that goes on here in Hong Kong does not really help the people who are going to finish up living in a building or using a building. Absolutely not! The system does not address the needs of the end-user and whether it is the governmental or it is the private clients, they want the cheapest price, everything cheapest no matter what. Because of the cut-throat nature of the business, the way it is contracted and tendered it does not look after the end users. The hard dollar bidding system serves Hong Kong well, of course you see lots of ruined paper, lots of sins out there and that has come because of the Hong Kong contracting method.
>
> We have very little contact with the ultimate user. I mean the client turns out with a design which is poor, such as it affects the ultimate user, we are going to build it. We really cannot do much about it. We see poor design, but of course to the clients here [in Hong Kong] the contractor is the lowest of the low. So, we can do very little about it. So because of the hard dollar bidding in Hong Kong, under which we operate, we cannot really look much at the ultimate user. We do think about it at times, it is different in design and construct works where you might be dealing a lot with the direct end user. Certainly they during the design process use a construction contractor, trying to make sure that this is really the required design. Especially if it is a non-expert client we try to make sure that we advise him as much as possible, based on our knowledge, that he does not come out with something not useful to him and cause him problems in the long run. In traditional contracts, we are concerned to ensure that something does not happen that cause problems to the end user once he takes over. However, the primary person we have to satisfy is the client's representative and his specification.

Another respondent (from Hong Kong) stated:

> Satisfaction of the ultimate user [of the building/facility] is my personal opinion.

Such respondents may be the order of 40% from both Hong Kong and Singapore who stated "quality in construction means satisfaction of the ultimate users of the building" in response to the questionnaire survey. Another respondent (from Singapore) elaborated on this perspective as follows:

> It is an important aspect that we must produce something that the client and buyer would be happy with. To provide a good service to the client and the consultant, we must be proactive. We should not wait until the problem arises to start to solve it. So, we must be proactive even at the tendering stage, we must bring up any unforeseen problems in construction.

The following respondent, a Senior Quality Manager of a large construction company in Hong Kong, described why they target the satisfaction of the ultimate users of the building.

We have had problems in the past. We complete the building and handover. Then the tenants are queuing up to get in and then our problem starts because of course the tenants who were looking at the flats or living in them were looking at the units with much closer eye. So, we may get a lot more callout. Unfortunately there is a fine balance between a defect and an issue that has nothing to do with our construction quality. It may not be a defect or anything, it may simply be a maintenance issue that is raised by the tenants. If the contractor is still on the site and still within the defects liability period, the tenants would go to the contractor. Even if the light bulb goes out, it must be the contractor to come and replace it! So, there is a tendency to steer things towards us and we have to strike a balance. In some cases it is easy just to do the job than to say it is nothing to do with us. So, clearly we have to strike a balance. We are trying to get the ultimate users' or the tenants' satisfaction. We know what their needs are and we try that everything is right when they get in. *[However, this contractor had not scored high in PASS relative to the other respondents to this survey and was not in the upper quartile of the league]*.

Appendix AA

CONSTRUCTION CO-ORDINATION ISSUES MEASURED UNDER PASS INPUT ASSESSMENT

Construction Co-ordination Issues Measured Under PASS Input Assessment

Source: HKHA (1997a)

Item		Description
3.1	**General Coordination**	
3.1.1	Co-ordination of Sequence of Work	Take leading role and necessary action to co-ordinate sequence and programme of works of all relevant parties including but not restricted to: (a) consolidating and recording their requirements, (b) planning, reviewing, rescheduling, (c) follow-up with actions and submission of programme if necessary, and (d) allow reasonable time for works of all relevant parties both in the programme and actual execution. (e) schedule the sequence of works to suit restrictions (if applicable) or requirements as provided in contract *(PSA7, A8)* such as, but not limited to: (i) phased commencement of works (ii) not commence laying of pipes in open area/roads in the first 12 months after commencement, for reclaimed Site (iii) complete placement of fill in the open area/roads to the required finished levels within 6 months after commencement, for reclaimed site (iv) phased issuance of working drawings and details (v) works subject to excision (vi) phased possession of portions of site
3.1.2	Obtain and Submit Builder's Work Requirements	Initiate necessary action and allow ample time to obtain and submit for approval details of services and builder's work requirements of all relevant parties , and make necessary arrangement for *(PS 1.46)* but not restricted to: (a) time and manner of execution of builder's work (b) delivery of materials of all parties (c) time and manner of drawing submission from all parties (d) time and manner of drawing submission of schedules of builder's work requirements, and obtain full particulars of any additional builder's works and requirements
3.13	Co-ordination of Physical Deployment of Works	Take leading role and necessary action to co-ordinate physical deployment of works among all relevant parties such as but not restricted to: (a) checking all drawings and submitted requirements for conflict between all services, works and services, (b) reporting on ambiguity, discrepancy or conflict, (c) giving details of the method of construction including all dimensions and necessary information to ensure correct work execution and materials/goods supply, and (d) resolving conflicts on site or drawing the attention of CM/CMR for instruction before any such work is due to be executed.

Item		Description
3.1.4	Hold Regular Co-ordination Meetings	Hold regular monthly or ad-hoc coordination meetings w hen necessary w ith all relevant parties record and issue minutes of meetings to attendees/project team, including but not restricted to: (a) monthly site meeting, (b) monthly building services coordination meetings, (c) utilities services coordination meetings, (d) site safety meetings, (e) any ad-hoc coordination meetings to resolve conflicts, problems, discuss matters on progress/quality, arrangement for inspections etc.
3.2	**Quality Control**	
3.1.2	Control of Workmanship	(a) Execute the works in strict accordance with the Contract and to the satisfaction of the CM/CMR. (b) Results of test, measurements and examinations of the works as required in the Contract or as instructed by the CM/CMR are in conformance with the Specification and Drawings.
3.2.2	Material Compliance	Failure to ensure material(s) comply with the required Specification or approved sample(s) without ju stifiable reas on(s) will consti tute a non-compliance case.
3.2.3	Remedial Works	When required, the contractor had submitted acceptable remedial work proposals (together with a realistic programme to carry out the re medial work) within the t ime stipulated in the C M/CMR's letter, site directions or recorded in notes of meeting. Where applicable, the remedial works are progressing in accordance with the approved programme.
3.3	**Supervision**	
3.3.1	Supervision of Work Progress	Take necessary action including but not restricted to: (a) monitor progress of all relevant parties and take action to mitigate delay (b) ensure timely submission of drawings, materials…… etc. for CM/CMR's approval including works of NCSs.
3.3.2	Supervision of Quality Standard	(a) Provide on-the-job training, demonstration of the necessary step by step procedures and precautionary measures for reference by workers. (b) Provide all necessary superintendence and monitoring to ensure all workers follow the proper steps and procedures in work execution.
3.4	**Communications, Compliance and Cooperation**	
3.4.1	Maintain Good Communications	Maintain good communication link with CMRICM and all relevant parties; issue or pass on directions, information, submissions, notification ... etc., to relevant parties and CMR/CM in good time (including submission of notice for inspection/examination of Works) and hold ad-hoc co-ordination meetings when necessary. Give adequate notice to CMR whenever work is ready for examination and afford full opportunity for CM/CMR to examine and measure any work before covering up.
3.4.2	Compliance with Site Directions	The Contractor had responded promptly to all Site Directions issued, and had taken necessary actions to ensure compliance with the directives.
3.4.3	Response to Meeting Discussions	The Contractor had responded pro mptly and had taken necessary actions in response standard to the a ction items in th e monthly site meetings and other coordination meetings.

Item		Description
3.4.4	Compliance with Site Instructions	The Contractor had responded promptly to all Site Instructions issued. Action taken includes but not restricted to the following, as appropriate: (a) informing sub-contractors (NSC and domestic) and distributing revised drawings, (b) placing orders for additional/revised materials, (c) re-planning work schedules and/or work methods as required and distributing revised work plans to other relevant parties, (d) complying with order in writing from CM/CMR for removal of unsatisfactory work/material and carry out proper re-execution of work.
3.4.5	Compliance with C MR's Written Directives	The Contractor had responded promptly to all written directives issued by CMR and had taken necessary actions in response to the written directives
3.4.6	Compliance with CM's Written Directives	The Contractor had responded promptly to all written directives issued by CM and had taken necessary actions in response to the written directives.
3.5	**Other Attendance**	
3.5.1	Provision of Gen eral Attendance Required by Contract	Provide proper general attendance to all relevant Parties as required by contract such as provision of storage space, attendance for testing, builder's work, use of facilities and plant, adequate temporary water, power supply, illumination and equipment calibration etc. for execution of the Works.
3.5.2	Timely Execution of Builder's Work	Provide builder's work and special attendance to relevant Parties on time as required by contract or agreed programme such as grouting-in, openings, access, equipment bases, cable ducts, making good... etc.
3.5.3	Provision for Testing	Provide assistance, instruments, machines, labour and other facilities e.g. power and water supply on time for testing by all relevant Parties, such as that required by PS Clause 1.46(3) and Table 1 .4 of the Specification etc.
3.5.4	Timely Handove r of Works Areas and Service Areas	Complete and handover to relevant Parties on time all works areas, service areas, plant rooms, services routes ... etc., such as that required by PS Clause 1.46(4) of the Specification.
3.5.5	Care of Works of Others	Take necessary action to protect works of all relevant Parties including: (a) liaise on proper sequence of work to avoid possible damage of completed works, (b) exercise care and precautionary measures when working near adjoining works, and (c) take expeditious remedial action to avoid further damage and mitigate delay where damage had already been caused.
3.6	**Completed Works After Sectional Completion**	
3.6.1	Outstanding Works – Control of Workmanship	Execute outstanding works in accordance with Specification, written instruction, and drawings.
3.6.2	Outstanding Works – A ttention to Site Safety	(a) Fences, barriers and warning signs provided. (b) Protection to third party and completed works provided. (c) All works and preparation confined within the approved area (d) Debris stored in approved enclosure and regularly removed. (e) Precaution against dirt and nuisance to third party provided.

Item		Description
3.6.3	Works of Repair – Cont rol of Workmanship	Make good defective works in accordance with Specification and approved remedial proposal.
3.6.4	Works of Repair - Attention to Site Safety	(a) Fences, barriers and warning signs provided where necessary. (b) Protection to third party provided. (c) All works and preparation confined within the approved area. (d) Precaution against dirt and nuisance to third party provided.
3.6.5	Works of Repair - Cleanliness	(a) Debris properly removed. (b) Protection of completed works provided and kept intact. (c) No mortar dropping, stain or damage to completed works.
3.6.6	Response to Reported Defects	(1) When required, the contractor has submitted acceptable remedial work proposals within the time stipulated in the CM/CMR's letter. (2) Take leading rol e and necessary action to coordinate sequen ce; programme and ex ecution of Works of Repair among all relevan t Parties including but not restricted to (a) consolidating and recording their requirements, (b) planning and resolving arrangements and conflicts on site, (c) liaising on proper sequence of work to avoid possible damage of completed works/third party's properties and injury to people; and (d) following up with actions if necessary. (3) Maintain good communication link with CM/CMR and all relevant Parties including, but not restricted to the following (a) submitting notice of inspection/examination of works in good time. (b) issue or pass on directions, information, submission, notification etc. to relevant Parties and CM/CMR in good time.
3.6.7	Outstanding Works - Progress Grading Standard	All outstanding works were on or ahead of schedule.
3.6.8	Works of Repair - Progress	All works were on or ahead of schedule as specified or agreed by CM.

Appendix AB

INTERVIEW STRUCTURE FOR THE INITIAL SURVEY OF EFFECTS OF PASS AND CONQUAS

Structure for the Interview

1. What is your overall opinion of PASS?

2. Do you think that PASS gives a useful assessment of the contractor's capabilities?

3. The way PASS scores are utilized, what benefits do you see for the *client, contractor* and the overall *construction industry?*

4. As a construction industry practitioner, what real benefits of PASS have you seen?

5. In your opinion, can PASS give a fair assessment of a contractor's capabilities and the quality of services?

6. Does measurement using PASS cover all the important aspects of construction process?

7. Do you feel a high PASS score means higher satisfaction of:
    - H KHA personnel
    - Futu re residents
    - Bo th

8. Have you attempted to co-relate the PASS score to:
    - Number of site instructions and variation orders
    - On-time and within budget completion
    - Claims and disputes
    - Level of client satisfaction during and after the project
    - Intensity of complaints after the facility is handed over to the users/residents
    - Any other

9. Are you happy/satisfied with PASS or do you think it is another burden on the contractor.

10. Do you think PASS has succeeded in ensuring that capable and competent contractors get more jobs?

11. Whenever you have made changes to your methods/working systems, have you compared subsequent PASS scores with previous scores to check suitability and effectiveness? If no, then how do you make an assessment of the usefulness of the changes?

12. Does PASS help you in any other way to improve your company?

13. What does quality in construction mean to you?

14. How do you measure quality, specially the 'soft' aspects such as customer satisfaction, leadership, employee involvement, degree of motivation, level of team work, responsiveness to complaints, etc?

15. Does a high PASS score mean a higher quality of work?

16. How do you utilize the results of quality measurement of construction processes:
    1) For Immediate improvement of the process
    2) To determine performance
    3) To forecast results at completion
    4) To obtain feedback for improvement on future products

17. What major benefits you foresee by improving the quality of construction processes?

18. What are the reasons for poor quality performance on construction projects?

19. What so rt of d ifficulties d id you en counter while measuring quality in you r company/organization or construction project?

20. It's often said, "*When it comes to measuring work process, the construction industry does* not *enjoy a good reputation*". What is your opinion in this regard?

THE END

Thank you very much for the kind effort and the valuable time spent.

Appendix AC

QUESTIONNAIRE FOR SURVEY OF EFFECTS OF PASS AND CONQUAS

THE HONG KONG
POLYTECHNIC UNIVERSITY
香港理工大學

000152

香港 九龍 紅磡
Hung Hom Kowloon Hong Kong

Department of Civil & Structural Engineering Tel: (852) 2766-6079 / 80 Fax: (852) 2334-6389

Opinion Survey on Effectiveness of PASS in Measuring Quality

The purpose of this survey is to find facts for a research carried out by D. Darshi De Saram and Riaz Ahmad, under the supervision of Dr S. M. Ahmed at the Hong Kong Polytechnic University. *The information provided with the identity of the company will not be divulged to any third party.* Your responses will be read only by the two researchers and the academic supervisor named above to be used for academic purposes of this survey only.

Objective: To understand whether Performance Assessment Scoring System (PASS):
- gives an indication of satisfaction of HK Housing Authority personnel and the eventual occupants of the buildings.
- can be used by a contractor to improve on his present output quality.

A measurement system is of no value if a higher score in it will not necessarily mean a higher achievement of the objectives of the organization/company.

Please return by FAX to 2334 6389

If you please indicate your name and contact details, we could send you a copy of the research findings.

Name .... Qualifications ....
(It may be convenient to fax a copy your visiting card) Designation ....
Name & Address of your Company ....
....

Please tick (☑) the appropriate answer

1. What is your overall opinion of PASS? Excellent ☐ Good ☐ Fair ☐ Poor ☐

2. Do you feel a high PASS score will mean:
   - Higher satisfaction of HKHA personnel . Yes ☐ No ☐ Not sure ☐
   - Higher satisfaction of future residents . Yes ☐ No ☐ Not sure ☐
   - Both (HKHA personnel & future residents) . Yes ☐ No ☐ Not sure ☐

3. Do you feel that PASS assessors try to:
   ☐ give you a very correct and accurate assessment ☐ just give you a high score
   ☐ just give you an average score ☐ just give you a low score
   Reason? ....

4. Do you make a big effort to get a high PASS score Yes ☐ No ☐ Not interested ☐
   Reason? ....

5. Do you think that a higher PASS score means less problems at site? Yes ☐ No ☐ Not sure ☐
   Does PASS give a *FAIR* assessment of contractor's capabilities? Yes ☐ No ☐ Not sure ☐
   Does PASS give a *USEFUL* assessment of contractor's capabilities? Yes ☐ No ☐ Not sure ☐
   Does PASS cover all the important aspects of the building process? Yes ☐ No ☐ Not sure ☐

6. Have you attempted to co-relate the PASS score to the intensity of problems at site? For example:
   - Number of site instructions and variation orders . Yes ☐ No ☐ Not sure ☐
   - On time and within budget completion . . Yes ☐ No ☐ Not sure ☐
   - Claims and disputes . . . . Yes ☐ No ☐ Not sure ☐
   - Level of client satisfaction during and after the project Yes ☐ No ☐ Not sure ☐
   - Intensity of complaints after the facility is handed over to the users/residents
     Yes ☐ No ☐ Not sure ☐
   - Any other ....

7. As a construction industry practitioner, do you think that PASS scores are utilized in a way that will benefit:
   - the CLIENT . Yes ☐ No ☐ Sometimes ☐
   - the CONTRACTOR Yes ☐ No ☐ Sometimes ☐
   Reason? ....

Page 1 *(Continued ....)*

(........ Continued)

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8. Are you happy with PASS? Yes ☐ No ☐ Not sure ☐
Are you satisfied with PASS? Yes ☐ No ☐ Not sure ☐
Do you consider PASS as another burden on the contractor? Yes ☐ No ☐ Not sure ☐
Do you think PASS has succeeded in ensuring that capable and competent contractors get more jobs?
Yes ☐ No ☐ Not sure ☐

9. Does your company practice *Total Quality*? Yes ☐ No ☐ Hope to (*in near future*) ☐

10. Do you use the PASS scores to check whether your improvements to the construction process have been effective and suitable? Always ☐ Never ☐ Sometimes ☐

11. What does quality in construction mean to you? Does it mean
Conformance to specifications ☐ Satisfaction of the ultimate users of the building ☐
Satisfaction of the client's team ☐ Any other ....
Any comments? ....

12. How do you measure the quality of:
- customer satisfaction?
- responsiveness to complaints?

Using PASS ☐ By surveys within your company ☐
By customer surveys ☐ By studying and assessing the internal culture of your company ☐
You do not measure ☐ Any other ....

13. How do you measure the:
- level of employee involvement?
- degree of motivation?
- level of teamwork?

By surveys within your company ☐ By studying and assessing the internal culture of your company ☐
You do not measure ☐ Any other ....

14. Does a high PASS score mean a higher quality of work? Always ☐ Never ☐ Sometimes ☐

15. What use have you made of PASS to improve your company?
....
....

16. What major benefits of PASS have you seen so far?
....
....

17. What major benefits do you foresee in improving the quality of your construction processes?
....
....
....

18. What are the reasons for poor quality performance on construction projects?

<u>Reasons due to Contractors</u>	<u>Reasons due to Consultants</u>	<u>Reasons due to Clients</u>
....	....	....
....	....	....
....	....	....

19. What are the difficulties in making consistent measurements of quality at a construction site?
....
....
....

20. Anything else you wish to say about PASS or measurement of quality in construction?
....
....

The END. Thank you very much for the valuable time spent and the kind effort.

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Appendix B

ARRAY OF CONSTRUCTION CO-ORDINATION ISSUES CATEGORISED UNDER TASKS, TIMING, RESOURCES, RESPONSIBILITIES AND GENERAL

Array of Construction Co-ordination Issues Categorised Under Tasks, Timing, Resources, Responsibilities and General

General	Manage Tasks	Manage Timing	Manage Resources	Manage Responsibilities
Provide guidelines and uniformity	Preparation of a project plan which is realistic, and acceptable by both the customer and contractor	Preparation of a project plan which is realistic, and acceptable by both the customer and contractor	Preparation of a project plan which is realistic, and acceptable by both the customer and contractor	Minimize conflict and confusion
	Revise the project plan as needed	Revise the project plan as needed	Revise the project plan as needed	
	Planning & Scheduling	Planning & Scheduling	Planning & Scheduling	
	Monitoring the progress of projects, especially in terms of time, cost and quality	Monitoring the progress of projects, especially in terms of time, cost and quality	Monitoring the progress of projects, especially in terms of time, cost and quality	
Encourage documentation	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers	Maintaining a plan which continuously displays the project's time, cost, are performance as well as resource commitments made by the functional managers
	Measuring and analyzing project performance regarding technical progress, schedule, and budgets	Measuring and analyzing project performance regarding technical progress, schedule, and budgets	Measuring and analyzing project performance regarding technical progress, schedule, and budgets	
	Information periodically required by management giving the commercial financial/progress status of the project	Information periodically required by management giving the commercial financial/progress status of the project	Information periodically required by management giving the commercial financial/progress status of the project	
Communicate clearly and effectively	Co-ordinating and integrating subsystem tasks	Provide early schedules on the entire project, emphasizing early tasks	Comparing actual to predicted cost and performance, and taking corrective action when necessary	Delineate work packages
Standardize data formats	Establishing and maintaining project requirements	Prepare an in-depth implementation schedule	Control and distribution of all project finances, including procurement, such that project cash flow limitations are adhered to	Insuring that all functional employees and managers are kept informed as to their responsibilities on the project and all revisions
Unify project teams	Directing the technical implementation according to established schedule and budgets	Identify early, potential delays and schedule to avoid them	Assisting in determining technical and workforce requirements, schedules and budgets	Require periodic functional status reporting
Provide a basis for analysis	Project planning and controlling	Identify strategic activities and schedule them accordingly	Establishing project organization and staffing	Monitor the time, cost, and performance activities in the functional departments and ensure that all problems are promptly identified, reported, and solved

Continued …………

General	Manage Tasks	Manage Timing	Manage Resources	Manage Responsibilities
Document agreements for future reference	Overall leadership toward implementing project plan	Co-ordinate offsite construction activities with onsite construction ones	Planning, estimating and controlling of costs (corrective actions)	Cut across all functional lines and interface with all levels of management as necessary to meet project requirements
Build an experience track and method for future projects	Quality of the work in accordance with the contract	Monitor the progress of the project Project	accounting	Renegotiate with functional managers for changes in personnel assignments
Refuel commitments	Performance to schedule	Ensure that each activity starts and finishes as planned	Estimating/Cost Control	Delegating responsibilities and authority to functional personnel provided that the line manager is in approval that the employee can handle this authority/responsibility level.
Minimize paperwork	Executive within operating budgets	Compare project progress information with the master schedule	Purchasing	Delegation and follow up
Bring new team members on board	Application of good technical practices	Analyse any variances that occur, especially between scheduled and actual completion dates	Forecast resource requirements	Establish an effective organizational structure
All formal communications between the customer and contractor	Progress reporting	Document all changes to the schedule	Allocate resources	Provide a detailed means for implementing decisions
Preparation of all project data items	Interpretation of all contractual commitments	Advise client on the effect of any delays in meeting red-letter dates	Prevent deviations in the quality and quantity of resources used	Delegate authority and responsibility
Keeping executive management informed as to project status	Head project engineering operations	Discuss potential and actual delays	Estimating costs and schedules from bid documents	Assembling a team of specialist subcontractors
Conducting trade-offs	Establish objectives	Review progress of project	Supporting own men and subcontractors with tools, equipment, and resources	Translating documents into task assignments for individuals
Co-ordinating and negotiating requirements between sponsor and performing organizations	Develop a program for achieving project objectives	Detect variances from schedules and deal with the effects of those variances	Paying all the bills and payrolls for its own and its subcontractors' work	Purchasing the services of contractors
Customer liaison	Schedule activities	Ensure all participants comply with time schedules	Update estimates at each major checkpoint	
Bid proposal development and pricing	Evaluate effectiveness of activities, and take corrective action	Revise existing schedules whenever a potential problem occurs	Determine whether the contractor has adequate personnel, equipment, and material to meet the schedule	
Project profit	Monitor actual ongoing operations to ensure that objectives, short-term and long-term are being met	Predict project duration	Schedule to prevent labour shortages	

Continued …………

General	Manage Tasks	Manage Timing	Manage Resources	Manage Responsibilities
Organizational development	Improve and reschedule activities, reallocate resources, and alter the objectives so that objectives are met	Examine the contractor's progress schedule, checking and recording progress and delays	Schedule to prevent funding difficulties	
Maintaining of proper client and project team relationships	Organizing activities at the construction site	Maintain records of working conditions and weather, including air temperature throughout the day	Estimate the requirements for resources, such as personnel, equipment, and materials	
Application of company procedures	Explaining and supporting the work for subcontractors	Maintain records of delays	Determine costs associated with activities	
Basic client contact	Controlling the performance of the project participants		Transfer excess resources assigned to some activities to others needing more resources	
Contact with authorities	Handling offsite activity relating to supply, fabrication, and pre-assembly required for the onsite work to be effective		Monitor manpower, plant and material utilisation	
Preparation of reports required by the client, third parties	Scheduling onsite work with offsite activity		Monitor the budget on all activities	
Project closeout report	Interpreting documents for those doing the work		Endorse day work vouchers in respect of time and materials	
Economic/Risk Analysis	Co-ordinating subcontractor activity		Assist the quantity surveyor with measurement as required - particularly foundations, drainage and other work to be covered up	
Contract Management	Overseeing the entire construction effort		Maintain records of site labour employed	
Analytical Skills	Publish daily construction reports which describe the activities that are occurring	Maintain	records of plant standing, or in use, on site	
Have a broad-based technical background	Meet with client and engineer to review the project's progress to ensure that the activities are producing what has been designed		Maintain records of principal deliveries to site and general particulars of shortages	
Preparing a competitive bid or proposal for negotiation	Co-ordinate project activities			
Designing and creating the job site	Refine project requirements			

Continued …………

General	Manage Tasks	Manage Timing	Manage Resources	Manage Responsibilities
Setting up the job office and providing the superintendent with job clerks, layout engineers, and watchmen	Receive clarifications on specifications and drawings			
Building the architect's office at the site	Rectify any deviations to plans or procedures			
Facilitating cash flow from client to suppliers, and contractors	Co-ordinate subcontractors			
Provide systematic approaches for developing estimates and schedules	Schedule to prevent late arrival of diagrams			
Develop means for allowing client, engineer, contractor, and subcontractors to provide input at various stages of a project	Prevent defective workmanship			
Establish communication channels for the whole project	Determine and eliminate unnecessary activities			
Facilitate meetings and encourages input from everyone concerned	Consider the effect of time and resource constraints on activities of the project			
Conduct periodic checkpoint review meetings	Examine alternative methods for carrying out a project under varying time and resource requirements			
Provide appropriate means for reporting the progress of the project	Concentrate on critical activities			
Provide an organized means for gathering information and compiling it	Inspect work in progress and materials			
Conduct checkpoint review meetings with department heads to ascertain the exact details in each facet of the project	Check the site grid and setting-out as the work proceeds			
Ensure that project progress information flows where it is needed	Provide outstanding information required by the contractor			
Exchange viewpoints	Attend to discrepancies in the drawings and other contract documentation			
Resolve differences among participants	Provide practical solutions to on-site problems when required			

Continued …………

General	Manage Tasks	Manage Timing	Manage Resources	Manage Responsibilities
Determine or clarify administrative procedures	Ensure testing and submitting for test, the materials used in the works			
Receive constructive input, in the form of suggestions and recommendations, from participants	Inform the contractor of work that does not conform to contract documentation			
Communicate and document project plans, schedules, and other information with different project participants	Liaise with consultant engineers on trades and sub-contractors under their direction			
Maintain records of visitors to the site	Check steelwork, and reinforcement cover, spacings and fixings			
	Check records and drawings of as-built status - particularly foundations, drainage and other work to be covered up			
	Prepare list of all defects or omissions prior to take-over of the building			
Maintain	records of verbal instructions received from supervising officer and consultants			
	Maintain records of directives passed to the contractor			
	Maintain records of drawings and information received from the consultants and contractor			
	Maintain records of work done outside the terms of contract and for which variation orders have, or should be issued			
	Maintain records of material tests			
	Agreeing details of method of construction			
	Issuing further drawings or details needed for construction			
	Ensuring that the works are constructed in accordance with the contract			

Continued …………

General	Manage Tasks	Manage Timing	Manage Resources	Manage Responsibilities
	Ensuring that workmanship and materials used are according to the specifications			
	Checking lines, levels, layout etc of the works to ensure c onformity with the drawings			
	Measuring the am ount of wor k done, checking inter im payments to contr actor and prepare the m to sub mission to the engineer			
	Examining the contractors clai ms and keeping records of f acts relating to any claims by the contractor			
	Recording progress in detail			
	Undertaking all t he r equired tests and keeping records			
	Recording progress in detail			
	Undertaking all t he r equired tests and keeping records			
	Reporting on all the for egoing t o the engineer in the form he requires			
	Directing and controlling all construction work			
	Ensuring that all work is constructed in accordance with the require ments of the contract			
	Liaison with the resident engineer			
	Regarding all contract matters			
	Ensuring the smooth r unning o f all construction activities			

Appendix C

ARRAY OF CONSTRUCTION CO-ORDINATION ISSUES SUBDIVIDED TO PLANNING, ORGANISING, CONTROLLING AND THEIR SUB-SUBDIVISIONS

Array of Construction Co-ordination Issues Subdivided to Planning, Organising, Controlling and their Sub-subdivisions

Planning

Planning → Identify

General	Tasks	Timing	Resources	Responsibilities
	Examine alternative methods for carrying out a project un der var ying tim e and resource requirements	Identify earl y, potential delays and schedule to avoid them	Assisting in deter mining technical and workforce requirements, schedules and budgets	Facilitate m eetings and develop m eans for encouraging client, engine er, contractor, and subcontr actors to provide input and exchange viewpoints at various stages of the project
Risk	analysis	Identify strategic activities and schedule them accordingly	Establishing pr oject or ganisation and staffing	Establish co mmunication channels for the whole project

Planning → Analyse/Plan/Schedule

General	Tasks	Timing	Resources	Responsibilities
	Revise the project plan as needed	Revise the project plan as needed	Revise the project plan as needed	
	Develop a pr ogram for achieving project objectives	Prepare an in-d epth i mplementation schedule	Planning a nd e stimating costs and schedules from bid documents	
Provide sy stematic appr oaches for developing estimates and schedules	Schedule activities	Predict project duration	Estimate the requirements for resources, such as personnel, equip ment, a nd materials	
	Scheduling onsite work with offsite activity		Forecast resource requirements	
	Schedule to pr event late ar rival o f diagrams		Transfer excess resources assigned to some activities to others needing more resources	
	Concentrate on critical activities		Schedule to prevent fundi ng difficulties and material and labour shortages	

Continued …………

Planning → Communicate

General	Tasks	Timing	Resources	Responsibilities
	Communicate and document project plans, schedules, and other information with different project participants	Communicate and document project plans, schedules, and other information with different project participants	Communicate and document project plans, schedules, and other information with different project participants	Communicate and document project plans, schedules, and other information with different project participants

Organising

Organising → Lead

General	Tasks	Timing	Resources	Responsibilities
Overall	leadership toward implementing project plan		Bring new team members on board	Delineate work packages
				Refuel commitments
				Unify project teams
				Cut across all functional lines and interface with all levels of management as necessary to meet project requirements
				Establish an effective organisational structure
				Provide a detailed means for implementing decisions
				Renegotiate with functional managers for changes in personnel assignments
				Ensuring that all functional employees and managers are kept informed as to their responsibilities on the project and all revisions

Continued …………

General	Tasks	Timing	Resources	Responsibilities
				Delegating responsibilities and authority to functional personnel provided that the line manager is in approval that the employee can handle this authority/responsibility level.
				Follow up delegated responsibilities and authority
				Purchasing the services of subcontractors
				Assembling a team of specialist subcontractors
				Resolve differences among participants

Organising → Facilitate

General	Tasks	Timing	Resources	Responsibilities
Build an experience track and method for future projects	Organising activities at the construction site	Ensure that project progress information flows where it is needed	Co-ordinate purchasing and delivery of material	Translating documents into task assignments for individuals
Maintaining of proper client and project team relationships	Directing, facilitating and controlling all construction work	Communicate and document project plans, schedules, and other information with different project participants	Supporting own men and subcontractors with tools, equipment and resources	Receive constructive input, in the form of suggestions and recommendations, from participants
All formal communications between client and contractor	Ensuring the smooth running of all construction activities	Provide appropriate means for reporting the progress of the project	Facilitating cash flow from client to suppliers and contractors	
Contact with authorities	Co-ordinate project activities		Paying all the payrolls and bills for the own and the subcontractors' work	
Contract management	Co-ordinating and integrating subsystem tasks	Allocate	resources	
Facilitate meetings and develop means for encouraging client, engineer, contractor, and subcontractors to provide input and exchange viewpoints at various stages of the project	Co-ordinate offsite construction activities with onsite construction ones	Co-ordinate offsite construction activities with onsite construction ones	Estimate the requirements for resources, such as personnel, equipment and materials	

Continued …………

General	Tasks	Timing	Resources	Responsibilities
Establish communication channels for the whole project	Handling offsite activity relating to supply, fabrication and pre-assembly required for the onsite work to be effective	Handling offsite activity relating to supply, fabrication and pre-assembly required for the onsite work to be effective	Transfer excess resources assigned to some activities to others needing more resources	
Conduct check point review meetings with department heads to ascertain the exact details in each facet of the project	Head project engineering operations		Monitor manpower, plant and material utilisation	
Provide an organised means for gathering information and compiling it	Application of good technical practices		Monitor the budget on all activities	
	Determine or clarify administrative procedures			
	Application of company procedures			
	Interpretation of all contractual commitments			
	Interpreting documents for those doing the work			
	Improve and alter activities so that objectives are met	Reschedule activities so that objectives are met	Reallocate resources so that objectives are met	
	Agreeing on details of methods of construction			
	Explaining and supporting the work for subcontractors			
	Co-ordinating subcontractor activity			
	Liaise with consultant engineers on trades and sub-contractors under their direction			
	Liaison with the resident engineer regarding all contract matters			
	Issuing further drawings or details needed for construction			
	Overseeing the entire construction effort			

Continued …………

General	Tasks	Timing	Resources	Responsibilities
	Controlling the performance of the project participants			
	Ensuring that all work is constructed in accordance with the requirements of the contract.			
	Ensuring that workmanship and materials used are according to the specifications			
	Inform the contractor of work that does not conform to contract documentation			
	Check steelwork, and reinforcement cover, spacings and fixings			
	Checking lines, levels, layout etc of the works to ensure conformity with the drawings			
	Undertaking all the required tests			
	Attend to the list of all defects or omissions prior to hand-over of the building			

Organising → Information and Records

General	Tasks	Timing	Resources	Responsibilities
Encourage documentation but minimise paperwork	Publish daily construction reports which describe the activities that are occurring	Progress reporting	Maintain records of principal deliveries to site and general particulars of shortages	
Standardise data formats	Reporting on all required matters to the engineer in the form he requires	Recording progress in detail	Maintain records of site labour employed	
Preparation of all project data items	Maintain records of drawings and information received from the consultants and other contractors		Maintain records of plant standing or in use on site	
Preparation of reports required by the client, third parties	Maintain records of directives passed to the contractor		Prepare day work vouchers in respect of time and materials	

Continued …………

General	Tasks	Timing	Resources	Responsibilities
	Maintain records of verbal instructions received from supervising officer and consultants			
	Maintain records of work done outside the terms of contract and for which variation orders have, or should be issued			
	Measuring the amount of work done, checking interim payments to contractor and prepare them to submission to the engineer			
	Assist the quantity surveyor with measurement as required – particularly foundations, drainage and other work to be covered up			
	Check records and drawings of as-built status – particularly foundations, drainage and other work to be covered up			
	Preparing claims and keeping records of facts relating to any claims by the contractor			
	Maintain records of material tests			
	Keeping records of all required tests			
	Project closeout report			

Continued …………

Controlling

Controlling → Monitor

General	Tasks	Timing	Resources	Responsibilities
	Monitoring the progress of the project, especially in terms of time, cost and quality	Monitoring the progress of the project, especially in terms of time, cost and quality	Monitoring the progress of the project, especially in terms of time, cost and quality	Monitor the time, cost, and performance activities in the functional departments and ensure that all problems are promptly identified, reported, and solved
	Monitor actual ongoing operations to ensure that objectives, short-term and long-term, are being met		Monitor manpower, plant and material utilisation	
			Monitor the budget on all activities	

Controlling → Analyse

General	Tasks	Timing	Resources	Responsibilities
Provide guidelines and uniformity and a basis for analysis	Measuring and analysing project performance regarding technical progress, schedule, and budgets	Measuring and analysing project performance regarding technical progress, schedule, and budgets	Measuring and analysing project performance regarding technical progress, schedule, and budgets	
	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers
	Improve and alter activities so that objectives are met	Reschedule activities so that objectives are met	Reallocate resources so that objectives are met	
	Consider the effect of time and resource constraints on activities of the project	Compare project progress information with the master schedule	Comparing actual to predicted cost and performance, and taking corrective action when necessary	

Continued …………

General	Tasks	Timing	Resources	Responsibilities
Evaluate	effectiveness of activities, and take corrective action	Analyse any variances that occur, especially between scheduled and actual completion dates	Determine whether the contractor has adequate personnel, equipment, and material to meet the schedule	
	Determine and eliminate unnecessary activities	Discuss potential and actual delays	Determine costs associated with activities	
		Review progress of project		
		Detect variances from schedules and deal with the effects of those variances		
		Revise existing schedules whenever a potential problem occurs		
		Examine the contractor's progress against the schedule, checking and recording progress and delays		

Controlling → Control/Correct/Maintain

General	Tasks	Timing	Resources	Responsibilities
Conducting trade-offs	Meet with client and engineer to review the project's progress and to ensure that the activities are producing what has been designed	Ensure that each activity starts and finishes as planned	Control and distribution of all project finances, including procurement, such that project cash flow limitations are adhered to	Minimise conflict and confusion
Co-ordinating and negotiating requirements between sponsor and performing organisations	Controlling the performance of the project participants	Ensure all participants comply with time schedules	Prevent deviations in the quality and quantity of resources used	
Customer liaison	Directing the technical implementation according to established schedule and budgets	Project planning and controlling	Controlling of costs (corrective actions)	
Conduct check point review meetings with department heads to ascertain the exact details in each facet of the project	Performance to schedule		Project accounting	

Continued …………

General	Tasks	Timing	Resources	Responsibilities
	Rectify any deviations to plans or procedures	Pr	oject profit	
	Quality of the work in accordance with the contract		Execution within operating budgets	
	Prevent defective workmanship			
	Inform the contractor of work that does not conform to contract documentation			
	Ensuring that the works are constructed in accordance with the requirements of the contract			
	Ensuring that workmanship and materials used are according to the specifications			
	Maintaining project requirements			

Controlling → Record/Communicate

General	Tasks	Timing	Resources	Responsibilities
Document agreements for future reference	Information periodically required by management giving the commercial financial/progress status of the project	Information periodically required by management giving the commercial financial/progress status of the project	Information periodically required by management giving the commercial financial/progress status of the project	Require periodic functional status reporting
Keeping executive management informed as to project status	Update estimates at each major checkpoint	Update estimates at each major checkpoint	Update estimates at each major checkpoint	
Ensure that project progress information flows where it is needed		Document all changes to the schedule		
		Maintain records of delays		
		Advise client on the effect of any delays in meeting red-letter dates		
Maintain		records of working conditions and weather, including air temperature throughout the day		

Appendix D

ARRAY OF CONSTRUCTION CO-ORDINATION ISSUES FURTHER SUBDIVIDED

Array of Construction Co-ordination Issues Further Subdivided

Planning

Planning → Identify

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
	Examine alternative methods for carrying out a project un der var ying tim e and resource requirements	Identify earl y, potential delays and schedule to avoid them		
		Identify strategic activities and schedule them accordingly		
Deployment of Work				
	Risk analysis		Assisting in determ ining technical and workforce requirements, schedules and budgets	
			Establishing pr oject or ganisation and staffing	
Services, Fixtures and Builder's Work				
Communications				
				Facilitate meetings and develop means for encouraging client, engine er, contractor, and subcontr actors to provide input and exchange viewpoints at various stages of the project
				Establish co mmunication channels for the whole project
Co-operation				

Continued …………

General	Tasks	Timing	Resources	Responsibilities
Supervision, Quality and Safety				
Remedial Works				
Attendance to Others				

Planning → Analyse/Plan/Schedule

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
Provide systematic approaches for developing estimates and schedules	Develop a program for achieving project objectives	Prepare an in-depth implementation schedule	Planning and estimating costs and schedules from bid documents	
	Revise the project plan as needed	Revise the project plan as needed	Revise the project plan as needed	
	Schedule activities	Predict project duration		
	Scheduling onsite work with offsite activity	Scheduling onsite work with offsite activity		
	Schedule to prevent late arrival of diagrams			
Deployment of Work				
	Concentrate on critical activities		Estimate the requirements for resources, such as personnel, equipment, and materials	
			Forecast resource requirements	
			Transfer excess resources assigned to some activities to others needing more resources	
			Schedule to prevent funding difficulties and material and labour shortages	

Continued …………

General	Tasks	Timing	Resources	Responsibilities
Services, Fixtures and Builder's Work				
Communications				
Co-operation				
Supervision, Quality and Safety				
Remedial Works				
Attendance to Others				

Planning → Communicate

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
Deployment of Work				
Services, Fixtures and Builder's Work				
Communications				
	Communicate and document project plans, schedules, and other information with different project participants	Communicate and document project plans, schedules, and other information with different project participants	Communicate and document project plans, schedules, and other information with different project participants	Communicate and document project plans, schedules, and other information with different project participants

Continued …………

General	Tasks	Timing	Resources	Responsibilities
Co-operation				
Supervision, Quality and Safety				
Remedial Works				
Attendance to Others				

Organising

Organising → Lead

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
Deployment of Work				
Overall	leadership toward i mplementing project plan		Bring new team members on board	Delineate work packages
				Refuel commitments
				Unify project teams
				Cut across all functional lines and interface with all levels of management as necessary to meet project requirements
				Establish an eff ective or ganisational structure

Continued …………

General	Tasks	Timing	Resources	Responsibilities
				Provide a detailed means for implementing decisions
				Delegating responsibilities and authority to functional personnel provided that the line manager is in approval that the employee can handle this authority/responsibility level.
				Renegotiate with functional managers for changes in personnel assignments
				Follow up delegated responsibilities and authority
				Purchasing the services of subcontractors
				Assembling a team of specialist subcontractors
				Resolve differences among participants
Services, Fixtures and Builder's Work				
Communications				
				Ensuring that all functional employees and managers are kept informed as to their responsibilities on the project and all revisions
Co-operation				
Supervision, Quality and Safety				
Remedial Works				
Attendance to Others				

Continued …………

Organising → Facilitate

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
		Reschedule activities so that objectives are met		
Deployment of Work				
Build an experience track and method for future projects	Co-ordinate project activities		Co-ordinate purchasing and delivery of material	Translating documents into task assignments for individuals
	Co-ordinating and integrating subsystem tasks		Supporting own men and subcontractors with tools, equipment and resources	
	Organising activities at the construction site	Provide appropriate means for reporting the progress of the project	Facilitating cash flow from client to suppliers and contractors	
Directing,	facilitating and controlling all construction work		Paying all the payrolls and bills for the own and the subcontractors' work	
	Ensuring the smooth running of all construction activities	Allocate	resources	
	Co-ordinate offsite construction activities with onsite construction ones	Co-ordinate offsite construction activities with onsite construction ones	Estimate the requirements for resources, such as personnel, equipment and materials	
	Handling offsite activity relating to supply, fabrication and pre-assembly required for the onsite work to be effective	Handling offsite activity relating to supply, fabrication and pre-assembly required for the onsite work to be effective	Transfer excess resources assigned to some activities to others needing more resources	
	Head project engineering operations			
	Application of good technical practices			
	Determine or clarify administrative procedures			
	Application of company procedures			
	Interpretation of all contractual commitments			
	Interpreting documents for those doing the work			

Continued …………

General	Tasks	Timing	Resources	Responsibilities
	Improve and alter activities so that objectives are met		Reallocate resources so that objectives are met	
	Agreeing on details of methods of construction			
	Explaining and supporting the work for subcontractors			
	Co-ordinating subcontractor activity			
	Issuing further drawings or details needed for construction			
	Undertaking all the required tests			
	Attend to the list of all defects or omissions prior to hand-over of the building			
Services, Fixtures and Builder's Work				
Communications				
Maintaining of proper client and project team relationships	Liaise with consultant engineers on trades and sub-contractors under their direction	Ensure that project progress information flows where it is needed		Receive constructive input, in the form of suggestions and recommendations, from participants
All formal communications between client and contractor	Liaison with the resident engineer regarding all contract matters	Communicate and document project plans, schedules, and other information with different project participants		
Contact with authorities				
Contract management				
Facilitate meetings and develop means for encouraging client, engineer, contractor, and subcontractors to provide input and exchange viewpoints at various stages of the project				
Establish communication channels for the whole project				

Continued …………

General	Tasks	Timing	Resources	Responsibilities
Conduct check point review meetings with department heads to ascertain the exact details in each facet of the project				
Provide an organised means for gathering information and compiling it				
Co-operation				
Supervision, Quality and Safety				
	Overseeing the entire construction effort		Monitor manpower, plant and material utilisation	
	Controlling the performance of the project participants		Monitor the budget on all activities	
	Ensuring that all work is constructed in accordance with the requirements of the contract.			
	Ensuring that workmanship and materials used are according to the specifications			
	Inform the contractor of work that does not conform to contract documentation			
	Check steelwork, and reinforcement cover, spacings and fixings			
	Checking lines, levels, layout etc of the works to ensure conformity with the drawings			
Remedial Works				
Attendance to Others				

Continued …………

Organising → Information and Records

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
Deployment of Work				
	Maintain records of drawings and information received from the consultants and other contractors	Recording progress in detail	Maintain records of principal deliveries to site and general particulars of shortages	
	Maintain records of directives passed to the contractor		Maintain records of site labour employed	
	Maintain records of verbal instructions received from supervising officer and consultants		Maintain records of plant standing or in use on site	
	Maintain records of work done outside the terms of contract and for which variation orders have, or should be issued		Prepare day work vouchers in respect of time and materials	
	Measuring the amount of work done, checking interim payments to contractor and prepare them to submission to the engineer			
	Assist the quantity surveyor with measurement as required – particularly foundations, drainage and other work to be covered up			
	Check records and drawings of as-built status – particularly foundations, drainage and other work to be covered up			
	Preparing claims and keeping records of facts relating to any claims by the contractor			
	Maintain records of material tests			
	Keeping records of all required tests			

Continued …………

General	Tasks	Timing	Resources	Responsibilities
Services, Fixtures and Builder's Work				
Communications				
Encourage docu mentation but minimise paperwork	Publish daily constr uction r eports which describe the activities that are occurring	Progress reporting		
Standardise data formats	Reporting on all r equired matters to the engineer in the form he requires			
Preparation of all project data items	Project closeout report			
Preparation of r eports r equired by the client, third parties				
Co-operation				
Supervision, Quality and Safety				
Remedial Works				
Attendance to Others				

Continued …………

Controlling

Controlling → Monitor

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
Deployment of Work				
Services, Fixtures and Builder's Work				
Communications				
Co-operation				
Supervision, Quality and Safety				
	Monitoring the progress of the project, especially in terms of time, cost and quality	Monitoring the progress of the project, especially in terms of time, cost and quality	Monitoring the progress of the project, especially in terms of time, cost and quality	Monitor the time, cost, and performance activities in the functional departments and ensure that all problems are promptly identified, reported, and solved
	Monitor actual ongoing operations to ensure that objectives, short-term and long-term, are being met		Monitor manpower, plant and material utilisation	
			Monitor the budget on all activities	
Remedial Works				
Attendance to Others				

Continued …………

Controlling → Analyse

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
		Examine the contractor's progress against the schedule, checking and recording progress and delays		
		Reschedule activities so that objectives are met		
		Detect variances from schedules and deal with the effects of those variances		
		Revise existing schedules whenever a potential problem occurs		
Deployment of Work				
Provide guidelines and uniformity and a basis for analysis	Measuring and analysing project performance regarding technical progress, schedule, and budgets	Measuring and analysing project performance regarding technical progress, schedule, and budgets	Measuring and analysing project performance regarding technical progress, schedule, and budgets	
	Improve and alter activities so that objectives are met	Compare project progress information with the master schedule	Reallocate resources so that objectives are met	
	Consider the effect of time and resource constraints on activities of the project	Analyse any variances that occur, especially between scheduled and actual completion dates	Comparing actual to predicted cost and performance, and taking corrective action when necessary	
Evaluate	effectiveness of activities, and take corrective action	Discuss potential and actual delays	Determine whether the contractor has adequate personnel, equipment, and material to meet the schedule	
	Determine and eliminate unnecessary activities	Review progress of project	Determine costs associated with activities	
Services, Fixtures and Builder's Work				

Continued …………

General	Tasks	Timing	Resources	Responsibilities
Communications				
	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers	Maintaining a plan which continuously displays the project's time, cost, and performance as well as resource commitments made by the functional managers
Co-operation				
Supervision, Quality and Safety				
Remedial Works				
Attendance to Others				

Controlling → Control/Correct/Maintain

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
		Project planning and controlling		
Deployment of Work				
Conducting trade-offs	Meet with client and engineer to review the project's progress and to ensure that the activities are producing what has been designed		Control and distribution of all project finances, including procurement, such that project cash flow limitations are adhered to	
Co-ordinating and negotiating requirements between sponsor and performing organisations	Directing the technical implementation according to established schedule and budgets		Controlling of costs (corrective actions)	
	Performance to schedule		Execution within operating budgets	

Continued …………

General	Tasks	Timing	Resources	Responsibilities
	Rectify any deviations to plans or procedures			
	Maintaining project requirements			
Services, Fixtures and Builder's Work				
Communications				
Customer liaison				Minimise conflict and confusion
Conduct check point review meetings with department heads to ascertain the exact details in each facet of the project				
Co-operation				
Supervision, Quality and Safety				
	Controlling the performance of the project participants	Ensure all participants comply with time schedules	Prevent deviations in the quality and quantity of resources used	
	Quality of the work in accordance with the contract	Ensure that each activity starts and finishes as planned		
	Prevent defective workmanship			
	Inform the contractor of work that does not conform to contract documentation			
	Ensuring that the works are constructed in accordance with the requirements of the contract			
	Ensuring that workmanship and materials used are according to the specifications			
Remedial Works				
Attendance to Others				

Continued ....

Controlling → Record/Communicate

General	Tasks	Timing	Resources	Responsibilities
Sequence of Work				
Deployment of Work				
Document agreements for future reference	Update estimates at each major checkpoint	Update estimates at each major checkpoint	Update estimates at each major checkpoint	
		Document all changes to the schedule		
		Maintain records of delays		
		Advise client on the effect of any delays in meeting red-letter dates		
Maintain		records of working conditions and weather, including air temperature throughout the day		
Services, Fixtures and Builder's Work				
Communications				
Keeping executive management informed as to project status	Information periodically required by management giving the commercial financial/progress status of the project	Information periodically required by management giving the commercial financial/progress status of the project	Information periodically required by management giving the commercial financial/progress status of the project	Require periodic functional status reporting
Ensure that project progress information flows where it is needed				
Co-operation				
Supervision, Quality and Safety				
Remedial Works				
Attendance to Others				

Appendix E

QUESTIONNAIRE FOR SURVEY OF RELATIVE IMPORTANCE OF CONSTRUCTION CO-ORDINATION ISSUES

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

香港 九龍 紅磡
Hung Hom Kowloon Hong Kong

Department of Civil & Structural Engineering

Tel: (852) 2766-6079 Fax: (852) 2334-6389

Survey on Relative Importance of Construction Co-ordination Issues

This survey is to find facts for a research study programme pursued by D. Darshi De Saram under the supervision of Dr. Syed M. Ahmed at the HK Polytechnic University.

Objective: To identify what are the most important issues pertaining to construction co-ordination that need to be addressed in the rest of the research project.

Please return by Fax to: 2334 6389 (D. Darshi De Saram, Department of Civil and Structural Engineering, HK Polytechnic University, Hung Hom, Kowloon, Hong Kong).
Telephone: + 852 2766 6079 E-mail: 9698

If you please indicate your name and contact details, I could send you a copy of the research findings.

Name ……………………………………………………………… Designation ………………………………………………………………………………………

(It may be convenient to attach your visiting card) Name & Address of your Company ………………………………………………………………

Qualifications ………………………………………………… ………………………………………………………………………………………………………

<u>Please give your opinion from the main contractor's point of view</u>.

Please tick (☑) the appropriate answer

Note:- N/A Tick this box if you think that the issue does not belong to construction co-ordination.

% Please write the percentage if you ALREADY have <u>or</u> can EASILY make an estimation of your time that issue consumes. Otherwise do not worry, just tick (☑) appropriate box to indicate High, Mid or Low

Importance				Time Consumed				Construction Co-ordination Issue
High	Mid	Low	N/A	High	Mid	Low	%	
								1. <u>Providing Leadership</u>
☐	☐	☐	☐	☐	☐	☐	…..%	1. Translating documents into task assignments
☐	☐	☐	☐	☐	☐	☐	…..%	2. Identifying strategic activities and potential delays
☐	☐	☐	☐	☐	☐	☐	…..%	3. Identifying technical and workforce requirements
☐	☐	☐	☐	☐	☐	☐	…..%	4. Delegating the work
☐	☐	☐	☐	☐	☐	☐	…..%	5. Following up the delegated work
☐	☐	☐	☐	☐	☐	☐	…..%	6. Motivating
☐	☐	☐	☐	☐	☐	☐	…..%	7. Developing a team spirit
☐	☐	☐	☐	☐	☐	☐	…..%	8. Resolving differences/conflicts/confusions among participants
☐	☐	☐	☐	☐	☐	☐	…..%	9. Maintaining proper relationships with client, consultants and the contractor
☐	☐	☐	☐	☐	☐	☐	…..%	10. Receiving constructive input from all participants in the project
☐	☐	☐	☐	☐	☐	☐	…..%	11. Establishing and maintaining an effective organisational structure and communication channels
☐	☐	☐	☐	☐	☐	☐	…..%	12. Interfacing with other Departments/Managers in your organisation outside the project team
☐	☐	☐	☐	☐	☐	☐	…..%	(Other)

(........ Continued)

Importance				Time Consumed				Construction Co-ordination Issue
High	Mid	Low	N/A	High	Mid	Low	%	
								2. Facilitating
☐	☐	☐	☐	☐	☐	☐	…..%	2.1. Identifying/gathering information on requirements of all parties and consolidate for use in planing
☐	☐	☐	☐	☐	☐	☐	…..%	2.2. Providing an organised means for gathering information and compiling
☐	☐	☐	☐	☐	☐	☐	…..%	2.3. Managing contractual issues
☐	☐	☐	☐	☐	☐	☐	…..%	2.4. Interpreting all contractual commitments and documents
☐	☐	☐	☐	☐	☐	☐	…..%	2.5. Interfacing/integrating the work on different subsystems
☐	☐	☐	☐	☐	☐	☐	…..%	2.6. Agreeing on detail methods of construction
☐	☐	☐	☐	☐	☐	☐	…..%	2.7. Improving/altering/eliminating activ ities an d con sidering b etter altern atives th at m ay efficiently meet the project objectives
☐	☐	☐	☐	☐	☐	☐	…..%	*(Added)* Preparing co-ordination drawings
☐	☐	☐	☐	☐	☐	☐	…..%	*(Added)* Establishing Project Quality Plan (PQP)
☐	☐	☐	☐	☐	☐	☐	…..%	2.8. Analysing th e p roject p erformance o n time, co st an d q uality, d etecting v ariances fro m th e schedule/requirements and dealing with their effects considering time and resource constraints
☐	☐	☐	☐	☐	☐	☐	…..%	2.9. Estimating resource requirements
☐	☐	☐	☐	☐	☐	☐	…..%	2.10. Co-ordinating and rescheduling the sequence of onsite work
☐	☐	☐	☐	☐	☐	☐	…..%	2.11. Co-ordinating offsite fabrications and their delivery with the onsite work
☐	☐	☐	☐	☐	☐	☐	…..%	2.12. Co-ordinating the purchases, delivery and storage of material
☐	☐	☐	☐	☐	☐	☐	…..%	2.13. Optimising resource allocation and utilisation
☐	☐	☐	☐	☐	☐	☐	…..%	2.14. Supporting own men and subcontractors with tools, equipment and resources
☐	☐	☐	☐	☐	☐	☐	…..%	2.15. Explaining and supporting the work of subcontractors
☐	☐	☐	☐	☐	☐	☐	…..%	2.16. Identifying or gathering information on defects, deficiencies, ambiguities and conflicts in drawings and specifications and having them resolved
☐	☐	☐	☐	☐	☐	☐	…..%	2.17. Obtaining further drawings, specifications and technical details on time for execution
☐	☐	☐	☐	☐	☐	☐	…..%	2.18. Identifying and gathering in formation on bu ilders wo rk r equirements (g routing-in, op enings, making good, etc.) of all relevant parties and co-ordinate the time and manner of their execution
☐	☐	☐	☐	☐	☐	☐	…..%	2.19. Providing g eneral atten dance (sto rage sp ace, testi ng facilit ies, scaffo lding, plant, power, water, illumination, etc.) to other parties
☐	☐	☐	☐	☐	☐	☐	…..%	2.20. Co-ordinate handover of work areas (service areas, plant rooms, service routs, etc.) to other parties
								(Continued ……..)

(........ Continued)

Importance				Time Consumed				Construction Co-ordination Issue
High	Mid	Low	N/A	High	Mid	Low	%	
								(…….. Continued) Facilitating
☐	☐	☐	☐	☐	☐	☐	…..%	2.21. Care of works of others by making staff and workmen aware, where relevant providing covers, where possible changing the sequence of work, etc.
☐	☐	☐	☐	☐	☐	☐	…..%	2.22. In case of defect or damage, proposing remedial work method and programme for executing
☐	☐	☐	☐	☐	☐	☐	…..%	2.23. Arranging for compliance with site instructions/directives from the Engineer and revising programmes/ordering material accordingly
☐	☐	☐	☐	☐	☐	☐	…..%	2.24. Arranging for timely carrying out of all tests or inspections and approval by Engineer
☐	☐	☐	☐	☐	☐	☐	…..%	2.25. Submitting material for approval by the Engineer
☐	☐	☐	☐	☐	☐	☐	…..%	2.26. Applying good technical practices
☐	☐	☐	☐	☐	☐	☐	…..%	2.27. Applying good administrative procedures
☐	☐	☐	☐	☐	☐	☐	…..%	*(Added)* Managing nominated subcontractor or utility undertaker
☐	☐	☐	☐	☐	☐	☐	…..%	2.28. Facilitating payments to own employees and subcontractors
☐	☐	☐	☐	☐	☐	☐	…..%	(Other)
☐	☐	☐	☐	☐	☐	☐	…..%	(Other)

Importance				Time Consumed				Construction Co-ordination Issue
High	Mid	Low	N/A	High	Mid	Low	%	
								3. Controlling
☐	☐	☐	☐	☐	☐	☐	…..%	3.1. Managing the quality of all work carried out
☐	☐	☐	☐	☐	☐	☐	…..%	3.2. Ensuring the timeliness of all work carried out
☐	☐	☐	☐	☐	☐	☐	…..%	3.3. Ensuring effective utilisation of manpower, plant and material
☐	☐	☐	☐	☐	☐	☐	…..%	3.4. Managing the health, safety and welfare of employees
☐	☐	☐	☐	☐	☐	☐	…..%	3.5. Managing the maintenance and safety of plant and machinery
☐	☐	☐	☐	☐	☐	☐	…..%	3.6. Ensuring proper and safe delivery, storage and handling of material
☐	☐	☐	☐	☐	☐	☐	…..%	3.7. Monitor the budget on all activities and take corrective action
☐	☐	☐	☐	☐	☐	☐	…..%	3.8. Controlling project finances
☐	☐	☐	☐	☐	☐	☐	…..%	3.9. Monitoring the overall functioning of each section and department of the project
☐	☐	☐	☐	☐	☐	☐	…..%	3.10. Ensuring discipline among all employees
☐	☐	☐	☐	☐	☐	☐	…..%	(Other)

(........ Continued)

Importance				Time Consumed				Construction Co-ordination Issue
High	Mid	Low	N/A	High	Mid	Low	%	
								4. Communicating
☐	☐	☐	☐	☐	☐	☐	…..%	4.1. Liaison with the Client and the Consultants
☐	☐	☐	☐	☐	☐	☐	…..%	4.2. Liaison with specialist Consultants, specialist subcontractors, nominated subcontractors, etc.
☐	☐	☐	☐	☐	☐	☐	…..%	4.3. Contact with outside authorities
☐	☐	☐	☐	☐	☐	☐	…..%	4.4. Communicating project progress, financial/commercial status, plans, schedules, changes, documents, etc., to all relevant participants
☐	☐	☐	☐	☐	☐	☐	…..%	4.5. Conducting regular meetings and project reviews
☐	☐	☐	☐	☐	☐	☐	…..%	4.6. Communicate instances of poor quality, dangerous or adverse incidents/situations to relevant personnel
☐	☐	☐	☐	☐	☐	☐	…..%	(Other)

Importance				Time Consumed				Construction Co-ordination Issue
High	Mid	Low	N/A	High	Mid	Low	%	
								5. Recording
☐	☐	☐	☐	☐	☐	☐	…..%	5.1. Maintaining records of all drawings, information, directives, verbal instructions and documents received from the Consultants and the Client
☐	☐	☐	☐	☐	☐	☐	…..%	*(Added)* Maintaining contract documents and amendments to contract at construction office
☐	☐	☐	☐	☐	☐	☐	…..%	5.2. Maintaining records of work done outside the contract, variations, day works and all facts/data necessary to support claims
☐	☐	☐	☐	☐	☐	☐	…..%	5.3. Maintaining records of quantities of work done and details required for as-built drawings; especially of the work that is to get covered up
☐	☐	☐	☐	☐	☐	☐	…..%	5.4. Maintaining records of price escalations where to contract provides extra payments
☐	☐	☐	☐	☐	☐	☐	…..%	5.5. Maintaining records of principal deliveries to the site and general particulars of shortages
☐	☐	☐	☐	☐	☐	☐	…..%	5.6. Maintaining records of labour and plant deployment, working conditions (such as adverse weather), plant breakdowns, accidents, etc.
☐	☐	☐	☐	☐	☐	☐	…..%	5.7. Maintaining records of all tests and inspections
☐	☐	☐	☐	☐	☐	☐	…..%	5.8. Publishing daily construction reports in the format required by the Engineer
☐	☐	☐	☐	☐	☐	☐	…..%	(Other)

The END.

THANK YOU very much for the valuable time spent and the kind effort.

Appendix F

STRUCTURE FOR INTERVIEW OF PROJECT MANAGERS PROTOTYPE 1

Structure for the Interview on Co-ordination Processes

On each of the two processes given below, please provide the requested information.

PROCESS 1: **Identifying strategic activities and potential delays**
PROCESS 2: **Ensuring the timeliness of all work carried out**
PROCESS 3: **Liaison with the Client and Consultants**

1. Who are the customers of this process?

2. Who would be other stakeholders (e.g., other organisations concerned, employer, employees, community, environment) of the process?

3. Traditionally, the objective was to manage the inputs, the process and the outputs. To ensure customer satisfaction, we need to go another step forward and understand what **outcomes** the customers make out of our **outputs** (Please see Figure 1).

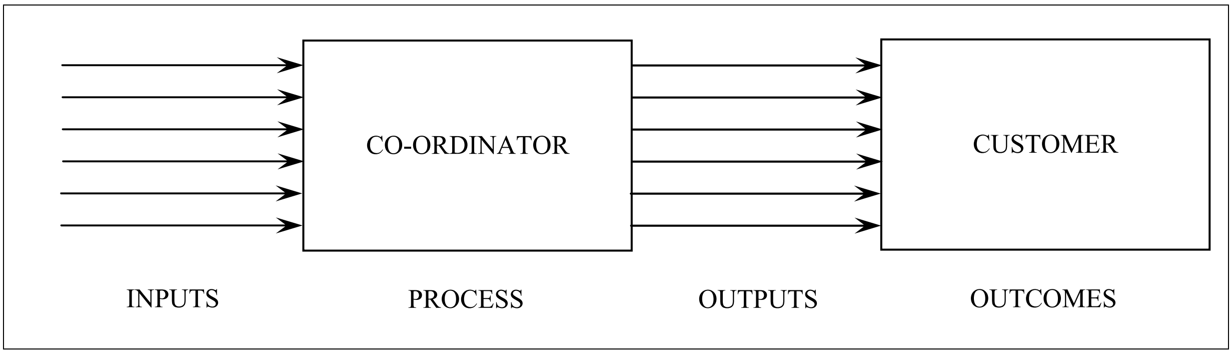

Figure 1: Inputs, Process, Outputs and Outcomes

How would each customer use the benefits of this process? What will be the outcomes/uses each of them will make out of this process? If you wish, you may answer this question together with Question 5)

4. Similarly, how would other stakeholders use the benefits of this process? What will be the outcomes/uses each of them will make out of this process? If you wish, you may answer this question together with Question 6)

When answering the subsequent questions, please use the following service quality model (given in Table 1) to identify types of requirements by customers.

Table 1: Service Quality Model

	Deliverables of the Process *(Attributes that are provided to the customer)*	Interactions During the Service *(How customers experience the process while it is performed)*
Faster Availability		Responsiveness
Convenience		Accessibility
Better Performance		Reliability
Features		Security
Reliability		Competence
Conformance		Credibility
Serviceability		Empathy
Aesthetics		Communications
Perceived quality		Style
Cheaper Price		

5. What are the needs of the customers of the process?

- What are the attributes explicitly requested?
  - Deliverables
  - Interactions
- What are the attributes not explicitly requested but taken for granted?
  - Deliverables
  - Interactions
- What are the attributes not really expected by the customer but would delight him/her if provided?
  - Deliverables
  - Interactions

6. Similarly, what are the needs of the other stakeholders of the process?

- What are the attributes explicitly requested?
  - Deliverables
  - Interactions
- What are the attributes not explicitly requested but taken for granted?
  - Deliverables
  - Interactions
- What are the attributes not really expected but would delight him/her if provided?
  - Deliverables
  - Interactions

7. To en able th e r esearcher to **FLOWCHART** t he t wo p rocesses c oncerned, please p rovide t he f ollowing information.

   Briefly describe how the process is performed in the construction industry.

   - What originates the process? When is it carried out?
   - What are the specific objectives of the process?
   - What are the resources required?
   - What are the data required?
   - What other inputs are required?
   - Who are the personnel/parties involved in the process?
   - What are their specific contributions to the process?
   - Any special analysis/processing required and how will they be done?
   - What are the outputs required and who will generate them?
   - How will the outputs be transmitted/communicated and who are the targeted recipients?

8. What are the measures internal to the process that control the performance of the process outputs against the requirements and specifications identified above?

9. What are the salient features of the process that give the above outputs?
   - As practiced now
   - What would be more preferable?

Appendix G

STRUCTURE FOR INTERVIEW OF PROJECT MANAGERS PROTOTYPE 2

<u>Interview Structure</u>

In a previous survey, Construction Project Managers and Co-ordinators have identified the following three co-ordination processes as most important.

Process 1. **Identifying strategic activities and potential delays**

Process 2. **Ensuring the timeliness of all work carried out**

Process 3. **Liaison with the Client and Consultants**

Q 1 From the point of view of the contractor's organisation,

- what work do these three processes involve?
- who are the personnel the co-ordinators have to interact with?

Q 2 In the above three co-ordination processes, what you are formally or contractually expected to perform may be different to what you informally end up doing. Could you please compare

- what you are *formally* supposed to do in these three co-ordination processes; with
- what you *informally* end up doing

Q 3 How are the above three co-ordination processes organised in your company?

- What are the specific objectives of these processes?
- Who are responsible for these processes? Of whom do the teams executing these processes consist? What are their specific contributions to the processes?
- What are the data/inputs/resources required?
- Any special analysis/processing required?
- What are the outputs generated?
- Who are the customers of these processes?
- Who are the other personnel/parties concerned?
- How do co-ordinators receive inputs from personnel concerned? and How are the outputs communicated to the customers?

Q 4 What are the needs/expectations of

- customers
- other personnel/parties concerned

<u>Note</u> :-

You may be able to identify 3 levels of needs/expectations

1. What do they **<u>take for granted</u>** that you will give? (Implicit needs/expectations)
2. What do they **<u>specifically request</u>**? (Explicit needs/expectations)
3. What would they **<u>not expect but be delighted</u>** if given? (Latent needs/expectations)

Page 2 →

Q 5 What may be the outcomes the customers make out of your outputs? How would each customer use the benefits of this process?

Note :-

Traditionally, the objective was to manage the inputs, the process and the outputs. To ensure customer satisfaction, we need to go another step forward and understand what **outcomes** the customers make out of our **outputs** (Please see Figure 1).

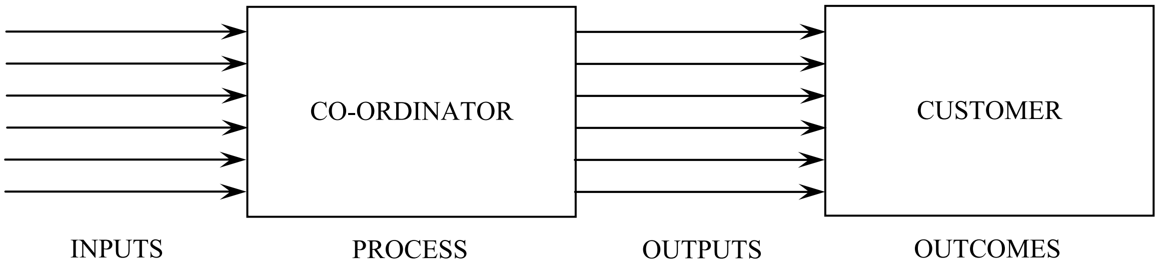

Figure 1: Inputs, Process, Outputs and Outcomes

Q 6 When receiving from Project Co-ordinators, the outputs identified in Q 3 and 4, the customers and other personnel/parties concerned may expect certain quality in:

Please see Table 5.2 in the thesis

- attributes *(defined in the attached sheet)* delivered
- interactions *(defined in the attached sheet)* experienced during the process

Using the service quality model given in the attached sheet, please elaborate on the quality of co-ordination process outputs that may be expected by the customers and other personnel/parties.

Q 7 Do the three co-ordination processes (identified above), as executed at present by the contractors, satisfy the expectations of the:

- customers
- other personnel/parties concerned

You may answer this question by either of the following:

1. giving a general comment that you wish to make
2. citing some shortcomings that are commonly occurring how they need to be rectified or some situation that are becoming a great concern
3. identifying where and in which directions should improvements be made to the three co-ordination processes to better satisfy the customers

Q 8 Anything else you wish to say in this regard?

Thank you very much for the valuable knowledge imparted, precious time spent and the kind effort

Appendix H

STRUCTURE FOR INTERVIEW OF PROJECT MANAGERS FINAL VERSION

Interview Structure

Part 1: How Co-ordination is Achieved in Your Company

In a previous survey, Construction Project Managers and Co-ordinators have identified the following three co-ordination processes as most important.

Process 1. **Identifying strategic activities and potential delays**

Process 2. **Ensuring the timeliness of all work carried out**

Process 3. **Liaison with the Client and Consultants**

Hence, I wish to focus my study on how the above 3 processes are carried out in the industry during the **construction phase**.

When answering the following questions,

- please **omit** the pre-bid stage
- please take the **contractor's Project Manager's** view point
- please **consider the day to day co-ordination** required when running a construction site

Q 1 From the point of view of the contractor's Project Manager,

- what work do these three processes involve?
- what are the specific objectives of these processes?
- who are the personnel the co-ordinators have to interact with?

Q 2 In the above three co-ordination processes, what you are formally or contractually expected to perform may be different to what you informally end up doing. Could you please compare

- what you are *formally* supposed to do in these three co-ordination processes; with
- what you *informally* end up doing

Q 3 Does the quality policy under the ISO 9000 QA system identify how co-ordination should be improved? Do project quality plans specify how co-ordination should be achieved?

Q 4 Could you please elaborate on your answers to Q1 and Q2 considering the following aspects?

- Is it the Project Manager himself who perform these processes?
  Who else is involved in performing them? What are their specific contributions to the processes?
- What are the data/inputs required?
- What are the resources required?
- Any special analysis/processing required?
- What are the outputs generated?
- Who are the people (both within your company and outside) who receive outputs of these processes?
- Who are the other personnel/parties affected by these processes?
  Who are the other personnel/parties who provide information and other inputs for theses processes?
- How do co-ordinators receive inputs from personnel concerned? and
  How are the outputs communicated to the recipients?

Part 2: Supplementary Questions

Part 2 was added because, the industry personnel who kindly responded before to the earlier versions of this questionnaire could not give a specific answer to Q4. The objective of Part 2 is to further understand:

- how co-ordination is achieved in your company and
- your perception of good co-ordination as opposed to bad co-ordination

Q 5 During the construction stage, how do you identify strategic activities and potential delays?

(There may not be just one method, but could you please elaborate on … what methods do you rely on most … what methods do you use more often?)

- By observations at the site
- By extensively studying the project requirements and being fully aware of all possibilities
- By informally requesting information from site personnel and subcontractors
- You expect site personnel and subcontractors to keep you informed on such matters
- From memos and letters sent in by parties to the project
- (Other) ……………………………………………………………………………………………
- (Other) ……………………………………………………………………………………………

Q 6 In situations such as those given below,

- How will you ensure that such situations are identified beforehand
- How do you achieve co-ordination
- What are the features of a good job of co-ordination as opposed to bad co-ordination

Situations:

- Where the work of different trades/services clash, e.g., a complex area with pipes/ducts/cables designed by different specialist designers, works of plasterers/tillers/joiners/installers of fittings, where shop drawings by different parties need to be carefully compared.
- Items that need to pass through concrete, that need burying/embedding/builder's work … where if any item is not put in on time will cause lots of inconvenience later.
- Where a specialist contractor is going to install something along a beam or a wall thus the general contractor's (or any other contractor's) access will be restricted due to this and it will be easy if they finish their work before the specialist contractor becomes an obstruction.
- Where carrying out work of a particular trade in an area where others have finished their work is a threat to the care of work finished by others. (Or even where the others are still in the process of some work, moving in another trade will be a threat to the semi-finished work or the material brought in for the work).
- Material management where supplies from external suppliers are concerned. Management of fabrication and other services by parties outside the site. Managing to suit sudden changes in design and time schedule at the site.
- Sharing of in-house resources such as cranes and other plant/equipment/craftsmen.
- Government and other statutory bodies requiring approval and providers of utilities such as water, electricity.

Q 7 When a subcontractor or a group of workmen are lagging behind time,

- How do you get to know it? … What methods of gathering information do you use?
- What action do you take to ensure timeliness of the work?
- How do you analyse the effects of such delays?
- To whom do you communicate effects of such delays and your analysis on same? How do you make such communication?
- How do you co-ordinate to prevent any adverse effects of their delay on others working in the same area?

Q 8 Regarding liaison with the Client and Consultants, could you please elaborate on the following aspects.

- What are your objectives of liaising with the Client and Consultants?
- How do you liaise with the Client and Consultants? How do you handle matters <u>such as</u>:
  - Missing details in drawings/specifications
  - Buildability problems
  - Clash of design on works of two or more trades/services
  - Variations/change orders
  - Delays … delay by your company requiring extensions … delay by others clashing with your schedule … their effect on other logistics
  - Effects of unforeseen problems
  - Changes in external conditions that affect the work in terms of … technical, quality, safety, legal, environmental, financial, material/labour/plant availability.
- How do you differentiate a good job of liaison from bad liaison?

<u>Thank you very much for the valuable knowledge imparted, precious time spent and the kind effort</u>

What are the needs/expectations of

- customers
- other personnel/parties concerned

Note :-

You may be able to identify 3 levels of needs/expectations

1. What do they **take for granted** that you will give? (Implicit needs/expectations)
2. What do they **specifically request**? (Explicit needs/expectations)
3. What would they **not expect but be delighted** if given? (Latent needs/expectations)

What may be the outcomes the customers make out of your outputs? How would each customer use the benefits of this process?

Note :-

Traditionally, the objective was to manage the inputs, the process and the outputs. To ensure customer satisfaction, we need to go another step forward and understand what **outcomes** the customers make out of our **outputs** (Please see Figure 1).

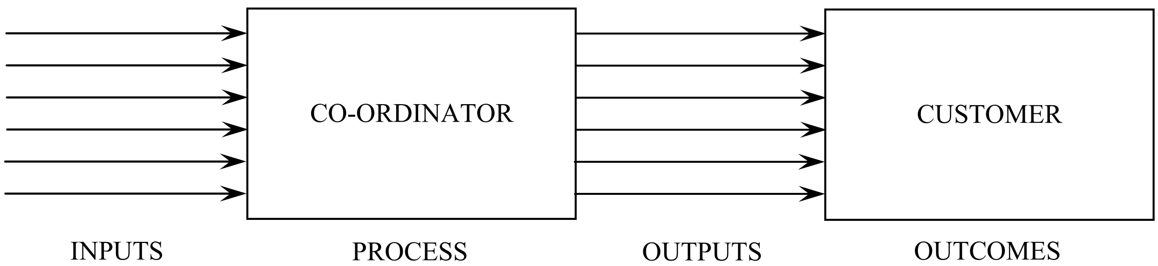

Figure 1: Inputs, Process, Outputs and Outcomes

When receiving from Project Co-ordinators, the outputs identified in the previous two questions, the customers and other personnel/parties concerned may expect certain quality in:

- attributes *(defined in the attached sheet)* delivered
- interactions *(defined in the attached sheet)* experienced during the process

Please see Table 5.2 in the thesis

Using the service quality model given in the attached sheet, please elaborate on the quality of co-ordination process outputs that may be expected by the customers and other personnel/parties.

Appendix I

QUOTATIONS FROM INTERVIEW TRANSCRIPTS REFERRED IN CHAPTER 7

Quotations from Interview Transcripts Referred in Chapter 7

The numbers given within square parentheses, e.g., [7.5.1], in the left hand side column indicate the subsection(s) of Chapter 7 where the quotation is referred.

Qt 1 [7.5.1]	Identifying strategic activities and potential delays. We initially do that assessment when we do the tender and we refer to the risks and opportunities associated with the job. We look what the risks are, the opportunities are in terms of time and work activities and often I have pros & cons against them. Initially it is done at the tender stage. Then when the tender is successful, it goes to the site people and the Project Manager and the Operations Manager and generally the Senior Supervisors would also go through and look at what they consider to be the risks and opportunities. … When we prepare a tender we have a Bid Captain. He is the person responsible for putting the bid together and he is normally the focus for any correspondence to and from the Client. If the tender is successful, there he is handed over the Project Manager and he looks after in terms of any additional processes, any other additional crisis that may come out of that as if there was a value engineering associated with the project.
Qt 2 [7.5.1]	My personal view is that Project Manager should understand at least 95% of the job. He should understand every nick and corner of the job; he should understand what is the programme; he should understand what is the process; he should understand what sort of equipment we are using. When the project file was first given to us, myself and an engineer, we went through and scanned the whole thing and went through the whole thing bit by bit to understand what it is. And with the past experience, you know what to do.
Qt 3 [7.5.1]	Talking about co-ordination onsite – I think it starts with a whole framework – an overall view – you must have a plan. It does not matter in the beginning whether you plan it with a very simple tool as a very simple bar chart or you plan it with a very sophisticated critical path – computer aided programme. Basically it is identifying all ‘strategic activities’.
Qt 4 [7.5.1] [7.6.1]	Usually at the beginning of the project, the main contractor would draw an overall programme and when the first overall programme is produced, normally it is with minimum co-ordination – I am talking about the first overall programme. In other words, this is a framework programme. So, once this framework programme is produced, then the real co-ordination will come in, with feedback from various subcontractors involved in the programme, such as whether or not the time frame allowed in the programme is too generous or tight. When they come in with their feedback and discussion, which is also co-ordination, you can sum up your overall programme.
Qt 5 [7.5.1]	Works activities in a schedule plan, this has to be identified from day one when you put out your overall schedule and you refine it by breaking it down into smaller activities and see how they can link to each other. This has to be defined and this has to be sticked to throughout your whole construction process unless you change your construction method. Unless you propose a new way of doing things or we introduce new material that involve new process, you cannot vary, you should stick to your method. So, that way, then you can realise – because it is very difficult to have a moving target or a moving goal. So, identifying critical activities have to be done from day one when you have the overall schedule and if you ever change then you will have to review the whole schedule and see how you can fix back into the main schedule.

Qt 6 [7.5.1]	During the construction stage, identifying potential delays come from actual delays. Strategic activities have to be all predetermined, so you know that these are critical activities. Whenever there is a delay, we need to look at these and say "Well, this would be affected. How can we make corrective actions to such critical activities that have to follow?"
Qt 7 [7.5.1]	To identify strategic activities, we have to study the drawings and come out with a proper plan. Of course every job is a bit different. Normally the Project Manager and Project Directors would come out with some plans. Potential delay, we monitor weekly programmes. At macro level of course we have the overall project schedule. We break it down to micro level – monthly, weekly or even daily.
Qt 8 [7.5.2]	So, once you have a plan, our follow-up is of course – there would be at least a monthly meeting – Project Meeting which involves the Clients and the Consultants. This in the beginning could be a weekly thing and as the project gets on track, you can go up to fortnightly or monthly and at the end of it – at the end where it is critical, at the finishing point there is a lot of decisions to be made and again this meeting could revert back to fortnightly meeting or even a weekly meeting – just to make sure that everything at the end is – especially there is lots of inspection, authority, clearings and it can be completed on time. So, that is one of the co-ordination tools that we use which is actually involving the consultants and the clients together. The other downstream control would be our co-ordination of all these subcontractors, nominated subcontractors and suppliers. That we do with a daily toolbox meeting. Normally we have a weekly meeting with the bigger subcontractors and nominated subcontractors to clear more administrative or higher level problems. But the daily work schedules are done in the toolbox meeting or the co-ordination meetings everyday.
Qt 9 [7.5.2]	We normally have formal weekly co-ordination meetings which senior supervisors would attend. With Projects of that size we will not have separate Departments. We normally have Engineers and Supervisors and we call them all together and have a weekly meeting. That meeting has minutes – get covered – it addresses number of things, safety, quality – So that is probably the co-ordination method we use internally. Similarly we have a monthly meeting with the Client which would be the co-ordination with the Client. In terms of programme, that is generally addressed at the weekly meetings. We do occasionally – once a month would have a programming meeting or an expediting meeting – not so much programming but expediting particularly the materials. There is an expediting report to tell how materials are coming what is running late and where our internal delays will arise. If it is production, then we can normally sort it out onsite. If it is something external – might need expediting – have a separate expediting report. Normally we have a weekly expediting report, probably only have a monthly expediting meeting.
Qt 10 [7.5.2]	Besides the master programme we have the individual block programme to monitor the progress. Also we will have a weekly meeting with the developer, the consultant. We also have a construction meeting – an internal meeting with our subcontractors because we have to issue weekly or biweekly programmes to the subcontractors saying within this week or two you must complete certain, certain work. Then we monitor daily. We have an overall or master programme for the entire construction period and then we breakdown into these subprogrammes.

Qt 11

[7.5.2]

Besides the main programme (overall programme) there will be mini three-monthly programmes, may even breakdown to mini monthly programmes, mini weekly programmes – breakdown into very detailed activities. All these programmes will help both parties [the main contractor and the relevant subcontractor] to monitor the programme. Also it is important that these co-ordination meetings are held very often – once a week. During the week anything that arise or delay is monitored and highlighted so that people can take remedial action. So, co-ordination is not just confined to talking; not just confined to meetings and writing down minutes. It also involves actual site monitoring.

Sometimes the subcontractors' person who presents the status or the programme to you sometimes may not know exactly what is happening onsite – sometimes because of miscommunications somewhere. So you cannot accept the status or the programme on the face value. Therefore the main contractor must have good supervisors. People ready to go all over the site everyday and know what is exactly happening, each stage of the work the individual subcontractor has completed. … How to achieve good co-ordination is, it does not just depend on meetings, it depends on actual inspection. That is one way to ensure good co-ordination, good result.

As a Project Manager you have to strike a balance. You cannot leave everything to your subordinate to do the co-ordination. At the same time, it is not possible for you to do everything yourself. So, there must always be this balance. … It is important to identify which are the critical activities for co-ordination. Then you pay more attention to them as the Project Manager. Because, you know that this activity is going to have greater impact than the other activities. So, again strike a balance. Specially those activities that are likely to cause delay. Sometimes when it comes to the actual project, it is quite difficult – it is easier said than done, when you are in an actual project you will realise. In principle, these should be the field guidelines.

Qt 12

[7.5.2]

In our co-ordination basically, the party involved need to be there and our people who know exactly what is going on out there need to be there. So, this is matching information, matching feedback, agreeing on what needs to be done next. This is what co-ordination is all about.

Memos and letters to all these people, some times they do not read them therefore a meeting where we record is the most effective thing; face-to-face, tell them. You must also get the right person to be there. That is another key consideration – you get the subcontractor's fellow from the office and he does not know what is going on and you tell him – he will say "Yes Sir, Yes Sir" and he does not know what is going on and he does not have the resources; he does not have the people or the material. You must make sure that guy is aware or if not he is actually personally involved in the work to be at the co-ordination meetings. Otherwise it is not effective.

Qt 13 [7.5.2]	Surely nothing works according to the schedule 100%; nobody can achieve that, not in a construction project. If we have a five activities project, may be we can. For a construction project that involves hundreds of activities and hundreds of trades, may be it is almost impossible to say that everything will work to schedule. So, short-term arrangements, short-term adjustments must be done. Therefore, all your data collected, you must translate it and update it to your schedule so that you know where there is a problem, what needs to be done, what needs co-ordination, what needs instruction, so on. Rate of progress is never constant. … If a project follows exactly what we planned and go on of course anybody would be able to do it quite nicely. … Somebody has to be consistently looking at it and experienced enough to say "Hey! A potential trouble is coming up there!" These are the very real, but very limited co-ordination to be done during construction period. You cannot anticipate these from the beginning because some of the ductings and some of the runs are not decided yet. Only as you develop you receive all the information. So, again it is what we call planning or co-ordination techniques; you have a long-term, you have a midterm and then you must have a day-to-day plan, so that you know, somebody may for some reason or another, you know – because of their own logistic backup, they have a problem and we may have to alter our plans. Say, they could not finish this area we ask the succeeding activities to go towards another area before coming back to this area. So, this kind of co-ordination is day-to-day and is very useful and effective. If you do not take a daily meeting, you should take a daily review of what have you progressed, what went wrong and why this is not done. That is what you call ensuring the timeliness of all works. They cannot finish because some reason or another or they cannot proceed because another trade is not finished or may be some other fellows have placed their material blocking – or what ever the reason we need to find out.
Qt 14 [7.5.2]	When you are doing a work according to the programme, if there is a problem, you have to shift certain things here and there. … It cannot be all the time smooth running because if you can control your job fine, no problem. That is if it is 100% by your own effort it is OK. But most of the time 50% is by your effort and 50% is by other contractors; main contractor is controlling you, consultant is controlling you, client is controlling you and other contractors are controlling you. So, the need for flexibility comes and project managers should be able to think laterally, sideways to see what else can we do to get around it, shift, move, to the other place and come back later.
Qt 15 [7.5.2]	Apart from something that pose a major, critical problem will get covered in our weekly co-ordination meetings. … If something needs to be done and it can be delayed, bring it in the minutes of the weekly meeting and it saves some hassle. Because as long as there is some action down the side and somebody is allocated to actually to follow-up the problem, that is the best way to do it too. Because everybody else watches to see if that person has any question.

Qt 16 [7.5.2]	ISO 9000 has specified a lot on the building and architecture. Because we have a M&E specialist subcontractor, a domestic subcontractor, that procedure is worked out by him. Then we will review it, hopefully he can co-ordinate it with our architectural and structural procedure. So, we have a lot of work methods adopted in our operation. Because in the project quality plan we have individual site staff and their responsibility – to be in charge of what – so all have to be spelt out carefully. We also have an M&E co-ordinator. Then this co-ordinator will have to look after the M&E domestic subcontractor. So, obviously to me, everybody knows how to do the work. Certain work they have to complete. But we have to co-ordinate it so that they will not clash or affect any other people's work. In other words, we must work in such a manner and sequence that is not affecting anybody's work. I think that is very important. So, specially to this project we will have a document, we will establish certain work methods onsite to specify the sequence of work so that this party will know exactly who will come in first to complete a certain task first before the next party can come in. So, we have a written one. What is not written in our procedure, we establish one. The main thing is to ensure the aim; everybody must do their works in such a manner and such a sequence that will not affect the others and also to achieve certain standard and requirement.
Qt 17 [7.5.2]	So far, not specified. It depends on the individual case, case to case basis I would say. It may not be a standard thing. Sometimes, I would say that a certain party will have to suffer. For example, because one party may be at fault you see, may be their material did not arrive on time and now their workers cannot work. May be a small difficult point to carry out the work. So, they could not. The construction manager or project manager has to deal on a case-by-case basis and make a decision. Sometimes he may have to take certain sort of risk. For example, services, there is a pipe that needs to be tested before they put up the ceiling. But then this sanitary contractor may not have the time to test it. So, sometimes the construction manager may ask the sanitary contractor whether he is confident in his work and if he is, then it has to be tested later. So now we are trying to get the ceiling contractor to finish the job. Of course we will have to have the understanding that eventually any leaking occur during testing and affect the ceiling, then the sanitary contractor will bear the cost of repairing the ceiling. I would say that we do not have a very written procedure, but then we look at it on a case-by-case basis. But come to this type of situation, contract manager and project manager have to look at the whole situation, make a decision. Also, when they make a decision, it will be based on the priority – why we need to cover the ceiling now. May be because the client wants us to handover the units or we want to handover the units to the sales unit so that they can open up for sales. So, a certain way to look at the situation. May be the project manager will have to consult the head office before making some decisions. So, I would say it is on case-by-case basis.
Qt 18 [7.5.2]	Basically Quality Policy and Quality Plans spell our roles, that is what we are supposed to do. We are supposed to co-ordinate between the consultants and subcontractors. But communication, co-ordination, when to follow what – no! Because then you will be too restricted. Everybody, every consultant, every client you deal with is different. They work differently. It is a different culture in every company. So, that would be restricting ourselves. We have a guideline. In our roles, we have a guideline on what to do. … In construction, it is more public relations to everybody. Everybody is different and everybody works different. For me the second thing is construction is a moving thing. Everyday it is changing, environment is changing. So as you say, the informal system plays a big part. This informal system is very simple, it is from experience. It is not written down. Culture cannot be written.

Qt 19 [7.5.2]	Our ISO 9000 too – the quality assurance manual does not have a working plan to identify what we can do to improve co-ordination. We feel that co-ordination is something that is intangible and not easily written down – you must say that, you must do this, you must do that. But it would be something that is difficult to implement because it is about human beings who run the site. … Because we believe in flexibility. So, we give them the flexibility of doing the right co-ordination.
Qt 20 [7.5.2]	With ISO 9000 coming in most of our meetings would have records one way or another. All the three meetings that I talked about, they are all considered formal. … Yes, we do keep records of the toolbox meeting. It may be a white board where we write, but what we do is – the white board can be printed as a record. In fact most of this I would say, can be considered as formal. If you talk about informal is particularly just bringing in a particular subcontractor up to you and telling him "look this is not working very well" – very confined situations, just involving one particular trade or subcontractor – we call him in, we talk to him, may be we discuss with him and we try to help on how he can organise his work, only those may be so called informal. Or I just pull-up the subcontractor's representative or supervisor onsite and tell him "look you have not got enough people" or "I think your workmanship is quite poor" or "why you are ordering too much supply or too little supply?". Now those could be considered informal. Now if that informal discussion or informal co-ordination did not work, we would surely bring that to the next toolbox meeting. So really, if you are talking about informally doing co-ordination, I think everybody out there is doing informal co-ordination. But that is of no significance because I think any significance ever have to come formally. Because the situation that arise now is, you tell him "I want you to do this, this, this, this tomorrow". Tomorrow you meet him again and he tells "no, no, yesterday you did not tell me to do this" or "you told me to do other things". You cannot get away from getting a little more formal in terms of records. If you do not keep records, you find that people argue or they may play the kind of situation where today he brings in A, tomorrow A will not come and he calls B to stand in. B says I do not know – I do not know what A did! Now we say there is no such thing as "I do not know" because we told you what to do. We do not care who comes to the meeting as long as you represent that party you are answerable to this. Therefore, co-ordination, if you take it seriously, there is no such thing as informal co-ordination. You have to do it very seriously.
Qt 21 [7.5.2]	In Singapore, there will be minutes to all co-ordination meetings. Whatever discussed is minuted and to that sense it is not informal. Some record for future reference and action.
Qt 22 [7.5.2]	*Q: Is it only the Project Manager who will practically talk to the client or the consultant? [Question asked by the interviewer (the Author)].* A: No! That is why it is important that you must have at least a monthly meeting. All these things "You told me to do this" – "No! No!! No!!! I did not say that" or "he told me he was going to do like this but he did not". We do not want that kind of thing happening. So everything when they discuss – you term here as informal – until recorded this may not/cannot hold water. … Officially, you cannot have multi-channels. These must be informal channels – you must make sure that all these things are rounded back into an official channel. Otherwise there is going to be hell.

Qt 23 [7.5.2] [7.8.4]	I think as long as whatever they discussed is captured, it is OK. Sometimes it is easier for the site engineer to deal directly with the consultant, if that process is made known to the Project Manager or the Construction Manager. Sometimes if you try to go through the Project Manager or the Construction Manager to contact the consultant, the work will get delayed. So, they make a sort of instant solution or the answer. Therefore, sometimes it is better to let the site engineer handling that work to directly deal with the consultant as long as all these discussions have been recorded – then everybody will eventually get to know of it.
Qt 24 [7.5.2] [7.8.4]	Firstly, you see, we always feel that verbal communication is the most effective; in the sense of time it is the fastest. But then, what we do normally is, we also give them a chance, we tell them to finish a certain work and within that time if we sense that it is not moving or it is not as we expected, normally we would register that in proper channel. … As far as the whole site is concerned, communication in writing I think is the most important although we do carryout a round of verbal instructions first.
Qt 25 [7.5.2]	Daily co-ordination is quite simple. It is knowing what is next to be done and knowing the effect or consequence of something not done. If you know that your electrical supplier cannot turn up on time you will know that the testing and everything will have to be delayed. So, once you can identify all these and then you can know that electricity cannot be turned on, on time. You will have to look at the consequential delays and how you will minimise them. So, you may now have to arrange testing to double up – get one team to come and test in one week. In that way you cut down your delays. That is why I say you have no special analysis. Lets say you use a very sophisticated scheduling software, again I must clarify that these are all human inputs. All the constraints to programme that software – you have to put in your constraints. Over reliance on these what you call artificial intelligence and they pointing it out to you may be a problem because it is the constraint that you first put in. If you have put in the wrong constraints or the wrong considerations, the whole thing would not workout. If you do not link those activities to the other activities, when one delays, the other does not show a delay. You know, if we just look at it, without looking closer, you do not get the correct output because you did not link it in the first place. So, if you ask me about special analysis – it will be our experience. Experience is one thing that functions particularly well – background knowledge is one thing and experience is another. So, you cannot put somebody who specialise in training of project management, put him on the job alone and ask him to do. Theoretically you can, but he cannot feel, he cannot see the potential problems.
Qt 26 [7.5.2]	I think it is a constant dialogue. I think it is quite important because if any problem, you do not bring it out nobody will be able to discuss it and solve the problem. You keep silent and by the time the problem surfaces it will be too late. In other words, you must bring out the problem early with the experience of the past projects. I would say that they should be able to identify all the potential problems they will encounter and try to solve it earlier. … Because some sites are quite large, quite big and they may not be able to cover 100%. But we try to solve as much as we can in other words, we anticipate such problem would come and then we will be able to tackle it. … Eventually, when it comes to a problem, definitely a certain party will suffer. But construction manager will have to make a decision there for every party and also to reduce the suffering of a certain party. That is why unfortunately when we encounter problems too late, nobody can get out of it.

Qt 27 [7.5.2]	I interpret it as situational management, anything has to be managed as for that situation. So, in my personal experience co-ordination is a very very important thing in management. … My boss asked me recently "Don't you read the programme?" and I said "No! I don't read the programme". So, he asked me why do you say that you do not read the programme? "Because I have no time". "Then how do you know are you on the programme?" I said "I know, I know the programme. If I don't know the programme, I should not be sitting here". A project manager should know the programme – not to the very bolt and nut but, at least, in these areas this should be done. Because as you absorb the job, within one or two years, you will find one day that you can sit in a corner and think about – you know what has to be done where. You may have missed certain things – finer points. That is why you have your other engineers for. In the site, the supervisor will know what is to be done in that area. But generally overall programme you should know. So, every time I go and talk to my boys, they understand what I talk about.
Qt 28 [7.6.1]	When I go back and deal with a project, I pick up the set of drawings, all sets of drawings, I prepare a programme and I go into great detail because without going into great detail, you cannot identify the critical path; you cannot identify where the problems are going to lie. If you cannot study the sections of a concrete pour, you cannot see that you've got a 2 m beam with lots of holes and lots of tie beams coming into it. You've got lots of re-bar you've got to be able to study that and see how long it is going to take; how many pours it is going to desire in this critical area. How many lifts of formwork do I have to do in this particular critical area? Then you can start putting a programme of those against it. Then you've got to study what impact these other services have in this critical area. This is just in one area and then you look at all these other areas and then you start putting a programme, sub-programme and then you can start working out the critical path.
Qt 29 [7.6.1]	Identifying a critical path programme – basically in preparing critical path programme you have to identify the most difficult areas to work in. Ones that have the least access, inaccessible areas, ones that have the most complicated construction or mechanical plant and equipment to install. Ones that are long leading procurement items for instance structural steel, you need to know which kind of building structural steel, and you need to know in advance. … So, clearly – also items of plant, you have got heavily serviced buildings lots of lifts – and lots of co-ordinations – escalators; these things need to be procured well in advance. So, you are looking essentially two-pronged thing in parallel, one thing is the complexity of the structure itself and the site upon which it is located and that has to be worked through as a method statement starting from conception – I mean starting from erection of hoardings, cleaning the sites, then pre-setting out, excavation, piling, site formation – you have to work through that critical path programme all the way up to finishes, finishing the building, handover, leading tenants in, right the way through to practical completion and DLP and what is going to happen through all that process. Already in that construction period start identifying the critical areas for the construction work – Bored piling – Is it far from the wall? Is it a wide area? Is it a soggy site? … Is it going to be difficult to actually pile? – Is it going to be difficult to put foundations in? – etc., et cetera.
Qt 30 [7.6.1]	Then obviously the potential for delay – are you involved in any improvement consent process by the BD [Buildings Department] – are you relying on subcontractors outside the country – suppliers – international suppliers – are you relying on international designers there are moments when designers meet in New York and you have got nobody in New York and you have another one in France and all these four people have to come together. All these are potential areas to delay and potential risk.

Qt 31 [7.6.1]	To achieve the correct sequence of work and to avoid abortive work or clashes of work, first of all what we do is in our design we will include whatever we can foresee that there will be a problem during the construction. That means we look at the plans, if something – services clash with each other for example – we would try to avoid it first. That is our first input in the planning. The second input would come from workshop drawings. Now the subcontractors will come up with workshop drawings. Then there would be co-ordinated drawings. Of course workshop drawings are only for services. Plus works statements have to come out with how to avoid any possible delay. That is the way of doing it. Prior to the work commencement, we will have a meeting to ensure that all things are in order before they start work, so that there is no delay. I mean normally if you do not do all these planning, when the workers come, for example he says, "there supposed to be a wall there, no wall there now".
Qt 32 [7.6.1]	Obviously we have regular meetings. We have sit down meetings; we go through the process with each individual subcontractor so that the – windows subcontractor or the louvers subcontractor – we sit down, we look at the shop drawings, how long is this going to take to manufacture the shop drawings; how long to get the approval; how long to resubmit, submit, resubmit, finally get the approval. Then look at the procurement process that lies underneath that; are you able to procure the Aluminium for the louvers ahead of time? Are you able to start the diecasting for the louvers yet; how long does that take? Does it need approval? How long does it take to procure the material? How long does it take to manufacture in the shop and then deliver? Then to deliver the material – how does it come packaged? How long does it going to take to install? How many pieces? What is the cutting list? What is the shop drawing list? What is the delivery? Is it shipped? Is it airfreighted? etc., et cetera.
Qt 33 [7.6.2]	A Project Co-ordinator splits the roles – basically by identifying who is doing what, what is this scope of work, what is the specification, are these specifications being met on the drawings, drawing co-ordination, make it sure that all things fit together – different sets of shop drawing – different contractors. That is what it formally goes, it informally ends up? … Sorting this out sorting that out with particular subcontractors, design consultants, trying to get it done, trying to expedite it without necessarily going into lots of paper work. I mean there are lots of things we can formally and informally do – ends up doing informally.
Qt 34 [7.6.2]	Co-ordination sometimes goes beyond the site. Our so-called drawing co-ordinators or design co-ordinators work on the project to put up these co-ordination drawings, which is actually putting all the services together. To see whether they clash somewhere where they are all in the same duct or whether they cross in the same place where it is impossible to be accommodated in the limited ceiling space. Somebody has to be consistently looking at it and experienced enough to say "Hey! A potential trouble is coming up there!" These are the very real, but very limited co-ordination to be done during construction period. You cannot anticipate these from the beginning because some of the ductings and some of the runs are not decided yet. Only as you develop you receive all the information. There must be a design co-ordinator or you call it detailer to put up all these services together, superimpose them and see whether do they clash, do they cross at a certain point where they all try to think they can go through a same opening or duct. So, this is one of the very important co-ordination activities – is to check the design.
Qt 35 [7.6.2]	Design co-ordinator or drawing co-ordinator got to be on his toes and got to look up all these things. Somebody happily draws his pipe running through the corridor and somebody else puts his Air-con duct right perpendicular across, you know you cannot accommodate. But you must be able to visualise the moment you see a drawing with a ducting cutting across that it cannot be done.

Qt 36 [7.6.2]	Detailing is not actually designing – I want to stress that. … He [Designer] looks at this and says I want such an idea to be achieved, I want such scheme to be achieved or I want such kind of installation to be achieved. He is not the person who actually looks at every detail of it. A very clear example is interior works. The interior designer comes with a perspective view and say this will look good, I want a door here, a window here, I want a light behind like that, I want the ceiling to be recessed in the middle, but he does not know and he does not care whether up there, there is a duct running right in the middle and he cannot recess the ceiling. He may have just checked the structural drawing and said there is no beam there and I can do it. He may not realise that there is a trunking that goes right across, a pipe running right across and he cannot do it. So, when he does such a thing, the contractor will have to look at it and say lets check whether there are other installations there, other services there in that space and whether the detailing can be achieved. This is what I mean by detailing. So the interior designer says I want this to look to be achieved this is how the effect should be, but he would not know whether it can be achieved. He will detail how the ceiling can be recessed and he will detail how the ceiling should be hung but he cannot know what is behind it, because it is not his scope. The guy who draws a trunking or a pipe right across submits without knowing the interior designer's intentions. These are the grey areas and these are the left out areas that the main contractor got to take care and this will make a successful project.
Qt 37 [7.6.2]	The corridor is full of piping, full of trunking, full of ducting until it is so congested that it cannot be done. That is also where the main contractor has to look whether it can be done. Inside the main contractor's set up again, the Project Manager has got his structural people, architectural people, M&E people. They have to do their part to make sure that things can work. M&E itself is just as complicating because you have many systems, water, electricity, sanitary, then you have fire fighting, of course you have lifts, escalators and now a days you talk about intelligent building installations. Now, all these things you need to have their respective people, then to scrutinise, to co-ordinate and when I say co-ordinate it means can they work together. The main thing in co-ordination is whether they can work together. If they can work together, it means you will be able to achieve the progress you set up. If they cannot work together, it simply means that somebody will be sitting down and doing nothing or somebody has to change the way they work or change what they are going to produce. Therefore, co-ordination among each discipline and/or among other trades needs to be done. And this has to be done at the higher level, which ultimately from co-ordinating all your trade subcontractors back to co-ordinating with other trades and from other trades it will go up to PM [Project Manager] who will look at the overall picture and say this is not working and that one is astray and this is a kind of a co-ordination techniques and co-ordination peak forces you got to watch.

Qt 38 [7.6.2]	For example a civil contractor can employ a mechanical engineer to co-ordinate the interfaces between civil and mechanical works. … He should know everything about all the equipment and pipe work going into the building. So, before any concrete pour, in advance he can talk to the mechanical and electrical contractors and say OK put your things in. Your penetrations and all that in place and keep the drawings up-to-date and all that. What they do here is that they [civil contractor] give them [M&E contractors] an inspection sheet to sign and then only they [civil contractor] can pour concrete. I found one day, in the first ever concrete poured in this site, one of the plinths were missed out. The starter bars were to come from the slab and they were missed out. They have poured the concrete. I went and asked how can they pour the concrete. "No, your drawings [our plinth drawings indicating the locations] were delayed and I have to pour concrete". But it is a wrong concept! Then I argued with them that this is a building where equipment are going to sit and not a basketball court or a gymnasium. You should be aware as a mechanical engineer and the co-ordinator of this job that this plinth has to be there and chase us and get the drawing in. Even if we do not have a complete drawing, we can do a partial drawing or a sketch or whatever with the co-ordinates, and the sizes and the case is done. That is what you call co-ordination. You drive it. You should call the shots. When you say co-ordination, you become the centre point.
Qt 39 [7.6.3]	Specialist subcontractor is basically the bigger problem in terms of co-ordination. Being a specialist, see cladding for example, the guy will come and say "Look, I cannot do this because my system only caters for that". He will tell you "Look, in the beginning I said that my proposal is based only on this, now you want to change, I cannot change!" If a project follows exactly what we planned and go on of course anybody would be able to do it quite nicely. But it is such kind of thing where sometimes a slight change made changes the whole thing and specialist contractors are the ones who can give you most problems. One very obvious is the lift. Lift takes a long manufacturing period. Cladding is another one. If you now make a late change, the fellows will not only charge you but will tell you now my delivery will have to be shifted back and that you cannot afford in the contract. Therefore you have to be very careful when you want to make a change, particularly if it involves or affects your specialist subcontractors. The first thing is you must check with the specialist subcontractors. "My material comes from Italy, they are having summer holiday now and I cannot even rush it for you". In Italy, the summer holiday is summer holiday you cannot get anything done – it is the way of life there.
Qt 40 [7.6.3]	[If] I am the subcontractor for window; I am only designing the window. I do not care how the wall is. Somebody else has now put up the cladding and he is not going to look at what the window details are. Only when you put these two things together you find that my window cannot hang on the cladding and the cladding cannot accommodate the windows fixing method – then it is too late. I need to put a sub frame to fix my window and now this is not done and this has to be ordered, manufactured all over again. So, these are what we call inputs that Project Manager must learn to look at. All these come from experience.

Qt 41 [7.6.4]	Objective [of co-ordination] I think is to minimise any delay of works. That means to be accounted for, pre-plan, be proactive and to identify the problem without waiting for the problem to surface and try to solve it. From our experience in similar kind of projects in the past, problems they encounter, I would say somethings, can be recurring. That is why similar problems will still occur project after project. Like water seepage, hollow tiles, these are problems that occur project after project. So the only way to minimise it is to detect the problems early and to ensure that works progress smoothly. … Sometimes it can be due to material, it can be due to design and it also can be due to workmanship. So, we have to identify, discover the problem and bring it up early so that everybody is aware. So, from past job experience it may be due to design, so they will look at the design whether the design have any problem for this project on the particular matter. If it is due to the workmanship, they will remind the subcontractor and say that most of the time it is due to the workmanship. So, you have to review your procedure for works and also we want to know whether your workmen are skilled or whether they are trained. So all these things, that is why we can identify early. That is hopefully when the jobs progress, everybody is aware of the problem and hopefully they can reduce the problem as much as possible. These are the common problems. Sometimes it could be due to material. Sometimes the client buys the material, can be tiles water absorption or can be the dimension control from the source. May be in the tile testing certificate everything may be OK; dimension control within tolerance. Come delivery, we have a material delivery procedure. When we receive the material or goods, we have to check. Sometimes we will identify, say, in one load it is not OK!
Qt 42 [7.6.4]	The guy comes today and he has happily finished his floor and tomorrow you check to see all your markings are wrong or all your dimensions are wrong or all your setting out is wrong. The day's work is totally wasted. Which means he got to come and do it one more day. This is what we mean by co-ordination must work with very close supervision. … These are the things usually the people onsite neglect. Because the guy onsite has got his primary concern of getting work done on time, after that, quality. He does not know this is a wrong specification he is following or this detail is wrong. He will just do it and get it done. So, a co-ordinator in this case from the main contractor's set-up is very important. This is essential to make sure that everything is OK. Our engineer actually does the marking; does the setting out for most of the trades. Our supervisors check even the M&E ducting lines to make sure that they are in the right place.
Qt 43 [7.6.4]	Then when it comes to [co-ordination] within M&E and process then the person who co-ordinates should understand the whole process. When people go in to do installation, when the equipment are going in, they should be talking to other people – this guy is putting his pumps in so when are you going to bring in your switchboards and when are you going to cable it? So, keep asking questions, he must understand the whole process and work backwards from the commissioning date.

Qt 44 [7.6.5]	Do not think of co-ordination as just making sure that the work they do is correct and they can work together. It is also the facilities available. For example, in a high-rise situation in fact there were more than one incident whereby they were so engrossed in getting work done, the structure to go up, they forgot or they delayed the installation of the passenger hoist. The passenger hoist was to facilitate the workers to go up. Then when they got very far up, they realised that the architectural works is not following up and they finally realised it is because the workers refused to move up and down manually climbing the stairs. You can imagine after 10 floors or 8 floors, nobody wants to get up and get down. So, if he comes up and he got no material he does not care, he will not come down and collect some more. So, progress keeps falling behind. Then they realised "Oh yeah! We were supposed to have the passenger hoist after the 8th storey". Then they realised it is not done and by the time they had the passenger hoist going, it was more than the 15th floor. So they were delayed; they were really delayed. This kind of thing is again planning in the first place. These are again temporary facilities which need to be planned.
Qt 45 [7.6.5]	Now we have two tower cranes and we are very happy again that these two tower cranes will be able to cater for all our lifting needs. But they forget, after a certain period you will take down one of the tower cranes because we also cannot allow equipment hogging, this is not an efficient way of working. If you need only one tower crane after you finish your main structural works, you cannot keep two tower cranes because that tower crane will be required for other use in another project. So, all the time in the beginning, somebody [a subcontractor] happily planning, "I have two tower cranes and I can do all the lifting". Come to this phase now he is left with one tower crane and all his material hoisting will suffer. So, temporary facilities onsite need to be planned too; need to be co-ordinated too. Like scaffolding, loading on scaffolding, high ceiling space, external scaffolding – you need to plan and design from day one or as soon as possible and review its effects. Otherwise that part of the co-ordination will also be very critical; from totally non-critical it will become critical. Because of miscalculations or some last minute changes you find that you have affected many trades and your progress will suffer.
Qt 46 [7.6.5]	In-house resources – it is what I would call onsite facilities. This is very critical. Because many subcontractors assume that "When I bring my material to site, the facilities, say the lift is there for me to use". It may not be! You see – this kind of thing, such requirements, therefore needs to be established from day one when you appoint such subcontractor. He would say I need this, this and this and you need to look at it and see whether we can provide. And if you cannot, you got to tell the fellow we cannot and to bring in even a hoist and take it up yourself or you are going to arrange your own labour to take it up yourself. All these things need to be done from the very beginning. Many [main contractors] do not care. The guy [subcontractor] writes in his conditions "lifting facilities will be provided" and the [main] contractor does not look at it until the end and ten fellows waiting for hoist to lift the material up and you find out that even if you work round the clock you cannot manage all these people. Therefore, it is a potential delay again. So, establishing all these temporary equipment and temporary resources required to facilitate the work is also a very important aspect of co-ordination.
Qt 47 [7.6.5]	Another simple thing is external scaffolding. Some authorities in Singapore who come for the DLP inspection – They will not come and inspect if the scaffolding is still on. They will consider this as not finished. They are supposed to come when you are substantially finished. If there is scaffolding all over the exterior of the building they will not inspect; they will say you are not really finished. So, these are the things you need to be very careful. So, this goes back to local knowledge; local requirements, local authorities, bylaws. Co-ordination also must include this kind of knowledge.

Qt 48 [7.7.1]	The timeliness of work carried out – We have to ensure that all the work is carried out on schedule. We have to review it even if daily, weekly, depending on the activities, how critical they are. Normally we start to review weekly, but if we are a little behind, we will review it daily. Then we have to come up with ways of achieving the schedule. At the same time we have to plan according to anything that is delaying us and we must overcome by increasing resources or by a different method of construction or something. We have to solve all problems that arise and then that would be step by step we finish up the job.
Qt 49 [7.7.1]	Talking about generation of outputs, compared to inputs, for example tiler, what a tiler can do, how many square meters per day? If asked to finish certain tiling work say within a month for the whole work, resources – how many labourers he is going to mobilise? What kind of material ought to be onsite? What kind of preparation work? So, all these entirely depend on the experience. It is purely the experience that tell because ultimately the productivity of a particular trade is not that clearly established in the local context. There is nobody who can tell productivity of this particular trade is exactly this much. This is something through experience that we have learnt. We also have to be flexible in the sense that we have an opportunity or see a delay. – We have to exert more effort or bring in more manpower to finish the extra work. Before that material delivery will be something pre-planned to ensure what has been planned by the project manager for that particular work will not be hindered because of material. These material will come in exactly just in time before the material be utilised. It also affects the cashflow, of course the most important of it. Secondly transportation and storage, on our sites it is very congested. Every time you do a double handling or a triple handling you are creating more damage to the material. So, these are what we are looking at. But how the planning is done basically depends on experience and you get the programmes and we will establish with subcontractors and suppliers whether these things can be met, if not what are the alternatives. So, we are always working on the contingencies and things like we know this is going to be delayed through our experience.
Qt 50 [7.7.1]	We have meetings with our engineers, all our in-house engineers. There you get feedbacks – "this is going to be delayed", "there is a problem here", "structure is not ready" or "structure is going to be ready and I need the switchboards and pipes" and so on and I record it. It is more discussion and less recording but still a record is there. Then I fax this minutes of meetings to the planner and the section heads. The planner will be going through it and talking to me most of the time and will ask questions from me; will call back and tell me "Hey! This is going to affect the plan a bit". Most of the time it is verbal communication than on paper. We communicate with each other and say how do you think if this is delayed, or earlier and so on and how it is going to affect the overall flow of work. We again become flexible to see how we can change various things to best achieve the target date.

Qt 51 [7.7.1] [7.7.2]	There are certain things that can be spoken in the mind, certain things by verbal conversations and there are certain things that have to be analysed on a piece of paper. I did a chart the other day to do a crash programme to a contractor. I said before the Chinese New Year you have to do these things. What we did is a bar chart – I did it on the computer. Once you put the bars together you see how things fall into place. You do not need a planner [software] you just do it on excel or you can do it by hand even, you just need a bar. Then you can see how many people you need for this job – so many parallel activities, 2 men there, 2 men there, 3 men here and suddenly the contractor realises you need 16 men onsite but you have got only 4. So, this type of analysis on paper is much better. The moment you see that there are not many people working onsite, you must go and find out how much of work all these guys have to do all over the site. There is not only one place, they have to work at six different places, but they have got only 4 guys. So, suddenly you realise there is something wrong here. You go and have all the activities listed up, see when and when they have to finish and you will see the bars overlapping. You need 2 men there, 2 men there, 3 men here, 2 men here and it all adds up to 16! I just took a print and gave it to him. Now do you understand my question? You need 16 men but you have only 4 men here. He looked at it and said I am very sorry, I will bring more men now".
Qt 52 [7.7.1]	So, these are all data inputs you are asking about – manpower – how many people are working at the site, you should monitor. Project management means continuously monitoring, you cannot layback. So people should feedback and say how many people are working. On paper, there is a procedure here that every week subcontractors keep submitting how many workers are there. [It is] OK if you have a large organisation here, a lot of staff to check labour charge and all that, so that people can compare how many people are here onsite compare with the work progress. But here, unfortunately or fortunately, wrongly or rightly, we work here with a minimum staff. That is the way the company has put the staff here, very basic staff. So all what we do is – we do hands-on, everyone is hands-on, so they go and have a look and they know what is happening at the site and they go and push the work. They do not work much on paper, but it works. That is the only way!
Qt 53 [7.7.1]	That is why I say you have no special analysis. Lets say you use a very sophisticated scheduling software, again I must clarify that these are all human inputs. All the constraints to programme that software – you have to put in your constraints. Over reliance on these what you call artificial intelligence and they pointing it out to you may be a problem because it is the constraint that you first put in. If you have put in the wrong constraints or the wrong considerations, the whole thing would not workout. If you do not link those activities to the other activities, when one delays, the other does not show a delay. You know, if we just look at it, without looking closer, you do not get the correct output because you did not link it [activities] in the first place. So, if you ask me about special analysis – it will be our experience. Experience is one thing that functions particularly well.
Qt 54 [7.7.1]	In this project [having two sections done by two different M&E contractors] there were two schools of approach. One [M&E] contractor said "the structure was delayed and I am going to get delayed". So, they went strictly contractual – you can find thousand odd reasons to prove the delay. But still they have caught up with it now because of pressure. We were looking at "even when the structures are delayed, how to get it done". Your focus must be on the purpose – the question in your mind must be how it could be done and NOT how not to get it done. Then you go into a different channel. If you want to see how to get it done, then you will have thousand odd ways. All these inputs, you are creating it for yourself by looking at various things.

Qt 55 [7.7.1]	This contract is divided into 4 parts, the silos and civil works S$ 183 million, ours is solid stream S$ 53 million, liquid stream is S$ 70 million and electrical instrumentation is another S$ 65 million. So, it is a big job – there are so many contractors and subcontractors – here all four are main contractors. So, who is [really] the main contractor? – The consultant! The consultant sits there to co-ordinate. So, what is happening is that, this guy who is doing the co-ordination between the contractors – you cannot blame him, he does not have the knowledge of the process – he sits and listens to contractors. So a contractor says, "I want to install my pump but the structure is not ready". So he records that. "I want to install my pipe on the wall but the wall is not ready". So he records that. So the minutes are about that thick [shows with his fingers] with wall not ready, scaffolds stopping you, some doing other things and all that. So our side, solid stream, there are only one or two comments. Half the time I am just sitting there just to fulfil the formality, because we handle these things onsite. These are simple things you know, rightly or wrongly here people have drawn lines between themselves. Here the contractors do not talk to each other much. I have told my guys, you must talk to them! You must talk to them!! Some people are not very comfortable with that but you have no choice – you have to talk to them. Some people are not very comfortable with that but you have no choice – you have to talk to them. So you can get things done faster.
Qt 56 [7.7.1]	Scaffolding is one thing always double worked. One contractor puts the scaffolding down and then the other person puts it back. Lots of time can be cut on the scaffolding. Scaffolding is a very big subject in terms of safety – once you put it up safety procedures have to go on to approve the scaffolding and all that. … Say the civil contractor puts up scaffolding. If you talk to them, you can use the same scaffolding. That fellow rips the whole scaffolding down for S$ 30,000/- and then you erect your own scaffolding and it always takes time. Scaffolding also costs a lot. So we talked to the civil contractor and the moment they finished their work, our guys are standing on their scaffold and finishing our work. So, there are lots of shortcuts you can take.
Qt 57 [7.7.1]	I solve most of the things onsite like that with the fellows of the other contractors. Nothing is minuted and you do not have to minute these things. I still feel that the contract document is the contract document. You can have so many things written in the minutes. In the meeting the civil contractor's representative will talk about how this statement should be written – this way, that way and so on. It is all about taking minutes. The consultant also bears with him to correct all these notes. OK, submitting minutes is necessary to get jobs done. It is an utter waste of time. Instead the consultant could have put a person there who understands whole project and the whole process. He must call the shots and say this is the programme, this is how you are going to commission it, you will finish this, you will finish here. So he tells the people and follows the progress. That way it has been very disappointing. The person co-ordinating it should understand the whole entity of it. He should not be a postman. If he is a postman, he will be just collecting data from one party to the other – any clerk can do it, he does not have to be an engineer.
Qt 58 [7.7.2]	When we find that any of our subcontractors are lagging behind, we have to study into what is the problem holding them back. Who is causing the delay? It may not be them, it may be somebody before them, it could be the work that is very difficult and of course all these we will have to solve. We have to analyse even the sequence of work. Right now we are doing, let's say earth works. We are delayed, we are scheduled to finish in a month. After two weeks he has still done only 10% of the work. When we study, the work is the problem. For example, why is he not cutting the earth, why is he not levelling the earth, is it a rainy season, how we can overcome these. Rains do not mean work has to stop. If you plan it with proper access, proper drainage, then there should be no delay at all.

Qt 59 [7.7.2]	So, you always have this kind of [subcontractor related] problem. But ultimately you still want to achieve the programme that you have planned for. Of course there are many ways of catching up. Sometimes by identifying the critical area. Sometimes your subcontractor may put ducting in the wrong place where he has to actually wait for a while. Sometimes as the main contractor, you can help him to re-plan his resources. Sometimes he is short of cash. It all depends on the situation.
Qt 60 [7.7.2]	All subcontractors will like to hide their problems "no problem, do not worry we can finish!" But if I give you a seven days period to finish the job and after 4 days you have done only 20%, and you tell me "no, do not worry I'll finish on the 7th day", you must be able to tell "Is it possible?" If this 20% is critical for the rest of the 80%, fine, then if he achieved that you know he can finish. But if his achieving 20% is not critical for the rest of the 80%, then you must be able to say "no, no, no, this cannot work" and you must be early enough to stop him and say "on the second day I already see you cannot finish so I have to ask you how you are going to do it, whether you are going to put in more labour or you are going to put in more labour hours or both?" So, this is again where, I emphasise, experience is the most important consideration for successful co-ordination.
Qt 61 [7.7.2]	In construction peculiarity is that if you work to the last hour of the midnight get it done, it is still done. So, there is no way to say that look you have to finish 50% by 50% mark in the time line and 100% by 100% mark. Although they have finished 20% by 50% mark in the time line, it does not mean that they cannot complete. When it comes to the last 30% – or we are talking about 50% onwards – we will have to really look into that. It is a precautionary matter. Although they can finish it based on the confidence they have and the people they have employed.
Qt 62 [7.7.2]	Rate of progress is never constant. … In the construction industry, there is no such thing called fixed rate [of progress]. Today I have 5 men working 8 hours. Tomorrow my same 5 men can work 10 hours or if not 12 hours or if not 16 hours. And if I cannot still make it, I can now actually put in 16 men and work 16 hours. So, this is the uniqueness of the construction schedule. … This is what is unique, this is what makes co-ordination so critical – we be able to recognise, we be able to see, we be able to device solutions, countermeasures, to make sure that you can catch-up. So, really co-ordination is the tool, but to find out and give instructions – on what is behind schedule, planning – the ability, experience to be able to see the consequential effects and how, what should be done to make sure that these corrective actions that you put in be able to bring you back on to schedule.
Qt 63 [7.7.2]	During the construction stage, identifying potential delays come from actual delays. Strategic activities have to be all predetermined. So, you know that these are critical activities. Whenever there is a delay, we need to look at these and say well, this would be affected. How can we make corrective actions to such critical activities that has to follow? Certain things cannot be done. So, you have to make corrections to other activities. Say Activity A delays Activity B, but you cannot shorten Activity B, because Activity B is already out of your control or at its best. Now you have to look at what follows Activity B – Activity C. So, the Activity C that follows may be able to be shortened and you plan for that to be shortened. So, the delay in A may not be overcome in the immediately following activity. But you must plan so that the 3rd or the 4th activity that follows can be made to adjust and catch back on time.

Qt 64 [7.7.2]	We would have worked out in the master programme and subsequently the detailed programmes. So, if anything drifts from what we had already planned, what our first reaction would be to do another catch-up programme. Do it to the sense of not to the last stage of work, but until the programme comes back to the original schedule. We do a catch-up programme to expedite the matter, to the particular trade, to the best we can. Subsequently if really the matter could not be completed, we would have to provide contingencies such as crashing more on the sequence and using the floats if there is any free time. Actually but certain things, events that are delayed, due to interference of the consultants or client we will immediately inform them that it will cause delay.
Qt 65 [7.7.2]	I have a typical example here on our job our subcontractors all have done well except one fellow who is doing the odour control ductwork. He never put people on time, he never bring the material onsite on time, so it was hard work to get them to work. Finally, what I did a couple of months ago, I walked into the site and they had not done work in some areas and I came back and told the contracts engineer. We wrote a letter to these guys saying that we would give you time until certain date and if you do not finish the job, we will get somebody else to do the job and deduct from your contract. So, we were doing a bit hard talking, it happens in contracts. We gave two warnings and in the meantime I have got the contracts engineer to get another contractor to come and quote for these areas so that we can also isolate somewhere so that particular area is done by someone else and connect to the system. You know what this guy did? He went and hung a few ducts here and there so that they [other contractors] do not enter. So, I have to again shift the strategy and turn the heat on him again and push him, push him, push him. … So, it was hard work with him. Again it was situational management. I had to put one supervisor who was good to oversee him.
Qt 66 [7.7.2]	Project managers and staff should be able to be flexible. Basics of project management are the same; engineering, ordering equipment, site establishment, subcontracting etc. is standard procedure. But, when you come to the site and when you see problems you must be able to shift a bit here and there, still stay on course. Critical path could be identified during the original planning. You can stick to that, but project managers should have the overall view of the contract to see in practical sense whether it is moving and then take early decisions. Because these are all man made equipment. Once you put into operation only you are going to see problem. So you need to have sufficient time to correct it. So, if you do it early, you have more time to play with it and solve the problems. That is what we did here. Once you come to installation and then you come close to the commissioning side, I think we have to work backwards. We have to work backwards from commissioning. Because our idea is to commission the plant. I personally feel that you must make sure that the basic system to commission the plant should be in place. That is the most efficient way of doing it. You can go and put some plant and some substations and some installations in some various things, which is not necessary to run the plant. You can waste time, you can go and say, "Well, I have done this, I have done that, I have installed some penstocks, I have installed some pumps, I have installed some sampling structures, whatever, whatever, whatever". But basically what the client wants is to run the system! So, once you come close to the installation, you must work backwards and see what is important now to connect it and (I am talking in terms of mechanical and electrical). … My instruction to our people is that commission the basic conveyors, the centrifuges and the basic pumps so that we can receive sludge and dewater it. So, when you start commissioning that way, you have more time to do the other things later. So, that is a very important point that they will miss and spend more time unnecessary things. Everything is necessary, but on the contrary first of all to get the substantial completion or practical completion, to prove to the client that our system is working, you must get the basic ones first.

Qt 67 [7.7.2]	Basically, they [subcontractors] take care of their own work and it is up to the main contractor to make sure that they are doing their parts so that they are not delaying somebody and they are not conflicting anybody else. It is also up to the main contractor to change or speedup some work or subsequent activities so that they can match the variations in progress of the earlier activities. This is how you can make day-to-day adjustments.
Qt 68 [7.7.2]	In many poorly managed contracts, they leave the co-ordination to the subcontractor. It is still happening. Subcontractor A got to chase Subcontractor B or got to go back to the main contractor and say "You got to chase Subcontractor B because they are delaying our work". That shows very obvious lack of co-ordination or poor co-ordination in that project. Otherwise the subcontractor will not come back to chase you saying "As the main contractor can you clear that part for me". He is actually saying, "You need to chase the other subcontractor to facilitate my progress". The more such will happen your co-ordination is worse. So, in the ideal situation, the main contractor's co-ordination will be just asking for feedback and saying "Can you do more? Can you do less?" and make sure that you push the other related activities to accommodate each other. You do not leave it to the subcontractors to co-ordinate among themselves "OK I will do this I will do that etc.".
Qt 69 [7.7.2]	The subcontractors who worked together before in one of our past projects, so they obviously understand one another pretty well, in terms of individual work procedure they understand one another, so they will be able to discuss among themselves sometimes. In one of my projects, the sanitary contractor had discussed over the coffee table with the steel-bending contractor on how to allow for the floor trap. This is because they have been involved in two or three projects before. To me, they are very close. No doubt they handle different trades. But they were able to discuss and have a dialogue among themselves. That means to say that they know that doing things together is beneficial to each other. So, hopefully in our subsequent projects there is a chance of having a group of subcontractors who have been working together before. So, I think as I say it is a constant sort of discussion and dialogue. Then they can build a better working relationship. Eventually I find it very beneficial to one another, why not rather than I do my work and you do your work and in the end one party got to suffer or sometimes both parties got to suffer. Because if you do not allow for the opening, I have to later hack it. Then you got to cast it back again. Sometimes it might be costly, so everybody will have to suffer. So, before they cast it hopefully they can co-ordinate at their level. Of course as a main contractor still you have to co-ordinate among them but they can co-ordinate at that level first and subsequently put it up to the higher level – so much easier. So, first the problems and issues solved may be 50%. If they straight go to the main contractor level still we have to discuss, still we have to argue it out. So it may take more time to resolve a problem. I would say it is so called sharing information – I tell you how I run my pipe and you tell me how you tie your pane. This kind of sharing information, after all there is nothing to hide. Why hide some information and suffer in the end. I do not see why we cannot share information.

Qt 70 [7.7.2]	First and most important thing in Project Management is first of all you must tell what is expected from everybody – your own staff and subcontractors. Your own staff also, you must tell what is expected of them. So, the rules are laid. Subcontracts also, you give good subcontract documents – this is what you would like them to do – rules are laid. Under the big framework of rules, you be flexible. You can be friendly, you can be nice, you can have a good relationship. You might yell at each other for something but generally you can keep a good relationship. Rules are laid first – that is very important. Under the rules, under that framework, be flexible. So, everyone knows what their responsibilities are – but I am helping you. Rules have to be laid, then you play a flexible game – give and take. Then most of the time you will win the game.
Qt 71 [7.7.2]	We have occasions where subcontractors come and tell this is not included in my price, that is not included in my price, how do you expect me to do this job. First of all we look at the contract and say "Well it is written here very clearly. If you have missed it then bad luck. We have missed out so many things to the Government in our contract. Same way you have missed it out. We cannot do much about it you have to go and do the job". But still we would see how it is. Maybe if he is still in a big problem, if I help him, he will also help us to get this job finished. My contracts engineer takes a very very regimented approach. So, in certain areas I explained to him "Look, if we help this fellow [subcontractor] here, he will get this job done and finished. I will save S$ 12,000 per day on LD. How much am I going to pay this fellow? Only S$ 1,500 – 2,000, that is nothing". You must always compare and see where the benefits are. So, if he gets help I get helped, it is fine just to get it done. Because people get penny-wise pound-foolish sometimes – most of the time – I do not know why! There are sometimes we come very hard at the subcontractors – no nonsense, that is in your contract, do it! So, it is situational management again – what situation you are in, what situation they are in.
Qt 72 [7.8]	Liaison with clients and consultants, this is done with a weekly meeting, technical meetings, or monthly progress meetings, it is normally two types of meetings. Progress meetings is to check on the progress, to catch-up any delay and any other things. … The other one is the technical meeting where we solve all technical problems with authorities, within ourselves, with the consultants, any technical problems that arises. … Liaison with the client and consultants would have happened the same whether here [Singapore] or Hong Kong, it makes no difference. Weekly, biweekly meetings are the same, they ask, you answer, "You are slow. Why are you slow? Resources?"
Qt 73 [7.8.1]	Informally, the main contractor has to go to the client; sometimes you have to go to the client direct to get some information. Because for the simple reason that he [main contractor] is responsible for the programme. Sometimes because he cannot get these information quick enough from the consultant. So, sometimes he may have to go direct to the owner. … So, informally, the project manager has to go to the owner and understand what is needed so that he can proceed. Sometimes you will come to some awkward situations where the consultants are not doing their job. So what do you do? You need the information so that you can proceed smoothly. More often than not, if just one trade for some reason cannot proceed, it will have impact on all the subsequent trades. Being the main contractor, because he got to co-ordinate so many trades it is not an easy task. Sometimes out of 10 subcontractors 8 or 9 contractors have no problem. But if one subcontractor has problem and cannot fulfil or meet the deadline given to you, the rest of the subcontractors also will get affected. And if that happens, there will be lots of finger pointing.

Qt 74 [7.8.1]	Talk to them nicely, that is how to get information. Buildability problems you can only tell the consultant and the client. So, this will be one of the factors they will consider when there is a delay. Especially in Singapore the architects like to design something really fantastic but very difficult to build.
Qt 75 [7.8.1]	Objective of liaison is to make them know your problem and hopefully they will help you out. For example if the consultant is not helping you enough, hopefully the client can ask the consultant to do something so that the contractor can continue working. Otherwise the contractor cannot continue because the information are lacking. As far as the owner is concerned, you can only ask him to help informally.
Qt 76 [7.8.1]	Every project is bound to have problems. There are very few projects, in Singapore specially, that can complete on time. That is the reason why it is important that the contractor has to act like a consultant and let the client know your problems – why you cannot achieve this, why you cannot achieve that, and so on. Because, if they know your problem, even though you delay a project they will consider not imposing LD on you.
Qt 77 [7.8.1]	So, obviously we will try to get as much information from the developer, from the consultant, from the tender document is one thing. Sometimes the design is still in the development stage, details not yet worked out. So, in order to get this sort of information, we need to workout a certain timetable, for example, according to the master programme we need this information by such and such a day. Otherwise we will not be able to proceed and it will affect the other work. For example, sometimes the sanitary ware is not a part of the contractor-supplied material. We need to know this sanitary ware supply award by such date. Otherwise we will not be able to determine the opening. Sanitary pedestal for different specific model – there is a different opening for outlet. So actually we need to know all these information early so that we can prepare our co-ordination drawing. All these things we can ask during a weekly technical meeting. I would say that is constant dialogue with the architects. There are many ways of requesting it – formal ways of requesting it or informal ways of requesting it. Formal way is by way of letter, by way of formal meeting, informal way is we can just give a call and ask or ask him when you meet "By the way which brand are you likely to accept?" so that I can call the supplier directly and ask him to fax us an installation detail.
Qt 78 [7.8.1]	Main objective is to clarify discrepancies and hopefully confirm their [client's or consultant's] requirements so that the work can proceed. Make decisions early. Otherwise, if they [client or consultant] do not make decisions, it is going to affect my work. Whether the flooring is timber or marble, the way of doing it is different. If the flooring material of living room and bedroom are different, my base floor levels must be different. I think that is the main thing. We want to have a confirmation on the requirements and clarification of any discrepancies.
Qt 79 [7.8.1]	So, main objective is to minimise the problems, detect the problems early and to ensure that works progress smoothly. Also to have a better working relationship with the developer, client's representative, with the consultants. Earlier that you discuss, then everybody will be willing to discuss. Of course [if] we wait until the problem surfaces, then everybody will be unhappy to discuss. … I think the main key personnel is the – the main player is the developer or the developer's representative. They must make the decision early. Consultant, must resolve the design discrepancy early. Then the subcontractor must always bring up any problems encountered early.

Qt 80 [7.8.2]	When you have a problem such as an omission of a penetration for services in the concrete structure, you have to go round it. The consultant may agree to it but the client may not accept it. Therefore you have to talk to all these people. It is challenging!
Qt 81 [7.8.2]	Ministry of Environment [Singapore] has its own way of looking at things; especially the electricals. So, the Environment Ministry's Electrical Engineer is now working for the consultant and they are very sticky and they want everything their way. They have certain standards and even specifications they want in their own way. That is the way it has been done and they will not accept anything else. So, in the other contract [referring to another contract] they have submitted the drawings and got it approved somehow and now they have done the [switch] boards and now rejected for some reason. In this job I have a guy [a subcontractor] who is an asset. He has been with the [Ministry of] Environment and he knows what the [Ministry of] Environment wants. So, every time a drawing is prepared, he goes and sits and talks to the consultants – are you happy with this, are you happy with that, we are deviating a bit here are you happy with that, we are going to put something else here what is your opinion about it and then he discusses with them. Every drawing, every switchboard design is discussed with them. Then he comes and produces the switchboard, tests and delivers with zero rework. Equipment is equipment but when it comes to switchboards, you can have a hundred different ways. Switchboard is a handmade thing which is put together as a package. So, if you can get exactly what they want, 90% of their problems are solved. Otherwise your defects list will go into volumes. They will call it defect, but it is not a defect – you have to change the whole packaged system. So, we have achieved a lot by taking to the consultants on every drawing. See, the consultant will say, even if I approve the drawing, I can ask you to change it. That is what the contract says. So, might as well spend some time, talk to the consultant and get the right thing done. Even commissioning, we go and tell the consultant that there are many different ways to commission. If you want to, we can do it this way or that way. So, unlike just keeping quiet to the end of the day to say "Well your system is not ready so I cannot commission it!" and just wait. Instead I can go and tell him "There is a way of commissioning this way can we do that?" they will appreciate it. My view with the client is keep a good relationship. That is very important. The clients should understand that we are trying to deliver the goods to them. So, you must project yourself *not with records*, but by actual facts and by truthfulness, that we are trying to give them a good product. We should create the impression on them and they should believe us by the way we do things. After that you build-up a certain confidence.

Qt 82 [7.8.2]	It is more important to liase with them on choices and decisions which are very personnel. See the colour scheme for example, this is something very personal. I cannot assume that this colour scheme good for my Project A will be accepted in Project B. So, if I have such kind of an approval or a choice to be decided, then I need to get the decision as early as possible. Because these are not logical decisions. These are very personal decisions. You are trying three schemes one is more of a red, one is more of a green and one is more of a yellow, there is no reason whatsoever why he should pick one of the three. He may turn and say I do not like all three. So, these are the things where we talk about co-ordination with them and liaison with them. These aspects we need to make sure we do as early as possible. But structural decisions or simple architectural decisions it is quite easy to get by. Your corridor, you have to narrow it by another 3", I do not think you get much problem because nobody will really feel it. You want to change the colour scheme, then you have to be really careful. Somebody will look at it and say I do not like this colour. It is "I do not like" you see, it is not "Why this colour is not suitable?" Even glass, you want this to be green tinted or blue tinted. Even that somebody is going to say "I do not like that green". Somebody will say I prefer a darker green or somebody will say I like a lighter green! This is not a technical decision. It is pure personal choice. This kind of thing it is something to watch out for and this got to be handled with a lot of tact and diplomacy and make sure that you get this done.
Qt 83 [7.8.3]	You must be proactive and not reactive, that is very important. [Wrong method is] I ask you A and you give me A then I ask you B and you give me B. [Correct method is] I ask you A and if B is also affected you must tell me B is also affected.
Qt 84 [7.8.3]	Again you must mention, you must be very diplomatic but truthful to tell him that if you want such thing [design change], such consequence can happen and will affect the overall situation. Sometimes, you must advice the client "Please do not change" or sometimes you must insist, "Please change or you will have very serious consequences".
Qt 85 [7.8.3]	Bad co-ordination is waiting for things to happen and then go and say that these are all wrong. Because you have to be proactive. If you are being reactive, you are reacting all the time to the problems that have taken place. If you are proactive, you are doing it earlier and you are driving it and you are in control of the job. You know the three verses: Some people make things to happen Some people watch things happening Some people don't know what happened So, for co-ordination these three aspects are important. If you make it to happen, then you are calling the shots and in control. Even if there is a problem, you can solve it. Some people watch things happening – so it is happening and they are just watching it. Everything has gone haywire and after that you say the whole thing has to be reworked. The other people do not know what happened really. It is all done and finished.
Qt 86 [7.8.3]	If the contractor cannot manage and co-ordinate, then there is no point in having even the best consultant you can have. At the end of the day it is the contractor who knows the most of every single trade. He is the one who knows which should come in, who should go. You have situations whereby one piece of work is left out and at the end of the day they realise it so late, they have to come back and do the work and obstruct everybody along their way. These are the things where the contractor knows the best.

Qt 87 [7.8.3]	If there isn't so much problems we [construction co-ordinators] will have no job. You would not have your job if you do not have to keep chasing. What is this – these all arise from poor co-ordination. Co-ordination is your contribution, but this is co-ordination within the consultant's set-up! They could not even keep to their schedule. They could not even do their work properly. Yet the co-ordination rests with you as the main contactor!
Qt 88 [7.8.3]	We see poor design, but of course to the clients here [in Hong Kong] the contractor is the lowest of the low. So, we can do very little about it. … We do think about it at times … Especially if it is a non-expert client we try to make sure that we advise him as much as possible.
Qt 89 [7.8.3]	Variations, changes – of course this is dealt with as if you are going to start the design all over again. The consequences, somebody must to be able to look at the consequence fully and explain. Again, consultants and client needs to be properly informed of the consequences. Otherwise the contractor would be blamed "Why didn't you tell me earlier? You did not tell me, so now you are not entitled to such extension of time or such benefits".
Qt 90 [7.8.3]	Say you change all the doors to a bigger door. You just quote me bigger door over the small door is so much. It is not good enough because we are forgetting that my opening for the small door is already formed and now I need to re-cut the opening! Not only the cost of such opening, you might have electric ducting put right next to it. So the electrical ducting too need to be shifted! Now, after your client accepts the variation, additional cost of x, you come back and say, now it should be 2x because all these things to have to be done. Your client will be very unhappy although you have a good ground to claim for it. Because you have to work on all kinds of these systems, you may have the work delayed. Your client then does not want you to do it and may be wants you to look at the alternatives. Because as the client you now tell me it is 2x and I am not ready to pay. I do not have the budget can you go back to 1x and see what you can do? Then you are in a very vicious cycle of going from one alternative back to the original and then going to another alternative.
Qt 91 [7.8.3]	What I want to point out here is, it is always good to keep the client and the consultant informed even if you have a potential problem. So that they will not get surprises or they will not push a panic button. So they will not come and stop you or prevent you from doing something. So, keeping your clients and the consultants informed is always a good thing. … This is very important when we talk of liaison with the client and the consultant.
Qt 92 [7.8.3]	Changes in the external conditions, I think that is less of a problem but I want to point out that changes in the local bylaws, requirements, regulations, that kind of thing you need to inform the client. This can have very serious effects and the client will be very unhappy even though it is something beyond your control as a contractor. But they will start to blame you "Why you did not tell me earlier. This kind of thing you need to keep me informed". Even if it is hearsay, even if it is just a draft proposal of some change in regulations I think these are things you should sound "If this thing happens we may be in trouble" so that at least he will know and he will not blame you why you have not been looking at it. In fact you have been looking at it but there was nothing you can do. You cannot do changes on somebody's idea until it becomes a rule or a regulation. However, the client is always right and the consultant is always on top of the contractor and we [contractor] must keep them happy by informing.

Qt 93 [7.8.4]	*Q: Is it only the Project Manager who will practically talk to the client or the consultant? [Question asked by the interviewer (the Author)].* A: No! That is why it is important that you must have at least a monthly meeting. All these things "You told me to do this" – "No! No!! No!!! I did not say that" or "he told me he was going to do like this but he did not". We do not want that kind of thing happening. So everything when they discuss – you term here as informal – until recorded this may not/cannot hold water. … Officially, you cannot have multi-channels. These must be informal channels – you must make sure that all these things are rounded back into an official channel. Otherwise there is going to be hell. Today I tell you that I can do it in one week. Tomorrow you meet my Engineer and he tells you "No! No!! No!!! I can do it in 5 days". Then the day after you meet my Supervisor actually supervising the job and he tells "No! Cannot be done!! This actually needs two weeks!!!" So, you come back and scold me "Two weeks?!" I cannot answer you, neither did I say I can do in 5 days nor did I say I need two weeks. He [Supervisor] may think he needs two weeks. So, such kind of thing now needs to come back and we thrash out and now we officially record. This is not so much co-ordination. These are what we call protocol in terms of communications. We cannot allow bypassing it we cannot allow multi-channels. Because you are going to cause more confusion than good.
Qt 94 [7.8.5]	Drawings should be co-ordinated. Sometimes, a column may be positioned at a wrong place. Sometimes, architects may need a certain column but the structure has not changed. So, it is my personal view that these things should be avoided before you call tender. I think in Hong Kong also you have this same problem. … Actually, the contractor is supposed to get a set of drawings ready straightaway for construction or to be built rather than solving all the design problems. That is I think at the moment about 80% [problems] still have to be resolved – the drawings come with various discrepancies.
Qt 95 [7.8.5]	As a contractor we will expect the consultant to give us a set of drawings co-ordinated between the structure, architecture and M&E. But most of the time because of the time given to the consultant to design and call tender, which is quite short sometimes, sometimes during the tender the client may do some changes, so the Engineer may not have time to update the drawing and the handed drawing may be pushed up for tender. So, that is the problem and eventually the contractor may end up having to spot all the discrepancies and co-ordinate all the drawings for the consultant. This not a very healthy situation, it is a liability.
Qt 96 [7.8.5]	Sometimes the designer may miss out certain parts. He may want the contractor to propose. This may involve a design aspect or a material aspect. Some problem of a roof truss for a complicated roof. If it comes to a normal bid and build sort of project, the consultant should come out with some detail. May be it is so complicated, the consultant would not have the time to do it. So, in the end they will say you tendered for the project, you are supposed to know how to build it. Otherwise why did you tender for the project? So, they would want the contractor to propose. So, we may end up helping a consultant to do a design. Sometimes the consultant even though they have designed every detail, come to the actual site conditions, it may need to do some modifications or some changes. So, the designer may want the contractor to propose. So it may end up becoming a contractor's responsibility and may end up contractor engaging a PE to endorse the contractor's proposal. So, sometimes the consultant may pass the buck to the contractor.

Qt 97 [7.8.5]	Missing details in drawings and specification – we go and talk to them all the time and say look you missed this out. Contractors I know here, they do not tell the consultant that he has missed it out and at the last minute they will ask for a variation.
Qt 98 [7.8.6]	[It is important] whether your liaison is done amicably, with very good rapport among all the people. Because sometimes communication can be very offensive if you do not do it right. Especially if you write letters claiming for extension of time and extra on overheads, it can be very offensive. Then it develops ill feelings before we can talk; when we meet face-to-face we already want to stab each other. Liaison whether it is good or bad may be judged by how diplomatic you are and whether you can keep it to a very professional level and never, never get personal – that is the main thing.
Qt 99 [7.8.6]	When people stop talking to each other that is when you will have problems. And people often stop talking to each other within an organisation and outside the organisation alike. And people stop talking, that is when you will have problem. Writing to each other is not necessarily good – sometimes. But certainly people must talk to each other. And it is often better to talk to each other – to somebody before you write to them. To make sure that the man understands its content before you put it under writing! Because often we explain ourselves much better when talking than when we write.
Qt 100 [7.8.6]	He [Project Manager] has to be a very good experienced in south Asia and must also be a good PR [Public Relations] man. So, he must know how to deal with the situation because I would say that the Asian way of doing things is that want to make our paymaster happy. Unlike an European contractor who strictly go by the contract and do not care. If your contract says it has to be like this or have to pay in this manner, you have to follow. But for Asians, I think, you have to have a little space; you do not want to make the other party in an awkward situation. So you have to be a very PR man to handle this kind of sometimes-sensitive situations.
Qt 101 [7.8.6]	Somebody comes out to the consultant that his design is not particularly correct on the curtain wall. Then consultant will get offended – very silly. So it may make your life more difficult (because everything is under his approval) or delay your progress. So it is the time to tell the consultant diplomatically there is a little bit of construction problem without mentioning that it is due to his design. So, we propose certain, certain things to make it more beautiful but it will not affect the loading of the members. So it is how you rephrase your question. Instead of going direct so that everybody will know, here there is no lost face. Especially in a big meeting if you are pointing out the faults of the developer or the consultant, then who do you think will be very upset? Because the contractor in everything expects the developer or the consultant to give some tolerance, tolerance in the sense, for example, we cannot expect our works to be 100% perfect. So, we are also expected to give a little bit of tolerance to the consultant or the developer. So I think, that is the thing here to be very diplomatic.

Qt 102 [7.8.6]	Sometimes we may in a sensitive issue do it informally after the meeting we talk one to one and sometimes it may help to build-up an understanding and a working relationship between one another. Everybody do not want to loose face. Right is right and wrong is wrong but people can be a little touchy. … So, sometimes you can go informally, sometimes you can go formally. If the subject is too sensitive, better go by the informal way. But there are times when you need to be very formal. My objective is to let the project move smoothly. So, even though you are unhappy never mind as long as the job finishes on time ultimately. If you bring in personal hard feelings to the work, I think it will be a big problem. … If it is a sensitive one, we have to go informally. If it is a genuine one then we go formally discussing the technical things.
Qt 103 [7.8.6]	PR is also very important. It is not just how to do your job properly, it is also how to maintain good public relations.
Qt 104 [7.8.6]	The other thing with the consultants is that, your first impression is very important. When you give something to them and if they establish a good impression on you, after that they will go a bit easy on you. If you try to be a bit sticky at the start – come I will give you the test – it will become difficult.
Qt 105 [7.8.6]	When it comes to claiming for extension of time … If our PR with the developer or client is not very good, sometimes it is very difficult claim extension of time.

Appendix J

STRUCTURE FOR INTERVIEW OF PERSONNEL INTERACTING WITH CO-ORDINATORS

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November 3, 1999

«Title» «Name»,
«Office_Address»

Dear «Salute»,

<u>SURVEY ON CRITICAL INCIDENTS IN CONSTRUCTION CO-ORDINATION</u>

I would be much grateful if you could please provide the following inform ation required. I am a PhD student at the Hong Kong Polytechnic University doing research under the supervision of Professor Michael Anson. The information you provide will be used solely for this research project and will not be disclosed to any third party.

The exact area that I am focusing m y present research study is 'Construction Co-ordination'. You m ay appreciate that Construction Co-ordination processes (as perform ed in day to day *real* life in a project) are very intangible and informal that many people find it really difficult to understand. Hence, I am try ing to apply a technique called 'Critical Incident Technique' to identify "what is a good j ob of co-ordination" as opposed to " a bad j ob of it" <u>from the perspective of the project participants (other than the contractor's Proj ect Manager) in the construction phase</u>. Then, the final obj ective is to derive possible ways of "measuring" such intangible and informal processes.

Hence, I would be much obliged if you could please provide the following information:

Think of a time when, as a construction project participant (at the construction stage), you met with a particularly satisfactory (or unsatisfactory) incident of site co-ordination by the main contractor and answer the following two questions.

1. How exactly did the incident happen? *(Need not disclose the names of the site or companies or individuals involved. Use their designations only e.g., client, main contractor, project manager, site engineer, QS.)*

2. What actions in that incident exactly made you feel satisfied (or dissatisfied)?

It will be much appreciated if y ou could please, in the above sequence, separately describe a very satisfy ing incident and a very dissatisfying incident. You need not bother to write the inform ation because I am prepared to m eet y ou at a tim e convenient to you to record the information. I am writing this letter to request for an appointm ent to meet you for a duration of up to 20 minutes to record the data. To save time, if you do not mind, I could use a Dictaphone to record our conversation.

However, if unable to give me an interview you may please either use the two reply forms attached herewith to write y our response or write an e-mail and transmit to me at the address given above.

Thank you very much for the valuable time spent and the kind effort.

Yours faithfully,

D. Darshi De Saram
Postgraduate Research Student

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<u>Reply Slip</u>

To:- Mr. Darshi De Saram **<u>Fax to - 2334 6389</u>** – (Department of CSE, HKPolyU) «No»

From:- «Title» «Name»

You may meet me on ………th November at ……….. a.m./p.m. My contact telephone number is …………………
Venue ……
……

Sorry I cannot help, you but I feel that Dr./Mr./Ms. ………………………………………… m ay kindly help y ou. Please contact him/her on the telephone number ……………………

Description of a Satisfactory/Unsatisfactory Incident

Think of a time when, as a construction project participant (at the construction stage), you met with a particularly satisfactory (or unsatisfactory) incident of site co-ordination by the main contractor.

In that site, what was your position? …………………………………………………………………………………
working for the Client/Consultant/Main Contractor/ Other (please specify) ………………………………………….
(Delete inapplicable)

1. How exactly did the incident happen? *(Need not disclose the names of the site or companies or individuals involved. Use their designations only e.g., client, main contractor, project manager, site engineer, QS.)*

2. What actions in that incident exactly made you feel satisfied (or dissatisfied)?

Thank you very much for the valuable time spent and the kind effort.

It may be convenient to attach your visiting card instead of filling in below. It is optional *give your name and other details, but if you kindly indicate your name and address I can send you a copy of the research findings.*

Name - ……………………………………………………
Qualifications - ………………………………………….. Designation - ………………………………….
Organisation Name & Address - ....…
....

Description of a Satisfactory/Unsatisfactory Incident

Think of a time when, as a construction project participant (at the construction stage), you met with a particularly satisfactory (or unsatisfactory) incident of site co-ordination by the main contractor.

In that site, what was your position? ……………………………………………………………………………………
working for the Client/Consultant/Main Contractor/ Other (please specify) ………………………………………….
(Delete inapplicable)

1. How exact ly di d t he i ncident happen? *(Need not disclose the names of the site or companies or individuals involved. Use their designations only e.g., client, main contractor, project manager, site engineer, QS.)*

2. What actions in that incident exactly made you feel satisfied (or dissatisfied)?

Thank you very much for the valuable time spent and the kind effort.

It may be convenient to attach your visiting card instead of filling in below. It is optional *give your name and other details, but if you kindly indicate your name and address I can send you a copy of the research findings.*

Name - ……………………………………………………
Qualifications - ………………………………………….. Designation - ………………………………….
Organisation Name & Address - ....……
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