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Do construction workers accept automated monitoring?

A study on the acceptance level and its antecedents

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CERTIFICATE OF ORIGINALITY

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Lee Lap Piu

Abstract

The use of Automatic Data Collection (ADC) technologies in the construction industry has become uncommon in recent years. One of them is automated construction monitoring, which could collect and visualize site activities effectively, including the behaviors of workers. Although there is an increasing trend to adopt automated monitoring systems in the industry, no or very little research was done to investigate whether construction workers accept automated monitoring. This thesis endeavored to bridge the literature gap between automated construction monitoring and the perceptions of the workers being monitored. A research model was proposed to examine the potential antecedents and moderators that could influence construction workers' intention of the acceptance where the constructs of the model were adopted from previous research about workplace monitoring with appropriate refinements in order to suit construction environments and practices. A face-to-face, one-to-one survey was conducted to collect the data from construction workers. After data analysis, it was found that both antecedents "organizational identification" and "organizational commitment" positively influenced construction workers' intention to accept automated monitoring. Interestingly, a proposed antecedent "attitudes towards the appropriateness of automated monitoring" was found negatively affecting the acceptance intention, which is not coherent with previous studies about workplace monitoring that suggesting the relationship as positive. Moreover, the proposed moderator "belief of monitoring systems for caring purposes" was found insignificant to affect any

relationship. Finally explanations for both supported and unsupported antecedents, research limitations, implications for the practice of automated construction monitoring, and future research are discussed.

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Chapter 1

Introduction

In the construction industry, site and operation monitoring and inspection is one of the indispensable procedures for quality control. Arising from technological advancement and affordable price of equipment in recent years, the use of electronic devices for site monitoring has become more common. By integrating heterogeneous information and communication technologies (ICT) such as environment condition sensing, wireless networking, video streaming, stereoscopic imaging, artificial intelligence, etc., the implementation of intelligent construction site visual surveillance systems become feasible. As one of the Automatic Data Collection (ADC) technologies, such a system could collect valuable site information automatically, where it is useful for workforce productivity analysis, workforce training, and safety monitoring (Yang et al., 2010). Recent research has shown the effectiveness of applying ICT and ADC in site monitoring and inspection. For instance, various wireless network technologies, network cameras, and collaborative systems were integrated to form a monitoring and communication environment such that project team members could monitor project progress and behaviors of site workers ubiquitously (Leung et al., 2008); Radio Frequency Identification (RFID) technology was used to track the precise movement and location of materials (Song et al., 2006); A global positioning system (GPS) unit and a hand-held computing device were used to improve materials-locating processes (Caldas and Haas, 2006). Even for large-scale construction projects like Guangzhou MTR, a wireless-LAN (WLAN) system was used to track the positions of workers with satisfactory accuracy (Woo et al., 2010).

While researchers have been spending efforts to enhance the technologies and to seek alternative ways to improve the efficiency and effectiveness of automated construction site monitoring and inspection, perceptions of the construction workers who are being electronically monitored are always neglected. Surprisingly for other work environments such as office or warehouse, enormous amount of literatures and research studies can be found on workforce's feeling of workplace monitoring (e.g. Aiello and Kolb, 1995; Larson and Callahan, 1990, Stanton and Julian, 2002, and Stanton and Sarkar-Barney, 2003). In contrast, very little attention has been paid on understanding how construction workers perceived when they are being monitored. This may be because the construction industry is highly fragmented such that from the managerial perspective, the relationship between top management and workers is weak and therefore the research value on this area does not seem to be significant. However, as studies on office workplace monitoring suggest that a monitoring system could shape or control the behaviors of employees (Stanton and Julian, 2002), a construction site monitoring system may also influence the behaviors of workers. If this is the case, the productivity of construction workers could be affected and further project management problems thus be introduced. It is also interesting to understand if construction workers' perception of the purposes of implementing a site monitoring system affects their acceptance level of the system. For example, in case a monitoring system is installed, some workers may perceive it is used for safety purpose while some may think it is made for spotting errors of workers. Ethically, even a monitoring system is not aimed to track the behavior of workers, if any worker's data is being logged, visualized, or transmitted for any purpose, it is still essential to investigate their degree of acceptance on such kind of electronic monitoring systems.

This thesis inherits Leung et al. (2008)'s study that focused on the technical aspects of a construction monitoring system. While the previous study shows the technical feasibility of using cost-effective information technologies to monitor construction work environments, this thesis presents an empirical study of the perceptions of construction workers on automated monitoring. As the proposed monitoring system was implemented in two construction sites, the stakeholders of the sites who used the system were interviewed. The interviews are not only targeted on collecting the comments of stakeholders on the monitoring system, but also helpful to understand what they expect a monitoring system can do for them, especially for the purposes that involve construction workers. The core part of this thesis aims to investigate construction workers' degree of acceptance of implementing a monitoring system on their working sites and the possible antecedents that influence the acceptance level. A research model was developed according to the theory of planned behavior (TPB), previous studies on electronic workplace monitoring, and studies on employee behaviors. Then a survey was designed and refined according to literature about workplace monitoring. After analyzing the survey data, two antecedents including “organization commitment” and “organization identification” were found to be significant to affect workers’ degree of acceptance on automated construction monitoring positively, while one antecedent “attitudes towards the appropriateness of automated monitoring” influenced the acceptance negatively.

This thesis is organized as follows. Firstly it introduces the research background with the descriptions of the common practice of construction site monitoring and the elaborations of how recent technologies could assist the monitoring process. Then it briefly reports the follow-up tasks of Leung et al. (2008)’s work including the interview results of the stakeholders who used their construction monitor system. As there is very little or no literature concerning construction workers’ perception on electronic site monitoring, this thesis reviews the literature about workplace monitoring in other environments such as office and hospital, which aims to adopt their theories and findings to support a research model for analyzing construction workers’ degree of acceptance of electronic monitoring and its antecedents. After explaining the rationales behind the research model, the survey results and data analysis are revealed. Finally the thesis ends with conclusions, difficulties encountered, and future research directions.

Chapter 2

Background and Objective of Research

Site monitoring is one of the indispensable procedures in assuring construction quality. It does not only reduce construction defects and human errors but also support project team members to make timely, *ac hoc* or strategic decisions like contingency plans at critical points throughout the construction processes. However it is often a difficult and complicated task due to the continuously changing site environment. In practice, construction site monitoring in the majority of the industry is still mostly a manual task using visual inspection and paper based checklists, stakeholders such as site inspector and safety supervisor have to ensure the quality of materials, work progress, safety of a site is in accordance with the agreed specifications and acceptable standards. However, due to the limitation of manpower and the dynamic environment of a construction site, where unplanned changes to work regularly occur (Ward, 2004), it is rather infeasible to monitor site activities, behaviors of workers and progresses effectively from time to time. Furthermore, the construction industry is widely considered as a fragmented industry such that massive amount of organizations and stakeholders are involved in a construction project. When a quality problem is observed, stakeholders from different organizations, or even from different geographic locations have to make critical decisions and consolidate a contingency solution as soon as possible. The efficiency of this kind of collaborative tasks intensively relies on the effective communication.

Therefore it is not surprising to see more and more construction practitioners increasingly rely on information and communication technologies (ICT) to assist and automate site monitoring and inspection.

2.1 Information and Communication Technologies for Construction

The use of ICT for construction project management is not uncommon because ICT provides real time access of information and improves coordination and collaboration among the project team members. Its benefits include richer information to aid decision making, project information obtained quicker, improved communication, closer relationships, improved information flow, greater management control and getting geographically dispersed groups to work together (Nitithamyong and Skibniewski, 2006; Love et al., 2004). Researchers have been spending efforts to develop project management information systems using ICT for the industry (Yang et al., 2010; Deng et al., 2001; Tam, 1999). Faraj and Alshawi (1999) presented an object-oriented implementation of a rapid prototyping environment called SPACE, which supports a subset of construction project lifecycle. Caldas et al. (2005) introduced a model-based integration approach with semi-automatic methods for classification, retrieval, and associating text-based documents. Internet connection has become indispensible nearly all walks of life and business, and likewise for construction firms. The capability of the Internet now can integrate various platforms together in order to form collaborative environments for project team members. It is not rare to see the studies concerning how web-based services are beneficial to construction projects. For instance, Wang et al. (2007) proposed a middleware framework for integrating heterogeneous building automation systems on the Internet, which can be integrated with any existing system easily. Similarly, Boddy et al. (2007) suggested a process driven approach by integrating client software and web service technologies. For information about web-based construction project management systems, Nitithamyong and Skibniewski (2004) have provided a comprehensive summary and comparison of web-based construction project management systems.

With the development of mobile devices, project management systems become portable and wireless. Researchers of the construction industry studied several common wireless communication models, such as General Packet Radio Service (GPRS), Bluetooth, and Wireless Local Area Network (WLAN), where their coverage, power consumption, and data bandwidth were compared (Delsing et al., 2004). For technical feasibility studies, Shen et al. (2008) evaluated the achievability of applying emerging wireless network technologies for resources tracking at building construction sites (Shen et al., 2008), and Goodrum et al. (2006) studied the feasibility in using RFID technology to track tool inventory and tested the performance under different temperature conditions; Aziz et al. (2004) designed a multi-tier mobile collaboration support infrastructure and Kimoto et al. (2005) implemented a system with personal digital assistants (PDA).

2.2 Automated Construction Monitoring

Construction project participants increasingly rely on using technologies to update the collected site performance information. Conventionally, construction firms were generally choosing a semi-automated approach to check progress and site status, where the observed data is input by foremen or workers and stored in electronic spreadsheets (Navon and Goldschmidt, 2003). With the development of ICT and ADC techniques, fully automated construction monitoring systems have become feasible. These systems not only assist project team members to obtain realistic and objective information, but also provide micro but useful information that cannot be discovered by naked eyes. In order to implement a system for site monitoring and inspection purpose, more varieties of technologies are required, such as wired and wireless networking, integration of collaborative platforms, video capture and streaming, use of robots, location tracking, pervasive and wearable devices, and so on. In fact, researchers have attempted to apply the technologies to monitor the quality of construction materials and defects long time ago. As a pioneer, a stereoscopic three-dimensional (3D) system was proposed for recognizing bricks (Slivovsky et al., 1996) a decade ago. In more recent literature, researchers tried to combine cameras with robots to identify defective tiles (Navon, 2000) and used digital images to analyze the coating surface of bridges (Lee et al., 2006). In order to obtain large quantities of figures describing the as-built conditions, laser scanners and embedded sensors were the target of research (Foltz, 2000; Tepke and Tikalsky, 2001). For example, a 3D laser scanner was applied to investigate different data filtering, transformation, and clustering techniques for improving construction site resource management (Gong and Caldas, 2008); and video laser scanning technology was employed as a real-time 3D modeling methodology to rapidly detect, model, and track the position of static and moving obstacles from a static or moving sensor platform for site safety management (Teizer, 2008). For wireless object tracking applications, a global positioning system (GPS) unit and a handheld computer were integrated to improve materials-locating processes (Caldas et al. 2006); and Radio Frequency Identification (RFID) technology was used to track the precise movement and location of materials on a construction site (Song et al., 2006).

While the above-mentioned research and applications have concentrated on monitoring the status of objects and materials, recent studies show interest in visualizing and capturing the information of human activities within a construction site. With the advance of technologies such as higher network bandwidth, better quality cameras, more accurate position tracking, more intelligent object recognition, etc., it is now possible to identify the positions of individuals in order to (i) investigate if the workers behave inappropriately in operation, (ii) enhance security, and (iii) provide a safer work environment. In fact, for large-scale construction projects like tunnel construction, researchers have already implemented similar monitoring systems to assist management in decision making. As an example, Woo et al. (2010) applied a Wi-Fi based indoor position system for labor tracking in the Guangzhou MTR station. They combined wireless LAN with access points and active RFID tags to track the movement and location of the construction workers, with an accuracy of only five meters. Motivated by the fact that the United States has had more than 1,100 construction-related fatalities in each of the past 16 years, Yang et al. (2010) demonstrated the feasibility of tracking multiple workers from static and mobile cameras. Likewise, Teizer and Vela (2009) proposed several tracking algorithms for cameras to recognize the shape of construction workers in construction environments with the presence of occluding and moving obstacles. By taking a step forward, Leung et al. (2008) not only made use of cameras, but also integrated them with a long-range wireless network and a web-based collaborative platform to form a "7 x 24" and weather-proof monitoring system. Users of it could monitor the work progress and the behavior of workers anytime and anywhere with Internet connectivity. After that, Lee et al. (2010) further extended Leung et al.'s infrastructure and confirmed that the system is capable to monitor interior construction work activities by adding mobile communication components.

With the growth of the adoption of ICT in construction projects, it could be anticipated that more construction firms will attempt to equip with electronic gears and gadgets for site monitoring or surveillance purposes in the future. With the advance of the above-mentioned technologies, more precise and high quality information, especially the behaviors of people who are working in a construction site could soon to be obtained in no time. Obviously, from the perspective of construction project management such as owners, contractor, or safety inspector, implementing a cost-effective and robust monitoring system in their construction sites does more good than harm. However, when considering from the view of construction workers, it could be another story. As a simple scenario, supposed that a contractor installed a camera only for security purpose, even the purpose are told, there might exist some workers suspect the camera is used to track their misbehavior. To a certain extent, implementing any monitoring system may induce privacy concerns and work performance issues. As the construction workers possibly are the major group of project team members being monitored, no matter considering from managerial view or ethical perspective, it would be essential to investigate their level of acceptance on the monitoring systems. There were studies examining the attitudes, perceptions, and opinions of construction workers, where most of them are about safety concerns (Garrett and Teizer, 2009; Dingsdag et al., 2008; Lingard and Yesilyurt, 2003; Trethewy, 2003; Mohamed, 2002; Neal et al., 2000); some of them investigate perceptions of stress (Wong et al., 2010); and very few of them study cultural issues of migrant workers (Loosemore et al., 2010; Hoecklin, 1995). However, very little or no research to date has explored the attitudes and perceptions of construction workers towards electronic monitoring, and even conventional inspection. Therefore, a literature review of the studies about monitoring of other working environments is essential to this study.

2.3 Electronic Workplace Monitoring

First of all, it is important to define the meaning of electronic workplace monitoring in this thesis. There is a distinctive difference between "conventional" monitoring and electronic monitoring. For the conventional one, it is a kind of "walk around" or "over the shoulder" observation performed by the supervisor of the employees being monitored, where the monitored employees could be aware of the monitoring activity, if they intend to do so. In contrast, electronic workplace monitoring is the use of electronic hardware and software to collect, analyze, and report individual or group actions or performance (Alder and Ambrose, 2005). The activities of such kind of monitoring are usually invisible and inaudible such that the employees have no idea whether monitoring is in progress, regardless of the workers' knowledge of the existence of the monitoring equipment. For example, even an employee notices there is a CCTV (Closed Circuit Television) installed in the workplace, the employee cannot be sure if the supervisor is watching him or her behind the system, and cannot confirm if the system is recording his or her work. Instead of allowing the continuous collection of employee information in the absence of supervisors or coworkers, electronic monitoring can provide abundant amounts of data related to many multiple work dimensions, such as attendance, work speed, productivity, and efficiency (Alder and Ambrose, 2005). For most literature concerning workplace monitoring, electronic workplace monitoring includes the use of cameras, eavesdropping on computer and telephone networks, reading employees' emails, analyzing computer activity logs, etc. Stanton and Weiss (2000) indicate that while there are some techniques for facilitating monitoring of a broader range of work-related activities, some of which may not directly relate to performance. For example, organizations may monitor website utilizations in order to avoid legal liability or potential public embarrassment caused by employee visits to illegal sites.

Electronic workplace monitoring has historically been applied to a range of jobs, including airline reservation agents, telephone operators, data entry personnel, telemarketing agents, insurance claims clerks, as well as some stockbrokers and computer programmers (George, 1996). Organizations collect information on employee work activities electronically for various purposes, including evaluation of employee performance, limiting employee access to Internet content, and providing performance feedback. From the managerial point of view, it was suggested that electronic monitoring could be used for initial training, and retraining of employees for the purpose of offering instructional feedback to employees (Westin, 1992). For instance, the work of air-ticket reservation staff is monitored with computers because the management has to ensure the employees respond promptly and politely to customers (Oz et al., 1999). It was not surprising that some companies installed monitoring software in employees' computer to capture and store the screens and send to employers for further analysis (Spitzmuller and Stanton, 2006). Even for an employee who does not use computer and is not working in an office, he or she could be electronically monitored. Nussbaum (1989) reported that a small hidden computer was used to record the number and length of stops that a truck driver makes on his way to and from a destination. While these examples are just a tip of the iceberg, CitiCorp, a large and well-known organization in the U.S. has been spending a lot of resources on electronic monitoring (Kerr, 1990). They use expert systems that analyze data to see if any unusual activity has occurred. One program they have implemented monitors employees responsible for processing vendor invoices. To create a processing pattern, the program is fed information on times of the week or month during which the employees are supposed to process the invoices. The actual data are then compared with these patterns and with other historical data. In fact, about two decades ago, Nussbaum (1992) estimated that 26 million American workers were subject to some form of electronic monitoring already, and Orthmann (1988) predicted that about two-thirds of work organizations have implemented some type of employee and surveillance technology. More recent research revealed that the prevalence of electronic monitoring and surveillance in the workplace has increased almost exponentially over recent years (American Management Association, 2005).

It is noteworthy that a construction site is quite different from other workplaces because it is a dynamic place where the environment changes with the progress of a construct project, and most workers (except those working in site office) do not use email, telephone, and computer during work hours. Anyhow, with the absence of literature studying the perceptions of construction workers on electronic monitoring, it is still valuable to review the literature about electronic monitoring for other kinds of workplaces.

2.4 Perceptions, Attitudes and Reactions of Employees Being Monitored

A majority of literature reviewed highlights the negative impact and the reactions of the employees being monitored. This implies that the employees' acceptance level of the monitoring system is not high. For instance, Alge (2001) and Hovorka-Mead et al. (2002) revealed the privacy concerns of the employees being electronically monitored. Aiello and Kolb (1995), Larson and Callahan (1990), Stanton and Julian (2002), and Stanton and Sarkar-Barney (1996) focused on employees' task and job performance; Aiello and Kolb (1995), Douthitt and Aiello (2001), and Holman et al. (2002), cared about job stress and employee well-beings; Hovorka-Mead et al. (2002) and Stanton and Lin (2003) aimed at organization attraction and turnover; Alge (2001), Douthitt and Aiello (2001), Hovorka-Mead et al. (2002), and Stanton (2000) investigated how policies and practices on monitoring impact employees' perceptions on fairness and justice. While there are numerous qualitative studies concerned with the employees' attitudes and perceptions on electronic monitoring, there exist some large-scale empirical studies. In one of them, the researcher conducted a survey to question 700 office employees who were electronically monitored, and the result generally confirms the claim that electronic monitoring brings negative impact on employees (Nussbaum, 1989; Ottensmeyer and Heroux, 1991). The employees who participated in the survey complained that the implementation of electronic monitoring in their workplace caused paced work, lack of involvement, reduced task variety and clarity, reduced peer social support, reduced supervisory support, fear of job loss, routinized work activity, and lack of control over tasks. In another study, the authors surveyed and compared 144 clerical workers, in which 50 of them were electronically monitored and 94 were not (Irving et al., 1986). It was found that the electronically monitored workers expressed that the quality of work was underemphasized at the expense of quantity, the stress was too high, and the morale was low. Moreover, they reported that monitored workers experienced decreased job satisfaction and a decline in the quality of relationships with peers, supervisors, and senior management. In another comparative study involving 461 electronically monitored workers and 283 non-monitored workers in the telecommunications industry, monitored workers reported higher levels of workload and work pressure (Smith et al., 1992).

In contrast, some studies have revealed that employees do not always perceive electronic monitoring negatively. Grant and Higgins (1991) reported that some employees could not confirm if they accept or reject the practice of electronic monitoring. Among the 1498 employee subjects of the survey, more than 40% of them agreed with the statement “Management has the right to decide monitor design and use”, while more than half of them believed that employees should have the right to resist electronic monitoring. Interestingly, the authors found that the monitoring activity could be more acceptable to the employees when the tasks monitored were quantifiable, such as the length of breaks and the number of goods produced. Moreover, it was found that employees were more accepting of a monitoring system that gathers group performance data than the one that collects only individual performance data. The researchers also revealed that employee acceptance was inversely correlated to the number of recipients of the collected data. They preferred the data be furnished only to them and to their immediate supervisors. Their result was coherent with Zweig and Webster (2002)’s study, which suggested if a monitoring system do not invade privacy, if justifications for system implementation are provided, and if the system is perceived useful, the employees may likely accept the monitoring activity. In another study, Chalykoff and Kochan (1989) found that job satisfaction increased and intent to leave decreased when employees who were subjected to telephone monitoring perceived such monitoring as justified. They concluded that for some employees, the negative effects of monitoring are inherent, but for other its negative impact can be mitigated by attention to feedback and performance appraisal processes. In a lab experiment, 42 women were hired to perform a simple data entry task (Griffith, 1993). Subjects who worked alone or under computer monitoring demonstrated a steady performance pattern. Although those monitored with the physical presence of a supervisor performed better than those under computer-monitored conditions, there were no differences in job satisfaction. In another experiment, Nebeker and Tatum (1993) found that computer monitoring and feedback led to increased output of keystrokes and there was little effect on work quality, satisfaction, and stress.

Instead of understanding the perceptions, research also revealed that employees might respond to electronic monitoring in a variety of ways. It was found that some employees disliked and were reluctant to accept electronic workplace monitoring, and some might even actively thwart their companies' use of the monitoring system by altering monitoring hardware or software (Stanton, 2002). Other employees sought "blind spots" in a network of control areas where they could escape the gaze of manager, thus providing them with space to maneuver (Nussbaum and du Rivage, 1986; Stanton and Weiss, 2000). For some critical cases, some monitored employees expressed resentment, left the organization (Holmes, 2003), resisted through negotiation (Stanton and Stam, 2003), or engaged in reverse surveillance (Sewell and Barker, 2006). Conclusively, implementing an electronic workplace monitoring system could affect the monitored employees in two broad domains. Firstly, the system may affect employees' feelings about work and the workplace, such as attitudes, emotions, beliefs, and so on. Secondly, it may modify the employees' behaviors that are related to productivity, citizenship, and unproductive behavior. Aiello and Kolb (1995), Nebeker and Tatum (1993), Stanton and Barnes-Farrell (1996), and other researchers have documented a variety of effects, not all positive, of monitoring on productive behavior. Citizenship behavior, also called pro-social or extra-role behavior, apparently declines under conditions of intensive performance monitoring (Niehoff and Moorman, 1993). Stanton and Weiss (2000) reveal that the more the managers monitor productive behaviors, the less the employees perform activities, such as helping others, that facilitate the overall performance of the organization. According to the transcripts of hearings in the US House of Representatives (1989) on the activities of monitored telephone operators, electronic monitoring could also affect unproductive behaviors. In those transcripts, telephone operators admitted intentionally hanging up on customers who might have adversely influenced their monitored average call handling time.

2.5 Research Objectives

As the studies on electronic workplace monitoring suggest that a monitoring system could shape or control the behaviors of employees, it could be valuable to explore the question of whether the construction workers intend to comply with or resist the monitoring systems installed in their working sites. It appears that if the workers resist and allocate effort to circumventing these systems, they may do so at the expense of performing more productive activities. For example, if there exists a monitoring system, a construction worker who wants to smoke in working hours may take a short break and seek a “blind point” to smoke. His work effectiveness may be lower than that in the scenario without the system because he could smoke and work together without taking a break. In other words, if the major purpose of adopting a monitoring system in a construction site is to increase the work performance, the construction workers’ acceptance level on the system should not be too low otherwise the technology may provide little of its intended value to the management. Therefore it is crucial to investigate the possible perceptual factors that could influence construction workers’ acceptance level on automated monitoring systems. Insights into construction workers’ intentions on whether to comply with or resist the use of monitoring systems may prove helpful in promoting both fair and effective use of these technologies. There was not only no literature found to discuss the perceptions of construction workers on electronic monitoring, but also very few studies in workplace monitoring examine employees' acceptance and compliance with monitoring policies and practices as an outcome variable (cf. Spitzmuller and Stanton, 2006). Therefore the research question of this thesis is:

What are the factors or the antecedents affecting construction workers’ acceptance level of automated monitoring?

In order words, the major objective of this thesis is to examine construction workers' attitudinal, personality and social antecedents of compliance and resistance with the implementation of construction monitoring systems.

2.6 Uniqueness of Construction Site Monitoring

Although there are plenty of literatures contributing to office workplace monitoring, it is important to emphasize the previous observations and findings about electronic workplace monitoring cannot be applied directly or simply be replicated in the construction environment. The construction industry is well known as being a fragmented and divisive industry in that a multitude of companies, professions, and occupations co-exist and co-operate in the construction project life cycle (Kanji and Wong, 1999; Milakovich, 1995). Because of the subcontracting practice, various stakeholders usually handle different stages of the building life cycle independently, where very little information passed down the hierarchy from the top management is necessary to reach to the worker level (Bateman and Snell, 1999), and the workers usually are not familiar with the parties that do not directly employ them. Therefore, when studying perceptions of construction site monitoring systems, the relationship between the observer and the one being monitored cannot be purely considered as employer and employee, and adequate refinements have to be applied to the existing research frameworks of electronic workplace monitoring. Another uniqueness of a construction workplace is that it is a dynamic and hazardous environment where the environment changes with the progress of the project. As a result, safety issues are critical in a construction site and the workers may be more willing to consider one of the purposes of installing a monitoring system is for safety reasons. This point is noteworthy because in other workplaces such as an office, the employees may not accept safety issue as an explanation of implementing electronic monitoring systems. In other words, construction workers' acceptance level on electronic monitoring may be higher because they may perceive the system is for caring, more than for spotting their misbehaviors.

There are more fundamental differences between construction site monitoring and other workplace monitoring. An example is that construction workers may have less privacy concern because they get used to work in public areas, where their work behaviors could be seen by the public already (e.g., residents living in the buildings nearby). Moreover, construction workers are usually closely monitored by safety inspectors and foremen, therefore, they may find electronic monitoring just as a tool and may show little awareness about the system. This is also a unique situation for construction working environment. In an office or a shop, today's automated monitoring practices are possible to entirely replace manual monitoring, if the management wishes to do so. However for the construction industry, because of safety, legal and other rationales related the complex working environment, manual inspection and monitoring have to be conducted by professionals regularly, no matter how advanced the installed monitoring system is. Therefore, investigating the uniqueness of the construction industry and the characteristics of a construction workplace are essential before adopting and refining any well-developed research frameworks and models for this thesis. To accomplish this, the users of a construction monitoring system were interviewed and related literature was reviewed. The details are described in the subsequent sessions.

2.7 Case Studies of a Construction Monitoring System

This thesis is partially inspired by Leung et al. (2008)'s work[1], which mainly focused on the technical aspects of the implementation of a construction monitoring system. Conventionally most of the monitoring processes in the construction industry are conducted manually. For instance, a site foreman ensures the workers are compliant with the design, construction as well as regulations, a safety officer are concerned with the safety and health of persons, and so on. The proposed system automates part of the manual processes so that the workload of the involved team members could be reduced and therefore they may be more focused on decisional and managerial issues. Most importantly, although the proposed system is named as a monitoring system, indeed it also assists stakeholders in collaboration and decision-makings. It is because the system provides a real-time virtual meeting and interactive

[1] The author of this thesis is one of Leung's team members, and both contributions of this thesis and Leung's work are under an umbrella project in "Quality control and assurance of construction works"

environment for users to analyze and comment on the monitored results anytime and anywhere with Internet connectivity. The system is integrated with a long-range wireless network, network cameras, and a web-based collaborative platform. It supports simultaneous user access therefore project team members could view real-time captured images or video of a construction site, discuss and exchange ideas with gadgets such as video conference, text and shared whiteboard at a distance via the Internet. As the monitoring viewpoints of the system are able to pan, tilt, and zoom, the system is able to not only visualize the condition of an entire construction area, but also capture the details of site activities at the level that the body movements of any construction worker are visually recognizable. Moreover the system was carefully configured in order to maintain the reliability under the messy and muddy environment of construction sites so that it can operate in 7x24 fashion. The system was implemented and tested on two construction sites and promising results were obtained. Figure 1 shows the user interface of the system and the actual monitoring result. After that, there were more construction monitoring systems introduced for monitoring the behaviors of workers, such as the projects implemented by Woo et al. (2010), Yang et al. (2010), Lee et al. (2009) and Teizer and Vela (2009).

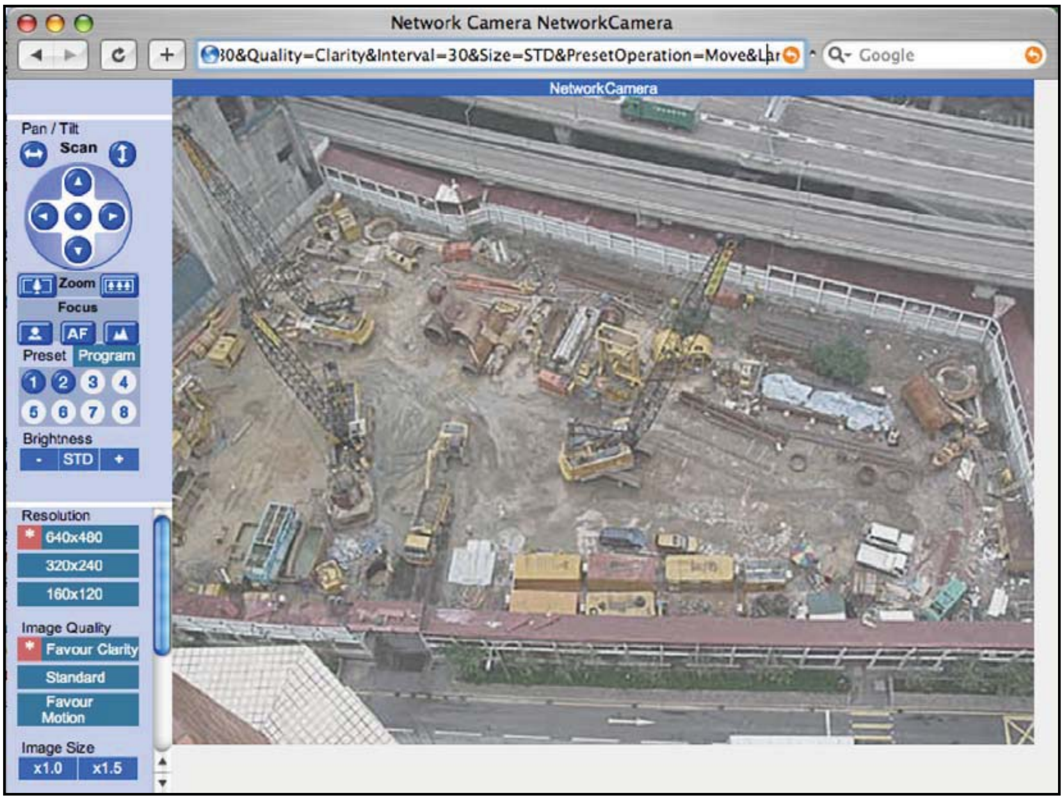

Figure 1. User Interface of Leung et al. (2008)'s monitoring system

Being a pilot study using real life construction projects, while the previous work confirmed the technological feasibility of the proposed system, this thesis is aimed at examining the attitudes of construction workers towards such kind of construction monitoring, and the antecedents affecting their acceptance and/or resistance of the electronic monitoring practices. The previous work provided important insight in the study of this thesis because the users of the monitoring system were the actual construction practitioners. They were enthusiastic to not only give comments to further enhance the system, but also share the insight on how the system benefits their management and decisions, particularly what they were expected to observe regarding the behavior of the workers. Furthermore, their experiences in the industry are very useful to bridge the literature gap between the existing studies on electronic monitoring for general workplaces and the actual situations of construction sites. Therefore semi-structural interviews were conducted with the practitioners who used the system, including property owners, contactors, and engineers. It was encouraging to know that they found the system was a helpful decision support tool to assist them making immediate strategic decisions according to the incidents spotted or recorded. One of the incidents they would to share is that the system captured concretors' malpractice in a concrete slab pouring process. As shown in the captured images (Figure 2), the concretors injected water directly into the poured concrete in order to dilute the concrete for easier flattening. The management took an instantaneous action immediately after they saw the images. The interviews gave information and insights on automated construction monitoring from the view of construction management, and most importantly, the interviewees shared their perspectives on the unique characteristics of the industry such as interdependency and insufficient communications. As mentioned, there are fundamental differences between construction site monitoring and other workplace monitoring, it would be essential to identify the characteristics before establishing the research framework.

Figure 2. Malpractice spotted

2.8 Characteristics of the Construction Industry

The construction industry is well known as being a fragmented and divisive industry in that multitude of companies, professions, and occupations involved in the construction project life cycle (Kanji and Wong, 1999; Milakovich 1995). As a result, the achievement of building quality inevitably relies on the cooperation, communications, as well as negotiations among the stakeholders, such as the representatives of owners, architects, contractors, subcontractors, suppliers, and so on. The owner perceives a need to invest in a building project then he employs consultants, architects and engineers to start the project. After that, a main contractor will be employed to implement. Indeed, construction projects are becoming increasingly complex and dynamic in their nature (Carr and Tah, 2001). Winch (1987) even criticizes construction projects as one of the most complex of all undertakings. Because of the complexity, there are dozens of factors affecting the success of a construction projects. Chan et al. (2004) identifies the critical success factors from 43 literatures and summarizes them into five categories, namely, (i) project management, (ii) project procedures, (iii) project-related factors, (iv) external environment, and (v) human-related factors. The authors argue that project management is a key for project success, which is also confirmed by other researchers (Hubbard, 1990; Jaselskis and Ashley, 1991; Walker and Vines, 2000; Chiang, 2008). Noticeably, although not mentioned by Chan et al. (2004), four of the nine factors under project management category are related to the communication and interactions between project team members; namely (i) communication system, (ii) control mechanism, (iii) feedback capabilities, and (iv) control of sub-contractor's works. As suggested by Jaselskis and Ashley (1991), in order to maximize the project's chance of success, stakeholders should adopt management tools. In this information age, appropriate and adequate use of information and communication technology (ICT) can be an effective tool to facilitate a communication and interaction environment among construction team members.

Because of the highly fragmented nature of the industry that is caused by geographical distribution of projects team members, the different responsibilities of various parties, and different time to join the construction teams, it reinforces the importance of communication in construction project management, communication difficulties or disorders during the projects process can directly lead to a sharp increase in the volume of unnecessary expenditure, and also affect the progress and quality of the project (Anumba et al., 1997, Anumba and Evbuowan, 1999). In Hong Kong, the fragmentation characteristic is perhaps more prominent because of the multiple layers of subcontracting. Sub-contractors in the mid to lower layers are typically very small firms but collectively they undertake most of the works. Chiang (2008) suggests that the extent of subcontracting is even larger due to further subcontracting down the stream by subcontractors with or without the knowledge or consent of the contractors or the clients. This kind of partnering relationship may cause quality issues due to the temporary or one-off nature of construction projects, where the project team members may not be familiarized with the competence, especially the practice behavior of each other. In fact, the construction industry is persecuted by some common partnering problems such as ineffective communication, limited trust, and lack of cooperation (Chan et al., 2004). This kind of adversarial relationship between stakeholders could cause project delays, cost overruns, difficulty in resolving claims, litigation, and a win-lose climate (Moore et al., 1992). Therefore, it could be foreseen that if the parties have more knowledge about each other, some uncertainties and risks could be reduced.

As the construction industry is so complex, the above-mentioned challenges are possibly not exhaustive. However, according to the literature reviewed, one major challenge is the lack of effective communications. The other one is uncertainty, that is, not having sufficient knowledge of party and project status. The following two sections will further investigate the said challenges.

2.8.1 Uncertainty and Interdependence

The complex procedures and party relationships may cause inefficiency in operations (Cox and Thompson, 1997) and there is a trend of increase in degree of complexity (Gidado, 1996) that brings negative effects to the industry. For example, by comparing the level of acceptance in adopting new techniques with other industries, Shammas-Toma et al. (1998) argue that the construction industry has failed to adopt quality management techniques that have improved performance in other industries, while Vrijhoef and Koskela (2000) and Cox (2004) believe the supply chain management in the construction industry lags behind others. Gidado (1996) concluded that the complexity in the industry originates from several causes, namely, the environment of construction sites, the quality resources employed, the level of scientific knowledge, and the number and interaction of different parts of the workflow.

The complexity in the construction industry, according to Gidado (1996), could be divided into two categories. One is "uncertainty", which is related to "the components that are inherent in the operation of individual tasks". Dubois and Gadde (2002) further explain that there are four factors in this category: (1) management is unfamiliar with local resources and the local environment; (2) lack of complete specification for the activities at the construction site; (3) lack of uniformity of materials, work, and teams with regard to place and time; and (4) unpredictability of the environment. Factor (2) and (3) are related to the organization of construction-based records that shared amongst the team members (Beastall, 1998), where the effect of them could be alleviated through the adoption of content management systems or customer relationship management systems (Craig and Sommerville, 2007). During the last decade, the construction industry has widely adopted the use of IT and the concept of managing projects using web-based technologies is closer to reality than ever before (Nikas et al., 2007) because it could simplify the methods for recording information generated throughout the life cycle of a project (Rankin and Froese, 2002). Stewart (2007) further explains that these systems are capable to reduce the high levels of waste on construction projects usually caused by information that is inadequate, inappropriate, and inconsistent. Although these systems increase the efficiency of storage, organization, and retrieval of construction information and documents, they lack the capability to capture the status of the environment of a construction site instantly. Factor (1) and (4) are related to construction environment – an environment that changes dynamically with project progress, parties involved, unexpected incidents, and so on. Therefore, an active and instantaneous site inspection mechanism is be required in order to assist stakeholders to acquire site status and make decisions in a timely fashion.

Another category relates to "interdependence" among tasks, and represents the sources of complexity that "originate from bringing different parts together to form a workflow". There are also three factors causing the "interdependence": (1) the number of technologies and the interdependences among them; (2) the rigidity of sequence between the various main operations; and (3) the overlapping of stages or elements of construction (Gidado, 1996). Simply speaking, in a construction project, stakeholders implement their own parts independently but they have to cooperate with each other in a rigorous workflow. As a result, inordinate amounts of information do not only exist within an organization, but are also shared between organizations. Although Inter-organizational information and records management systems are now being used for this purpose (Caldas and Soibelman, 2003), and some researchers believe that an effective information and records management system could solve many of the information related problems (Lam and Chang, 2002; Mak, 2001), over 90 percent of company documentation exists on paper only (Doverton, 2001). Loesch and Theodori (2004) further comment that the records and documents are locked in drawers and filing cabinets with no global access to the information contained within. The findings reveal that the industry greatly focuses on paper work but the information on papers is rarely shared within organizations. The closed, and to a certain extent, protective practice may lead to another challenge: ineffective and inefficient communication.

2.8.2 Ineffective / Inefficient Communications

In addition to the challenge of complexity, ineffective communication between organizations is another critical factor causing fragmentation. Some researchers argue that the construction industry could be treated as a system (Ozel and Kohler 2004, Dubois and Gadde 2000, Love and Gunasekaran, 1997). Shoesmith (1996) described it as a Temporary Multi-Organization (TMO). To a certain extent, it could be considered as a loosely coupled system (Dubois and Gadde, 2002) because the stakeholders tend to implement their works independently. In other words, the industry strongly relies on localized decision-making and financial control. However, when the construction parties focus on paying their attention to conform their contractual requirements, they are actually informatively and even financially linked with each other.

According to Wong (1999), to a contractor, the overhead or preliminary items of a project only take up about 18 percent of the total construction costs, while 82 percent is represented by materials and services provided by the subcontractors and suppliers. Other research also reveals that communication between parties is critical to the success of an alliance (Wikforss and Lofgren, 2007; Cheng et al., 2001). Nevertheless, in practice, various stakeholders usually handle different stages of the building life cycle independently and overlook the importance of communications, which results in incomplete and loosely-coupled construction processes. Bateman and Snell (1999) reported that only 20 percent of the information passed down the hierarchy from the top management might reach the site workers. The Gartner group also agrees that the communications between stakeholders are limited and identifies that the highest level of interaction across organizations generally occurs between the middle level managers in an organization (Alshawi and Ingirige, 2003). Cheng et al. (2001) explain the possible factors of poor communication in the industry may be due to inappropriate / inefficient / ineffective channels, unexpected communication breakdown, and not having open lines of communication protocols.

Chapter 3

Theoretical Frameworks and the Research Model

As stated in the previous chapter, the major research objective of this thesis is to investigate the antecedents that affect the construction workers' compliance and intentional resistance (degree of acceptance) with construction monitoring systems. Although there is a numerous amount of studies investigating the consequences of electronic monitoring, as described in the previous chapter, very few of them focus on the antecedents of the acceptance level, except the studies done by Erickson et al. (2002), Greenbreg and Kuzuoka (2000), and Zweig and Webster (2002). The former two studies revealed that employees' privacy concerns could have an impact on accepting electronic workplace monitoring. In addition to privacy concern (privacy invasion), Zweig and Webster (2002) further hypothesized that fairness, perceived usefulness of the monitoring system affect the employees' attitudes towards the system and their willingness to accept the system. In their study, both fairness and privacy invasion significantly affect employees' attitudes and at the same time, greater perception of fairness is also affected by the characteristics of the system: (1) images are captured and projected intermittently versus continuously, (2) images are blurred rather than clear, (3) the employee has control versus no control over who can access to awareness information and, (4) the employee is given knowledge of who is using the system to determine their availability versus no knowledge. Although Zweig and Webster (2002)'s study gave an insight to this study, some of the constructs of their model including the characteristics and the perception of usefulness of the system are not applicable in the construction domain. The reason is very straightforward: most construction workers have very little or no knowledge about the purposes of the monitoring system, and the technologies behind it. According to the interviews (mentioned in the previous chapter), most construction workers knew the existence of the monitoring system because they had to help to adjust the positions of the monitoring viewpoints (cameras) regularly in order to avoid visual blocking by obstacles. Moreover, the subcontractor who directly employs the workers tend to declare to the workers that the system is indeed used by the higher management in order to avoid any unnecessary liability. Therefore, the system characteristics including image clarity, use frequency, control, and knowledge and the perceived usefulness of the system should be insignificant to affect the construction workers' attitudes and acceptance level on the system.

Nevertheless, Zweig and Webster's research framework and model (2002) shed light on this the study of this thesis, especially the authors suggested that the attitudes of the employees being monitored significantly affect their willingness to accept electronic monitoring. In fact, for the domain of information systems and management, the Technology Acceptance Model (TAM) (Davis, 1989) is widely adapted to explain the acceptance level of a technology. TAM is one of the most influential extensions of Ajzen and Fishbein (1975)'s theory of reasoned action (TRA), which suggests that perceived ease of use and perceived usefulness of a technology are the two strong determinants that affect the users' intention to accept and use a technology. It should be noted that this thesis aims to investigate the acceptance level of the construction workers who are not the users of the system and they have no choice whether they would like to be monitored or not. However, TRA and its successor, the theory of planned behavior (TPB) proposed by Ajzen (1991) could serve as the framework for explaining the compliance and resistance intention of construction monitoring system because TPB has subsequently proved useful for the prediction of intentions based on attitudes, beliefs, and social norms.

3.1 Theory of Planned Behavior (TPB)

In the theory of reasoned action (TRA), the predecessor of the TPB, Fishbein and Ajzen (1975) defined attitudes as evaluative links between objects and attributes. Beliefs are probabilistic evaluations of relations between objects. Social norms refer to an individual's perception of the expectations of individuals in his or her social environment (Fishbein and Ajzen, 1975). Meta-analytic reviews of the TRA (Sheppard et al., 1988) have supported Fishbein and Ajzen's claim that "… most behaviors can be accurately predicted from an appropriate measure of the individual's intention to perform the behavior in question" (Fishbein and Ajzen, 1975, p. 380). Later, Ajzen (1991) amended the theory of reasoned action to account for volitional control of behavior;

inclusion of this variable represented one of the primary structural differences between the theory of reasoned action and the theory of planned behavior. Volitional control served as a moderator variable: given a certain level of intentions, a behavior would more likely occur in situations where the behavior was under the control of the actor. The TPB and TRA frameworks have apparent application to the study of this thesis because the monitored construction workers may hold certain beliefs and may form attitudes about construction site monitoring and surveillance based on these beliefs. Moreover, intentions to comply or resist may relate to attitudes as well as social norms about these behaviors. Whether the construction workers then enact compliance or resistance behaviors may depend upon intentions and volitional control. Prior research has applied TPB to examinations of unauthorized behavior in organizations. For example, Loch and Conger (1996) applied TPB to employees' use of computers in organizations, and found that attitudes and social norms predicted intentions to misuse the organization's computers. Their study thus supported the utility of the theory in predicting behavioral intentions with reference to the use of technology in organizations.

In the TPB, attitudes are conceptualized as evaluations of objects. By evaluating an object, the individual attaches a certain positive or negative perception to the object. In a contemporary revision of TRA, Ajzen (1991) added the construct of perceived behavioral control to TRA in order to improve the model's applicability to situations in which the actors have environmental constraints that limit their behavioral options. Notably, Ajzen (1991) focused on the perception of such constraints, and thus cast behavioral control as a construct representing an individual's belief in his or her ability to act on an intention. Moreover, social norms within the organization are proposed to moderate the relationship between attitudes and intentions. In Fishbein and Ajzen's (1975) work, perceived social norms provided the individual with information about which behaviors are socially rewarded and which are socially prescribed in a given situation. In an organization, norms reflect what employees believe to be shared standards for acceptable and unacceptable behavior in their work environment. For instance, employees' perceptions of their workplace as highly profit-oriented might lead to the expectation that instrumental behaviors of employees to generate revenue would be socially acceptable. In other words, if employees perceive the condition of their workplace significantly affects the revenue of their organization, they might more accept the monitoring. For construction monitoring, however, social (organization) norms may not be appropriate to be used as a determinant to explain workers' acceptance or resistance. It is because their workplace, that is, a construction site, is such a messy and unpleasant environment that it is difficult to relate how the conditions of the site affect the revenue of the organization (i.e., the contractor employs them). Besides, other workplaces such as a service centre, a better service attitude may gain more customer loyalty, but to a construction contractor, their revenue is project based, and once the project is started, the organization revenue will not be increased because of better performance of their workers. Therefore, social (organization) norm is not considered as an antecedent that affects the acceptance level in this thesis, mainly because construction workers are unlikely to perceive their behaviors as socially (organizationally) rewarded.

3.2 Attitudes towards Acceptance and Resistance

In TPB, attitudes predict intentions. In this thesis, attitudes refer to the construction workers' attitudes towards electronic site monitoring, while the intentions are defined as the intentions to comply with electronic site monitoring, where the intentions reflect their degree of acceptance. In fact, Ajzen's TPB (Ajzen, 1991) and Trevino's framework (1986, Trevino and Youngblood, 1990) both contain similar elements that explain the relationships between attitudes and intentions. Trevino and Youngblood (1990; Trevino, 1986) developed a model of ethical decision-making that predicted an interaction of individual and situational factors in determining ethical decision making in organizations. In their framework, cognitions (defined similarly to attitudes in TPB) predict behavior, whereas situational and individual variables function as constraints (moderators) on the relationship between cognitions and behaviors. When their model is tested empirically, it was found that locus of control, organizational culture, and other variables influenced decision-making behavior. Most importantly, Trevino and Youngblood's (1990) study indicated that both contextual and individual difference variables functioned as main effects on ethical decision making, while locus of control functioned as a moderator, with an internal locus of control strengthening the relationship between environmental and other individual difference variables and ethical decision making. In other words, personal values or attitudes of an individual and the culture of the organization could influence the ethical decisions of the individual, and the strength of the influence is moderated by the individual's locus of control. When applying this concept in the context of this thesis, construction workers, on one hand, may perceive resistance to electronic monitoring as violating organizational rules. On the other hand, they may perceive compliance with the system as conflicting with their personal values, such as privacy and right. Locus of control may not be applicable to this study, as locus of control refers to the extent to which individuals believe that they can control events that affect them (Rotter, 1975). For construction monitoring, workers have no decision right and no control on the monitoring system so generally their locus of control should be very low and has very little effect on other variables. Conclusively, general attitudes pertaining to the appropriateness of electronic or automated construction monitoring can be categorized as an attitude predictor of compliance intentions because they are personal evaluations of the appropriateness of automated construction monitoring as an organizational practice. It is predicted in this thesis that construction workers who perceive any monitoring system to be a viable and justified means for the management to control and monitor their employees (not limited to the construction industry) would express higher intentions to comply with construction monitoring systems than those workers with more negative attitudes who do not generally endorse the development and application of the systems. Therefore the first hypothesis of this thesis is:

H1: Construction workers' attitudes towards the appropriateness of automated construction monitoring positively affect their intention to accept the monitoring systems.

3.3 Organizational Identification and Organizational Commitment

Instead of attitudes, job-relevant matters such as job satisfaction, absenteeism, turnover intentions, and job motivation may probably influence construction workers' intention to accept the monitoring systems. Although these matters seem to be more related to individuals' feelings, indeed they are tightly bonded with the organizational settings. As some studies suggest, attempts to understand organizational behavior inevitably raise the question of how attitudes and behavior are influenced by the psychological relationship between the individual and the organization (Ashforth and Mael, 1989; Meyer and Allen, 1997; Rhoades and Eisenberger, 2002; Van Dick, 2004). The extent to which individuals experience psychological linkage with the organization has been shown to be related to a host of job-relevant factors (Riketta, 2005; Podsakoff et al., 2000). Understanding the psychological relationship between the individual (construction workers) and the organization (contractor) therefore is of great theoretical and practical relevance for this thesis. However except the mentioned factors, there are more job-relevant factors such as job anxiety, stress, environmental change, peer support, and so on. For the scale of this thesis, it is rather impractical to include all of them in the search model and test them empirically. Fortunately, research has conceptualized two concepts, namely organizational identification and organizational commitment, which were found to be significantly reflect job-relevant factors and some organizational behaviors.

3.3.1 Definition of "Organization" in this Thesis

As a construction project relies on the cooperation of many organizations and parties, including property owner, architect, main contractor, and subcontractors of varies professions, construction workers of the project are in fact involved in a multi-organizational environment. Therefore, it is essential to recognize which organization most significantly leads a construction worker define himself in terms of a membership in that organization. For an ordinary company, an employee should perceive a certain level of identification in that company because they work under the environment that is managed by the company, and most importantly, their salaries are paid by the company. Following the same vein, the organization that exerts most influence to construction workers is not the contactor or subcontractor that directly "employs" them; instead it should be the main contractor. Construction workers work in the site that is managed by the main contractor, and their income source is indeed from the main contractor and "distributed" by the subcontractor that "employs" them. Because of the practice and culture of the industry, if the main contractor delays the payment to the subcontractor, the subcontractor is likely to delay the salary payment to the workers as well. In fact, from experience and observation, given that a construction worker is employed by Subcontractor A and the current main contactor is B, when people ask him about his work status, he tends to say "I am engaging in B's project" rather than "I am working for A". Therefore, in this thesis, the term "organization" of organizational identification and organizational commitment refers to main contractor of the construction project that the monitored construction workers are engaged in.

Notably, according to the interview with the actual users of the proposed monitoring system, although the construction workers were aware of the existence of the system, they did not have information about the ownership of the system because the main contractor did not acknowledge the details to the subcontractors of the workers. In fact, as very little information is passed down the hierarchy from the top management to reach to the worker level (Bateman and Snell, 1999), it is reasonable to say that if there is an automated construction monitoring system, workers of the site should perceive the ownership of the system as either the main contractor, or any higher level of the hierarchy such as the property owner. As explained, since construction workers generally perceive they work in the environment that is managed by the current main contractor, the workers should probably predict the current main contractor has the closest relationship with the system.

3.3.2 Organizational Identification

In an organization, group or organizational memberships are self-definitional to a greater or lesser degree (Hogg and Terry, 2000). Research on self-categorization and social identity describes how the individual may not only be defined in terms of unique, individuating characteristics that distinguish the individual from others, but may also be extended to include social groups (e.g., Hogg, 2003; Turner et al., 1987). This self-conception in terms of 'we' rather than 'I' in which social group membership becomes self-referential, is referred to as social identity (Hogg, 2003) or collective self (Brewer and Gardner, 1996). The concept of social identification reflects the extent to which the individual is defined in collective terms (Tajfel and Turner, 1986). Social identification implies a psychological 'integration' of self and group that leads individuals to perceive himself or herself as similar to other members of the group that he or she belongs to, to ascribe group-defining characteristics to himself or herself, and to take the group's interest to heart (Turner et al., 1987). Ashforth and Mael (1989) proposed that the extent to which individuals define himself or herself in terms of the membership in the organization is reflected in the concept of organizational identification, that is, the perceived oneness with the organization (Ashforth and Mael, 1989; Mael and Ashforth, 1992).

Organizational identification thus reflects the psychological combining of the individual and the organization (Haslam, 2001; Tyler and Blader, 2000). The more people identify with an organization, the more the organization's values, norms, and interests are incorporated in the self-concept. Collective interest is experienced as the self-interest (i.e., the collective self-interest), and individuals are intrinsically motivated to contribute to the collective (Ashforth and Mael, 1989; van Knippenberg and Ellemers, 2003). When self-definition is tied to the collective, people are also more inclined to remain members of the collective, and personnel turnover declines (Mael and Ashforth, 1995).

Following the vein of pervious studies, organizational identification in this thesis refers to the extent to which construction workers feel they share the current main contractor's value and belief, as well as the characteristics of organization members. If construction workers perceive themselves as sharing the main contractors' characteristics and values, they should unlikely intent to resist the policies and practices. In other words, if construction workers consider their own value system to be in congruence with the current main contractor, they should view organizational actions, including the implementation of monitoring systems as the current main contractor's attempt to act based on its values. As the result, for construction workers who consider their own values and beliefs to overlap with that of the main contractor, they should be less likely to resist monitoring systems than those who perceive the main contractor is acting upon values dissimilar to theirs. With regard to automated construction monitoring, construction workers' higher levels of organizational identification should thus lead to higher compliance intentions. Therefore this thesis hypothesizes that:

H2: The degree of construction workers' organizational identification positively affects their intention to accept the monitoring systems.

3.3.3 Organizational Commitment

Instead of organizational identification, the psychological link between individual and organization has typically been conceived of in terms of attitudinal organizational commitment (Meyer and Allen, 1997; Meyer et al. 2002; Mowday et al., 1982). Meyer and Allen (1997) identify three components of commitment, including continuance commitment (commitment from necessity), normative commitment (commitment from obligation), and affective commitment. Among the three components, the one most relevant to the comparison with organizational identification is affective organizational commitment (Gautam et al., 2004). Affective commitment is defined as "emotional attachment to, identification with, and involvement in the organization" (Allen and Meyer, 1990). Remarkably, although this definition refers to identification, it is not rooted in a social identity analysis highlighting the self-definitional nature of organizational membership. Just like identification, affective commitment has been found to be related to such attitudes and behaviors as job satisfaction, absenteeism, and turnover intentions, and in-role and extra-role performance (Elanain, 2010; Mathieu and Zajac, 1990; Meyer and Allen, 1997). An obvious question therefore is how identification and commitment are different from each other.

When recognizing the apparent overlap between the concepts of identification and commitment, Ashforth and Mael (1989) propose that the core difference between identification and commitment lies in the fact that identification reflects individuals' self-definition, whereas commitment does not. Whereas identification is a cognitive or perceptual construct reflecting the extent to which the organization is incorporated into the self-concept, commitment is more typically viewed as an attitude toward the organization (Pratt, 1998). In line with these differential conceptualizations, organizational identification is seen as contingent on factors such as perceived similarity and shared fate with the organization that may serve as precursors to self-categorization as a member of the organization, and on the extent to which organizational membership may positively reflect on the self and thus may contribute to positive self-conception (Dutton et al., 1994; Mael and Ashforth, 1992). Antecedents of affective commitment as a more attitudinal construct, in contrast, are usually sought in factors that make the job enjoyable and involving and may thus contribute to a positive attitude toward the organization (Meyer and Allen, 1997; Mowday et al., 1982), and in the quality of the exchange relationship between the individual and the organization (Rhoades and Eisenberger, 2002; Rousseau and Parks, 1993).

For the comparisons between organizational commitment and organizational identification, van Knippenberg and Sleebos (2006) contributed a comprehensive study. With the emphasis on self-definition versus social exchange is the most fundamental difference between commitment and identification, the authors suggested that commitment refers to a relationship in which the individual and the organization are separate entities psychologically, identification implies that the individual and the organization are one in the sense that the organization is included in individual's self-conception. Their empirical study tested and revealed three important differences between commitment and identification: (1) commitment is more closely related to perceived organizational support than identification is; (2) commitment is more closely related to job satisfaction than identification is; and (3) commitment is more closely related to turnover intention than identification is. Among the literature discussing the differences, Pratt (1998) gave an interesting and understandable argument:

> *"Organizational commitment is often associated with, 'How happy or satisfied am I with the organization?' Consequently, it is sometimes viewed as similar to, but more global than, job satisfaction, and it is often used to predict turnover and absenteeism. Organizational identification, by contrast, is concerned with the question, 'How do I perceive myself in relation to the organization?' This is not to say*

> *that individuals who identify strongly with the organization do not experience satisfaction; rather, satisfaction in identification is more 'ground' than 'figure'; that is, it is not central to the concept."*

Pratt's argument is coherent with other studies, such as commitment is found in variables related to the extent to which the job itself is enjoyable and challenging (Mathieu and Zajac, 1990; Meyer and Allen, 1997). Therefore, commitment thus should be closely aligned with job satisfaction (Reichers, 1985). Because people tend to think positively about things associated with the self, identification too may be positively related to job satisfaction (van Knippenberg and van Schie, 2000), but this should be a more distal association than for commitment and satisfaction.

Recall that Allen and Meyer (1990) distinguished among three components of organizational commitment, affective commitment as: "an emotional attachment to, identification with, and involvement in the organization"; normative commitment was defined as "a perceived obligation to remain with the organization"; and continuance commitment reflects "the perceived costs associated with leaving the organization". Therefore, it is predicted that construction workers with high affective organizational commitment, or high emotional attachment to the main contractor of the current project would be more likely to perceive organizational goals (e.g., complete the project within schedule, fulfill requirements, avoid accidents and troubles, etc.) as congruent with their own goals. Similarly, it is anticipated that construction worker with high normative commitment, or strong perceived obligations to cooperate with the main contractor would not only perceive obligations to cooperate with the main contractor, but would also feel obliged to act in line with the organization's policies and procedures. Therefore, it is expected that construction workers' organizational commitment could predict their intentions to comply or resist automated construction monitoring. The third hypothesis of this thesis is:

H3: The degree of construction workers' organizational commitment positively affects their intention to accept the monitoring systems.

3.4 Purposes of Automatic Monitoring

It is important to mention again that construction workers generally have very little or no knowledge about the purposes of implementing a monitoring system on their site; therefore different workers may have different interpretations on the management's intention of implementing such a system. Some may perceive the system is used to spot their misbehavior, some may suspect it is built for security purposes, while others may consider it as a safety assurance system. In order words, construction workers' perception on whether the monitoring system is for caring or control may have effect on their acceptance level of the system. Although there was no literature concerning the perception of the purpose of electronic workplace monitoring, the studies about ethical climate shed some light on this thesis. For the study of intentions to comply or resist electronic monitoring systems, organizational ethical climate is one of the critical determinants to influence the intention (Victor and Cullen, 1988). According to the study, organizations with strong caring ethical climates emphasize the importance of friendship, team performance and cohesiveness, and social responsibility. Hence, employees in organizations with a strong caring ethical climate should be less likely to form compliance or resistance intentions on the basis of their attitudes than employees in organizations with a weak caring climate. In Spitzmuller and Stanton's study (2006), the authors further explained that due to the focus on benevolence towards others, caring ethical climate is expected to evoke a "benefit of the doubt" phenomenon in which people would be more likely to comply regardless of their attitudes on the appropriateness of the use of electronic monitoring systems. They found that employees in organizations with a strong caring ethical climate to recognize their organization's focus on employee well-being. Spitzmuller and Stanton (2006) empirically tested that in the case of forming intentions to comply with electronic workplace monitoring, subjects who were exposed to highly caring ethical climates decided not to act upon their attitudes if the attitudes are not in line with their organizations' expectations. This implies that the link between attitudes and resistance to monitoring systems would be strong only in a climate perceived as uncaring.

In general, construction workers' perception on organizational (main contractor's) caring climate should be low as their relationship with a main contractor is weak because of the highly fragmentation characteristic of the industry. Therefore, Spitzmuller and Stanton (2006)'s argument "caring ethical climate moderates the relationship between attitudes and intentions to resist MST (employee monitoring and surveillance technologies) policies and practices such that the relationship would be stronger in uncaring climates" may not be applicable to the study of this thesis. However, as discussed, construction workers' perception on whether the monitoring system is intended for caring or control purposes may have effect on their acceptance level of the system, where the effect, as suggested by Spitzmuller and Stanton, is a moderating effect that influence the relationship between construction workers' attitudes towards the appropriateness of automated construction monitoring and their acceptance level of the system. As an example, if a construction worker perceives the system serves a strong caring purpose (e.g., for preventing accidents), even he thinks it is not very appropriate to implement monitoring systems in construction sites (e.g., it violates his privacy concerns), his acceptance level of implementing the systems in the site he is working in may still be high. With the above rationales, the fourth and the last hypothesis of this thesis is:

H4: Construction workers' belief on monitoring systems for caring purposes moderates the relationship between their attitudes towards the appropriateness of automated construction monitoring and their intention to accept the systems, such that the relationship is stronger when the belief is strong.

3.5 Research Model

In summary, three independent variables, one dependent variable, one moderator and four hypotheses are introduced in this thesis. The three independent variables, namely "attitudes towards the appropriateness of automated construction monitoring", "organizational commitment", and "organizational identification" are hypothesized to positively affect the dependent variable "intention to accept monitoring systems". The moderator, "belief on monitoring system for caring purposes" is hypothesized to moderate the relationship between the attitudes and the intention. The research model was constructed by adapting the research frameworks about electronic workplace monitoring in environments other than construction sites, theory of planned behavior (TPB), organizational identification, and organizational commitment with adequate refinements in order to fulfill the actual situation of automated construction site monitoring. As TPB suggested that behavioral intentions predict actual behaviors (Ajzen, 1985), instead of investigating the antecedents that influence construction workers' intention to accept monitoring systems, it is also anticipated that the proposed research model is also useful to explain the actual behaviors of construction workers by understanding their acceptance level of automated construction monitoring (actual behavior is not within the scope of the empirical study of this thesis). The proposed research model is illustrated in figure 3.

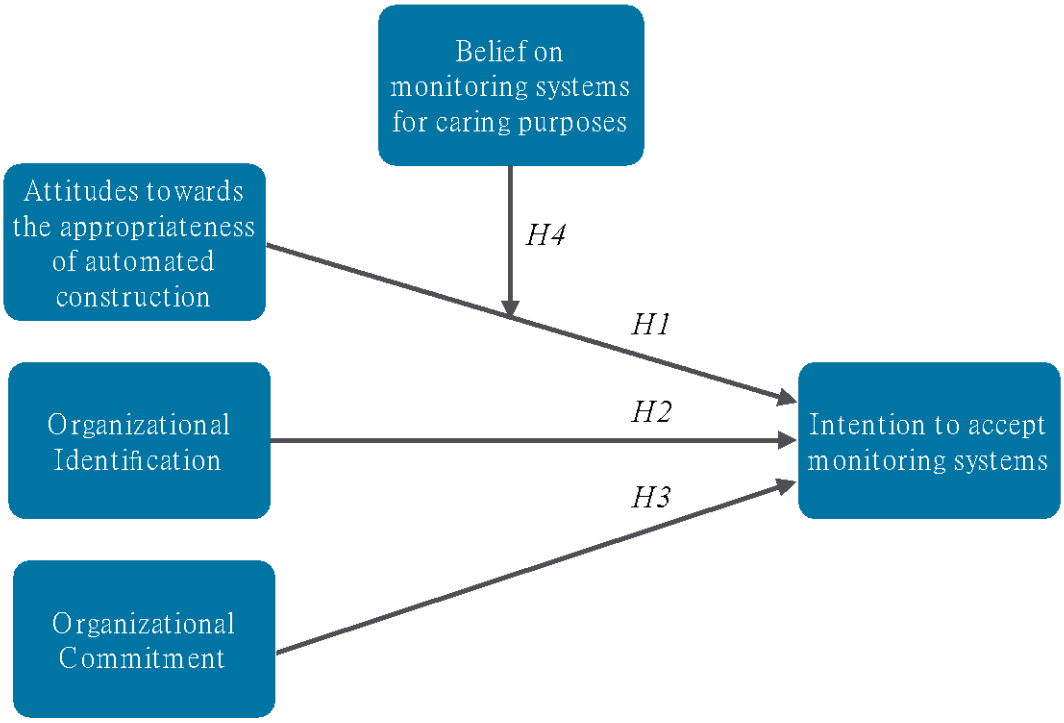

Figure 3. The Research Model

Chapter 4

Research Method

In order to test the hypotheses made in this thesis, an empirical study was performed. A questionnaire was designed by adapting and refining the survey items from previous studies on workplace monitoring and organizational behaviors. Then the questionnaire was further improved and refined according to the result of a pilot test (22 construction workers as the subjects). Finally the empirical data was collected through a face-to-face survey with construction workers (or laborers) as the subjects.

4.1 Instrumentation

The primary research activity was data collection through the use of a survey instrument, that is, a questionnaire. Prior surveys have relied upon independently developed questionnaires to collect data rather than previously validated instruments. One reason for this may be that most research projects focused on different and unique issues. Therefore, in the absence of an appropriate instrument, while some of questionnaire items were adapted and refined from different related literature, some of question statements were developed based on careful review of similar instruments and were modified as a result of comments and feedback from a test sample. The modified questionnaire was then pre-tested for validity through a pilot survey with construction workers. The measurements in the questionnaire are presented in Likert scale. A Likert item is simply a statement that the subject is asked to evaluate according to any kind of subjective or objective criteria; generally the level of agreement or disagreement is measured. It is considered symmetric or "balanced" because there are equal amounts of positive and negative positions (Likert, 1932). Designing a scale with balanced number of items can avoid the problem of acquiescence bias (always agree with statements as presented), since acquiescence on positively keyed items will balance acquiescence on negatively keyed items. Often five ordered response levels are used, although there exists some research advocate using seven or nine levels. A recent empirical study found that a five- or seven-point scale may produce slightly higher mean scores relative to the highest possible attainable score, compared to those produced from a ten-point scale, and this difference was statistically significant (Dawes, 2008).

For the first construct: “construction workers’ attitudes towards the appropriateness of automated construction monitoring”, the questionnaire items were adapted from one measure in Spitzmuller and Stanton (2006)’s study that assesses the attitudes of office workers towards monitoring and surveillance policies and practices. The measure examines whether individuals feel employers have the right to use various monitoring and surveillance technologies to monitor and report on both current employees and job applicants. Some of their question items mention the technologies that are not used by construction workers in construction sites nor considered as ways for constructing monitoring, including email, Internet, and computers. Moreover, in Hong Kong, there are about 89% of registered skillful construction workers who are over 40 years old (Construction Workers Registration Authority, 2010), and with the fact that construction workers generally have low education level, they may not be familiarized with the mentioned technologies. Therefore, some of the items are not included in the study of this thesis. For other questions such as “organizations like mine have the right to use cameras to monitor employee’s activities on the job”, and “organizations like mine have the right to use technologies to track the location of employees within companies” were excerpted and rephrased to in order to fit the context of this study. A five-point Likert scale was applied, with response option ranging from “strongly disagree” to “strongly agree”. The questionnaire items about the attitudes are:

1. For a construction site installed with video cameras, the efficiency of construction workers is better than the sites without video cameras.
2. The relationship between construction workers and the management will not become worse even video cameras are installed in their construction site.

3. Main contractor and management team have the right to monitor construction workers' activities within the construction site they are working in.
4. Main contractor and management team have the right to use technologies to track the location of construction workers within the construction site they are working in.

In order to measure organizational identification, a five-item scale ranging from "strongly disagree" to "strongly agree", developed by Mael and Ashforth (1992), was adapted in this thesis. The items were used in few studies (Wiesenfeld et al., 2007; Mael and Tetrick, 1992) and therefore they were empirically validated. The refined questionnaire items (except question 1) about organizational identification are listed below.

1. What is the name of the main contractor you recently cooperated with?
2. (It is assumed that now you are involved in a project that is held by [the name of the main contractor].) [The name of the main contractor]'s successes are my successes.
3. I am very interested in what others think about [the name of the main contractor].
4. When someone praises [the name of the main contractor], I feel like a personal compliment.

5. If a story on the media criticized [the name of the main contractor], I would feel embarrassed.

For the literature about organizational commitment, many of them (Sptizmuller and Stanton, 2006; van Knippenberg and Sleebos, 2006; Meyer and Allen, 1997) adapted Allen and Meyer's (1990) 8-item affective and normative commitment scale. In this thesis, their measurements of organizational commitment were not used because the questions may not be understandable to most construction workers. By considering the average education level of the workers, the questions like "I do not think that I could easily become as attached to another organization as I am to this organization" and "one of the reasons I continue to work for this organization is that I believe loyalty is important" may be too hard to understand to the workers, and they probably do not fit for the actual situation of construction industry. As a result, organizational commitment was measured using Currivan (1999)'s scale because not only are the items more understandable to common people, the measures also have demonstrated acceptable reliability and validity in previous studies of employee orientations in work organizations (Iverson, 1992; Iverson and Roy, 1994; Kim et al., 1996; Mottaz, 1988). Originally, all questionnaire items about this independent variable employed a five-point scale with 1 assigned to "strongly agree" and 5 assigned to "strongly disagree". For these five-point scales, Currivan (1999) reversed-coded "positively-worded" items so that the data record higher scores for respondents who agreed with each item.

This reversal modification suits the study of this thesis because it is hypothesized that organizational commitment has a positive effect on the intention of acceptance. The rephrased questionnaire items are as followings:

1. [The name of the main contractor] is the best of all main contractors that I have ever cooperated with.
2. I care about the fate of [the name of the main contractor].
3. I speak highly of [the name of the main contractor] to my friends.
4. I am proud to tell others I cooperate with [the name of the main contractor].

The dependent variable in this thesis is the construction workers' intention to accept automated construction monitoring systems. Since monitoring policies within organizations vary substantially in form and content (i.e. different technologies, personnel policies, and degrees of publicity to employees), obtaining retrospective reports or making on-site observations of actual compliance and resistance behavior would potentially suffer from memory biases, low base rates, or both (Spitzmuller and Stanton, 2006). Prior research has indicated the viability of using intentions as a proxy for future organizational behavior (e.g. Rogelberg et al., 2001; Sheppard et al., 1988). In this thesis, there are five behavioral intention items that were excerpted and modified from Spitzmuller and Stanton (2006)'s measurements. They developed the items according to the strategy described by Ajzen and Fishbein (1980). Item content was derived from open-ended interview studies reported by Stanton and Weiss (2000, 2003). Item development was also guided by the literature on workplace deviance (e.g. Bennett and Robinson, 2000) and the literature on compliance with organizational policies (e.g. Hope and Pate, 1988; Hodson, 1991). These sources converged on the importance of including items that focused on active and passive forms of behavior (e.g. sabotage vs. acceptance) and interpersonally-focused versus impersonally-focused forms of behavior (e.g. reporting a non-compliant worker vs. modifying a computer's settings). Again, as some of the questions are not suitable for measuring the acceptance level of automated construction monitoring system, the questionnaire items regarding the dependent variable are modified as below (5-point Likert scale, ranged from “strongly disagree” to “strongly agree”):

You are now working in a construction site is managed by [the name of the main contractor]. If there is a construction monitoring system installed in the site:

1. I will accept the monitoring system.
2. I will circumvent the system. (reverse)
3. I will encourage my co-workers to alter the system so that none of us can be monitored. (reverse)

4. I will ask my co-workers to try to circumvent being monitored. (reverse)
5. I will complain about it with my supervisor and / or with someone who are responsible for the implementation of the system. (reverse)

The final set of questions is about construction workers' belief on monitoring systems for caring purposes, a moderator that affect the relationship between their attitudes and the intention to accept the systems. In the absence of appropriate measures about the belief in previous studies, the questions below were developed specifically for the study of this thesis. The questions were pre-tested for validity through the mentioned pilot survey, and are listed below (5-point Likert scale, ranged from "strongly disagree" to "strongly agree"):

1. I believe the monitoring system is used to prevent accidents.
2. I believe the monitoring system is used to check if the construction workers are overloaded.
3. I believe the monitoring system is used for security purposes.
4. I believe the monitoring system is used to check if the construction workers do something not appropriate. (reverse)
5. I believe the monitoring system is used to monitor if the construction workers are hardworking enough. (reverse)
6. I believe the monitoring system is used to spot the errors of the construction workers. (reverse)

4.2 Data Collection

With the assistance of technologies, nowadays there are various ways to collect survey data, including telephone, direct email, online questionnaire forms, and even developing software programs specifically for simulating actual situations and collecting subjects' perceptions (Chau et al., 2007). Although this thesis examines construction worker's propensity to accept a technology, conventional face-to-face, one-to-one survey method was used because live question and answer interview is one of the most accurate forms of information gathering. Although time consuming and costly, the face-to-face survey method collected data that was practically looked upon as scientific fact. Arguably true, interviews were the most reliable form of surveys at one time, and they were considered to provide the most accurate data because the questions could be lengthy and the interviewer could get a more in-depth response from the subject. While the instruments of this thesis are structural, one reason to adopt face-to-face survey is that most subjects, that is, construction workers are relatively not young (as mentioned, about 89% of registered skillful construction workers in Hong Kong are over 40 years old). The response rate of any Internet-related survey method, including email and online questionnaire is generally considered as not high. Using such data collection methods in this study may obtain even more unsatisfactory response rate, because the subjects may not be familiarized with the Internet.

Although it is costly (time and personnel) to conduct face-to-face survey, there was a critical reason for not to use other data collection methods in this thesis: construction workers are generally with low education level. Although all questionnaire items were translated into Chinese (Appendix 1), some of them may not understand clearly with the questions, may find it difficult to answer them, or may be reluctant to read and complete them. Thus the collected data by using other methods may have low reliability. Nevertheless there is one major drawback of face-to-face survey. The question and answer nature of live interviews requires personnel who conduct the survey to be well-versed in the survey material. They also need to be prepared to handle a wide variety of potential questions and responses from the subject. If training is poor, interviewers can make errors when gathering their data. These errors run the risk of ruining the accuracy of a survey. In order to obtain reliable data, instead of the author of this thesis, a full-time researcher who has a Ph.D. degree and a part-time researcher who has an MPhil degree participated as interviewers for the study. They both have building, construction and real estate education background so they were familiarized with construction industry and the research background of this thesis.

4.3 Participants

Twenty-two construction workers were the subjects of the pilot survey. They were recruited through the connection with the construction practitioners involved in the previous study about implementing a construction monitoring system (Leung et al., 2008). The data collected in the pilot survey and feedbacks the subjects were used to adjust and refine the wordings of the original questionnaire items. The final questionnaire items are described in 4.1. None of the data collected in the pilot survey was included in the major survey. For the major survey, seventy-three construction workers from three different subcontractors were participated as the subjects. As a note, the response rate of this study is 100% as the survey was conducted in face-to-face, one-to-one fashion. They were approached through the connection of one of the interviewers who has a good relationship with the management of the subcontractors. In order to motivate the subjects to answer the questions more seriously, a HK$20 cafeteria coupon was given to each of them as an incentive; and they were told before the survey started. On average, about ten minutes were spent on each subject. The demographics about their job title and construction work experience are shown in Table 1 and 2, respectively.

Job Title	Percentage of Total Subjects
Carpenter	4.1%
Concretor	6.8%
General Worker	67.1%
Woodwork Joiner	16.4%
Others	5.5%

Table 1. Job titles of the subjects

Construction Work Experience	**Percentage of Total Subjects**
Less than 3 years	5.4%
3 – 6 years (exclude 6)	6.8%
6 – 9 years (exclude 9)	20.5%
9 – 12 years (exclude 12)	24.7%
12 – 15 years (exclude 15)	21.9%
15 – 18 years (exclude 18)	13.7%
18 – 21 years (exclude 21)	4.1%
over 21 years	2.7%

Table 2. Construction work experience of the subjects

Chapter 5

Results and Data Analysis

In order to test the hypotheses, several statistical techniques were used. First of all, as each of the independent variables (i.e., the antecedents) and the dependent variable (i.e., the acceptance intention) were measured by multiple correlated survey items, for each item, principle component analysis (PCA) was used to combine the correlated items into one index. For the moderator (i.e, belief on monitoring systems for caring purposes), it is generally considered as an interaction variable in statistical analysis, where it is common to use products of original variables as the basis of testing. In order to test the correlations between the antecedents and acceptance level, linear regression was used. Figure 4 summarizes the statistical techniques that were adopted in this thesis. Before processing to the data analysis part, the subsequent sections briefly describe the adopted techniques.

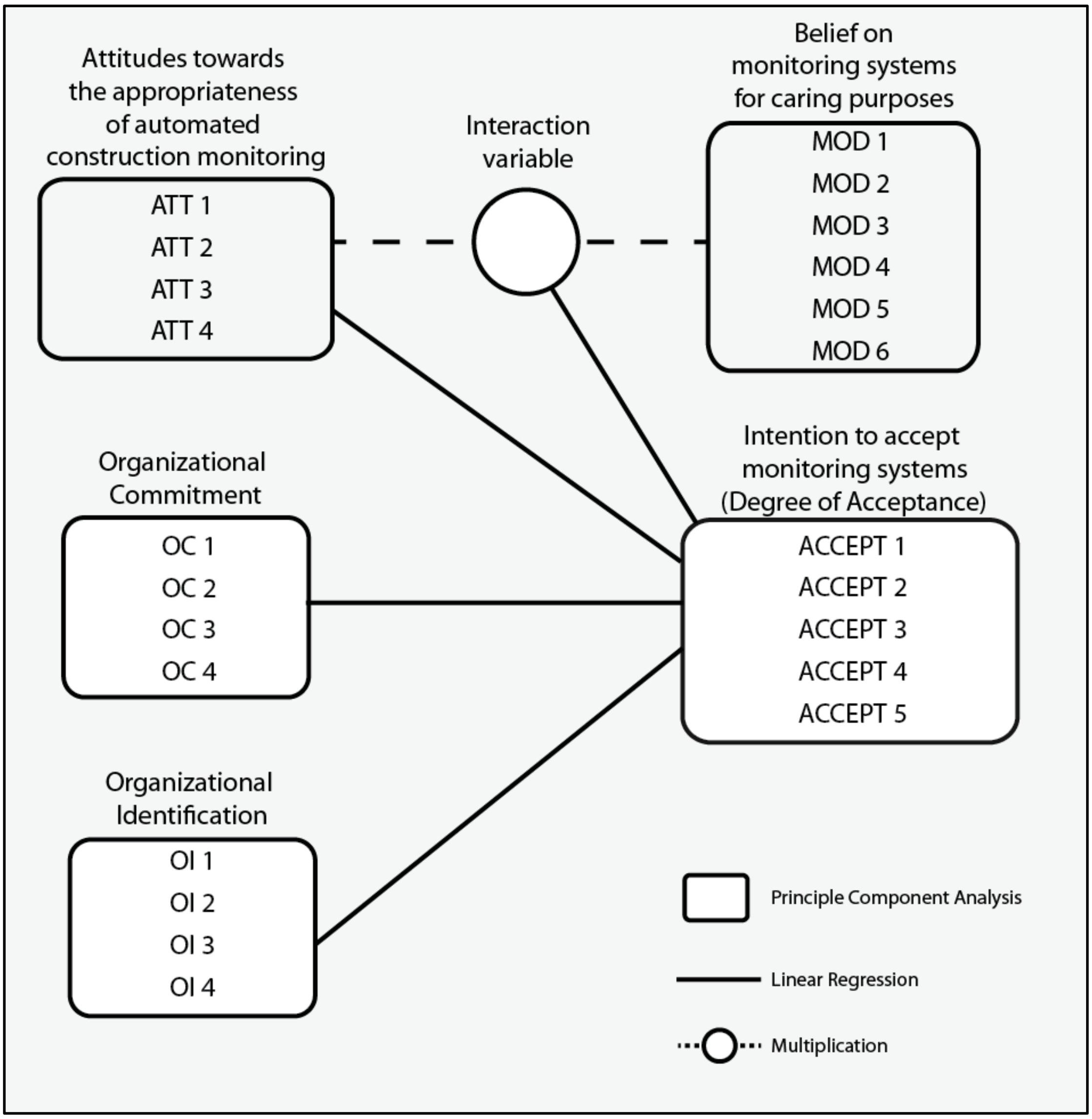

Figure 4. Statistical techniques used in this thesis

5.1 Principle Component Analysis

Principle component analysis (PCA) is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of uncorrelated variables called principal components. The number of principal components is fewer than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has as high a variance as, and each succeeding component in turn has the highest variance possible under the constraint that it be orthogonal to (uncorrelated with) the preceding components. Principal components are guaranteed to be independent only if the data set is jointly normally distributed. PCA is sensitive to the relative scaling of the original variables. Depending on the field of application, it is also named the discrete Karhunen–Loève transform (KLT), the Hotelling transform or proper orthogonal decomposition (POD) (Jolliffe, 2002). PCA is mostly used as a tool in exploratory data analysis and for making predictive models. PCA can be done by eigenvalue decomposition of a data covariance matrix or singular value decomposition of a data matrix, usually after mean centering the data for each attribute. The results of a PCA are usually discussed in terms of component scores (the transformed variable values corresponding to a particular case in the data) and loadings (Shaw, 2003). PCA is the simplest of the true eigenvector-based multivariate analyses. Often, its operation can be thought of as revealing the internal structure of the data in a way which best explains the variance in the data. If a multivariate dataset is visualized as a set of coordinates in a high-dimensional data space (one axis per variable), PCA can supply the user with a lower-dimensional picture, a "shadow" of this object when viewed from its (in some sense) most informative viewpoint (Kramer, 1998).

In this thesis, PCA was used to combine each set of correlated questionnaire items (measurements) into the single proposed variables (dependent or independent). Take the construct, "intention to accept automated construction monitoring systems" as an example, it consists of a set of five questionnaire items, namely, 1.) "I will accept the monitoring system", 2.) "I will circumvent the system" (reverse), 3.) "I will encourage my co-workers to alter the system so that none of us can be monitored" (reverse), 4.) "I will ask my co-workers to try to circumvent being monitored" (reverse), 5.) "I will complain about it with my supervisor and / or with someone who are responsible for the implementation of the system" (reverse). PCA was used to combine those five measurements into a single variable with the same scale, that is, from one to five. Since PCA expects the input measurements are correlated, it is necessary to test if those five measurements are indeed correlated before using PCA. As a rule of thumb, the correlation between two normal random variables is considered statistically significant if the sample correlation coefficient r is sufficiently large, where the sufficiency is dependent on the sample size n. Specifically, if $|r| > 2 / \sqrt{n}$, then the correlation is statistically significant at approximately the .05 level of significance (Machin et al., 1997). As seventy-three subjects participated in this study, any two measurements are considered as correlated if their $|r|$ is larger than 0.2341. Figure 5 depicts the correlation matrix of the five measurements. Perhaps the questionnaire items were developed from previous research frameworks with careful refinement, the correlation matrix shows that the correlations between the measurements are strong and therefore they were appropriate to be fed to PCA in order to form the dependent variable.

	accept1	accept2	accept3	accept4	accept5
accept1	1.0000				
accept2	0.7363	1.0000			
accept3	0.6677	0.6727	1.0000		
accept4	0.7579	0.7281	0.7477	1.0000	
accept5	0.7076	0.7216	0.7236	0.7274	1.0000

Figure 5. Correlation matrix of the measurement of "intention to accept automated construction monitoring systems"

The items in other sets of measurements, including "attitudes towards the appropriateness of automated construction" (att), "organizational identification" (oi), "organizational commitment" (oc), and "belief on monitoring systems for caring purposes" (mod, means moderator) were also found to be significantly correlated with each other. Their correlation matrices are shown in Figure 6. The smallest value of *r* is just 0.4285 (mod1 and mod6), which is significantly larger then the required value 0.2341. As a result, the five sets of measurements were gone through PCA and were combined as five variables (one dependent, three independent, and one interaction). Notably, PCA only returns new variables, the principal components or axes that summarize the information contained in the original full set of variables. PCA does not test any hypotheses or predict values for dependent variables. Therefore, the purpose of using PCA in thesis was only to combine the sets of measurements into the single variables, further data analysis technique were required to test the hypotheses.

	oc1	oc2	oc3	oc4
oc1	1.0000			
oc2	0.6187	1.0000		
oc3	0.7181	0.6506	1.0000	
oc4	0.6787	0.4637	0.7162	1.0000

	oi1	oi2	oi3	oi4
oi1	1.0000			
oi2	0.5515	1.0000		
oi3	0.6895	0.6401	1.0000	
oi4	0.6300	0.6038	0.6136	1.0000

	att1	att2	att3	att4
att1	1.0000			
att2	0.6626	1.0000		
att3	0.7856	0.5956	1.0000	
att4	0.8012	0.6361	0.6974	1.0000

	mod1	mod2	mod3	mod4	mod5	mod6
mod1	1.0000					
mod2	0.6768	1.0000				
mod3	0.6855	0.6691	1.0000			

mod4	0.4740	0.5666	0.6672	1.0000		
mod5	0.6736	0.6505	0.6890	0.6353	1.0000	
mod6	0.4285	0.4340	0.5533	0.6893	0.6195	1.0000

Figure 6. Correlation matrix of the other four measurements

5.2 Interaction Variable

In statistics, an effect of interaction occurs when a relation between two variables is modified by one or more variables. In other words, the strength of a relation between two variables is different depending on the value (level) of some other variable(s). An interaction variable (or called "moderator" in social science disciplines) is a variable constructed from an original set of variables to try to represent either all of the interaction present or some part of it. In exploratory statistical analyses it is common to use products of original variables as the basis of testing whether interaction is present with the possibility of substituting other more realistic interaction variables at a later stage (Bailey, 2008). When there are more than two explanatory variables, several interaction variables are constructed, with pairwise-products representing pairwise-interactions and higher order products representing higher order interactions. In this thesis, there is only one interaction variable (moderator). In order to test the significance of the moderating effect, the independent variable (the attitude antecedent, after PCA) was multiplied with another variable (belief on monitoring systems for caring purposes, after PCA) to form an interaction variable, then a correlation between the interaction variable and the dependent variable (acceptance intention) was tested through regression. The results are discussed in section 5.4.

5.3 Linear Regression

In statistics, linear regression is an approach to model the relationship between a scalar variable *Y* and one or more variables denoted *X*. Data is modeled using linear functions, and unknown model parameters are estimated from the data. Such models are called linear models. Most commonly, linear regression refers to a model in which the conditional mean of *Y* given the value of *X* is an affine function of *X*. Less commonly, linear regression could refer to a model in which the median, or some other quantile of the conditional distribution of *Y* given *X* is expressed as a linear function of *X*. Like all forms of regression analysis, linear regression focuses on the conditional probability distribution of *Y* given *X*, rather than on the joint probability distribution of *Y* and *X*, which is the domain of multivariate analysis. Linear regression was the first type of regression analysis to be studied rigorously, and to be used extensively in practical applications (Draper and Smith, 1998). This is because models which depend linearly on their unknown parameters are easier to fit than models which are non-linearly related to their parameters and because the statistical properties of the resulting estimators are easier to determine.

In particular, regression analysis is used to produce an equation that will predict a dependent variable using one or more independent variables. The equation has the form:

$$Y = b_1X_1 + b_2X_2 + \ldots + a,$$

where Y is the dependent variable; X_1, X_2 and so on are the independent variables; b_1, b_2 and so on are the coefficients or multipliers that describe the size of the effect the independent variables are having on the dependent variable Y; and a (constant) is the value of Y predicted to have when all the independent variables are equal to zero. Therefore in this thesis, Y is regarded as “intention to accept automated construction monitoring systems”, while the four Xs are “organizational identification”, “organizational commitment”, “attitudes towards the appropriateness of automated construction monitoring”, and the interaction variable introduced in the previous section. Noticeably, all of these variables were combined by PCA before regression.

5.4 Regression Analysis

When running regression, it is important to determine whether the coefficients on independent variables are really different from zero, such that the independent variables are having significant effects on the dependent variable, or if alternatively any apparent differences from zero are just due to random chance. Therefore null hypotheses were made such that each independent variable is having absolutely no effect (has a coefficient of zero) on the dependent variable. If a null hypothesis of an independent variable and a dependent variable is rejected then it could be assumed that the independent variable affects the dependent variable significantly. Moreover, the value of the coefficient for each independent variable gives the magnitude of the effect that variable is having the dependent variable, and the sign on the coefficient (positive or negative) is related to the direction of the effect. In this thesis, all independent variables, including the interaction variable were hypothesized to have positive effects on the dependent variable, therefore before data analysis, it was expected that all coefficients are positive. In regression with a single independent variable, the coefficient indicates how much the dependent variable is expected to increase (if the coefficient is positive) or decrease (if the coefficient is negative) when that independent variable increases by a certain amount. In regression with multiple independent variables like the data analysis of this thesis, the coefficient implies how much the dependent variable is expected to increase when that independent variable increases by a certain amount, while keeping all the other independent variables as constants.

It is not enough by only analyzing the magnitudes of the coefficients because the values imply nothing about the significance of the relationship between independents variables and dependent variable. It is possible to have a highly significant result for a miniscule effect. In order to measure the significance, *t*-value was introduced. It is the coefficient divided by its standard error, where the standard error is an estimation of the standard deviation of the coefficient. It can be regarded as a measure of the precision with which the regression coefficient is measured. However, the "sufficient" magnitude of *t*-value is case-dependent because it is often affected by other variables such as sample size. As a common practice, the *t*-value of a variable is compared with values in the Student's *t*-distribution to determine the *p*-value: the probability of seeing the result as an extreme case such that a collection of random data has no effect, or the probability that the null hypothesis is supported. If 95% of the *t*-distribution is closer to the mean than the *t*-value on the coefficient, then the *p*-value is 5%, or 0.05. A *p*-value of 0.05 or less is the conventionally accepted point at which to reject the null hypothesis. With a *p*-value of 0.05, there is only a 5% chance that the observed figures would have come up in a random distribution, or it is 95% confident to confirm a variable is having some effects.

Figure 7 shows the regression results of the test of the hypotheses for the antecedents, moderator and the intention of acceptance, which were produced by Stata, a general-purpose statistical software package. For clearer presentation, the research model with correlation coefficients R and p-values is shown in Figure 8. All statistical results are attached in Appendix A.

```
.
. regress accept oc oi att interactive

      Source |       SS           df       MS      Number of obs   =        73
-------------+----------------------------------   F(  4,     68)  =     44.55
       Model |  362.890451         4  90.7226128   Prob > F        =    0.0000
    Residual |  138.462106        68  2.03620744   R-squared       =    0.7238
-------------+----------------------------------   Adj R-squared   =    0.7076
       Total |  501.352557        72  6.96322996   Root MSE        =     1.427

------------------------------------------------------------------------------
      accept |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          oc |   .3762898   .1590264     2.37   0.021     .0589576     .693622
          oi |   .4422044   .1547676     2.86   0.006     .1333706    .7510383
         att |  -.2640749   .1134082    -2.33   0.023    -.4903774   -.0377724
 interactive |  -.0103757   .0098316    -1.06   0.295    -.0299943    .0092429
       _cons |   3.563163   1.004733     3.55   0.001      1.55825    5.568076
------------------------------------------------------------------------------

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of accept

         chi2(1)      =     4.19
         Prob > chi2  =   0.0405
```

Figure 7. Regression results

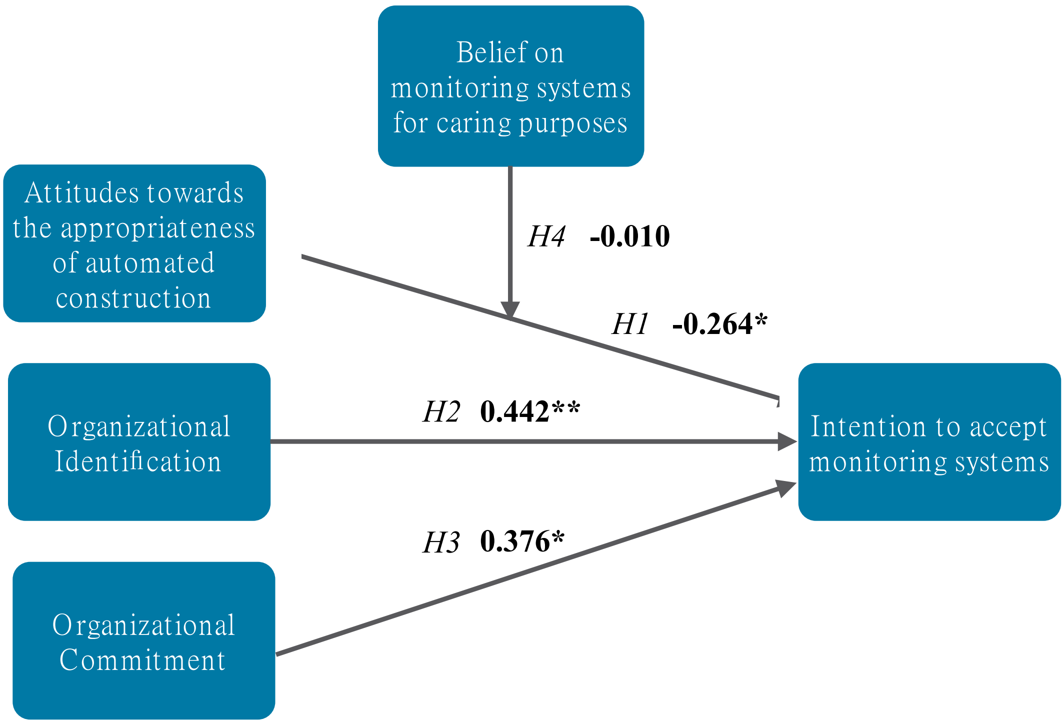

Figure 8. The research model with correlation coefficients (*p<0.05, **p<0.01)

The three independent variables (antecedents) “attitudes towards the appropriateness of automated construction monitoring”, “organizational commitment”, and “organizational identification” were found to be the prominent predictors that influence construction workers’ intention to accept monitoring systems. It was because the *p*-value of each relationship between the independent variables and dependent valuable is smaller than 0.05, which means the independent variables were significantly affecting the dependent variable. The relationship between “organizational identification” and the intention exhibited the greatest significance as the *p*-value was even smaller than 0.01. However, only Hypothesis 2 and 3 were supported but not Hypothesis 1. It was because the *R* of Hypothesis 1 was a negative value, which implied the attitudes were negatively affecting the intention, and it was totally opposed with Hypothesis 1. This was an interesting finding because the negative relation is also incoherent with literatures about electronic workplace monitoring claiming that for an employee who has more positive attitudes towards electronic monitoring, he or she should have higher intention to accept the systems. This finding implied that construction workers might have different attitudes towards automated monitoring when comparing with office workers, this may be due to the unique characteristics of the construction industry and it is worthy to be discussed in details in the next chapter.

For the two supported hypotheses, organizational identification was the strongest predictor of the intention to accept monitoring systems. Although as a predictor, organizational commitment was weaker (with smaller *R*) than organizational identification, it was still affecting the intention of acceptance significantly. The result was consistent with previous studies on workplace policies, which suggested the relationships between employees and employers, and employees' perception of their employers are determinants of employees' intention to accept a policy. The finding also confirmed that although both organizational identification and organizational commitment share some similarities, they have different effects on the intention. Last but not least, the proposed moderator, "belief on monitoring systems for caring purposes" did not have interaction effect on the relationship between the attitudes and intention of acceptance and therefore Hypothesis 4 was not supported.

Chapter 6

Findings and Discussions

This thesis aimed to examine the influence of the antecedents on construction workers' intention to accept monitoring systems. It was hypothesized that three antecedents, namely (1) attitudes towards the appropriateness of automated construction monitoring, (2) organizational identification, and (3) organizational commitment positively affect the intention of acceptance. Meanwhile, construction workers' belief on monitoring systems for caring purposes is hypothesized to be affecting the relationship between the attitudes and the intention. In the previous chapter, the research model was tested and it was revealed that both organizational identification and organizational commitment were significantly affecting the intention of acceptance (i.e., H2 and H3 were supported). Although the attitudes were significant enough to affect the intention of acceptance, the effect was negative such that construction workers' attitudes towards the appropriateness of automated construction monitoring negatively correlated with their intention to accept systems, which is reversed with the hypothesis made in this thesis (i.e, H1 was not supported). Finally the moderator was tested with the result that it could not affect the relationship between the attitudes and intention significantly (i.e., H4 was not supported).

6.1 Attitudes Towards the Appropriateness of Automated Construction Monitoring

The most important finding from the data analysis was that the subjects' attitudes towards the appropriateness of automated construction monitoring did not positively affect their intention to accept the systems. It was because this result contradicted with most studies about electronic workplace monitoring which suggested employees' perceptions of privacy invasion (Alge, 2001; Hovorka-Mead et al, 2002), unfairness (Zweig and Webster, 2003; Stanton, 2000), un-conscientiousness (Funder, 2001; Goldberg, 1992), etc. could cause employees' negative reactions with monitoring practices implemented in their workplaces. In Spitzmuller and Stanton (2006)'s study, the authors even found there was a strong negative correlation between surveillance attitudes and resistance intentions. Although the finding in this thesis regarding the relationship between attitudes and intentions is not consistent with the studies about electronic workplace monitoring, the phenomenon could be explained with the unique natures of construction industry. For a construction worker who feels implementing automated construction monitoring is appropriate, he probably considers the monitoring practice is beneficial to him and his co-workers in some aspects. For example, accident prevention and theft avoidance have a positive effect on project progress, and could leverage the quality of the entire construction industry. In other words, the higher appropriateness of implementing automated monitoring a construction worker perceives, the higher possibility he tends to consider the appropriateness of a new practice or rule from the perspective of justice, rationality, and benefits of the whole, rather than just relying on personal stands or emotion. Moreover, for someone who thinks a controversial practice is appropriate, to a certain extent, he or she should have considered more about the rationales behind the practice, and the consequences of implementing the practice than someone who thinks the practice is inappropriate, especially if the practice could violate his or her interest. Take "smoking in public places is illegal" as an example, for someone who smokes and still thinks the law is appropriate, he or she should have evaluated the costs, benefits, and consequences carefully before making the claim of appropriateness. In contrast, a smoker who thinks the law is inappropriate may simply because the law violates his or her interest, and therefore the claim of inappropriateness could be made without deep consideration. In the context of this study, according to the interviews with the construction practitioners, it is quite common that construction workers exhibit some misbehaviors on sites, such as improper littering, misplacement of tools, without attaching safety harness when working at heights, and so on. Following the logic mention previously, for a construction worker who thinks implementing automated construction monitoring is appropriate, he should probably have considered the possible purposes of the implementation (although he may be not sure the exact purposes), it's benefits, and most importantly, the consequences when any misbehavior is spotted. As a result, if he is asked whether he intends to accept any monitoring system installed in the site he is working in, his answer would be negative because he does not want him and his colleagues (in case he behaves well) getting into any trouble.

By analyzing from the perspective of a construction worker who tends to consider implementing automated construction monitoring as inappropriate and the fact that the industry is highly fragmented, his tendency of acceptance could be further explained. Despite the discussed possibility that the inappropriateness perception may imply low awareness of the rationales to implement the systems and the consequences of automated monitoring, with the possibility that workers generally believe the ownership of the systems is the main contractor or other parties instead of the subcontractor that the workers belongs to, he may not be care if there is any monitoring system installed. When the existence of monitoring systems is not a concern to him, the question of whether to accept any monitoring system could be interpreted as whether to comply the rules or fulfill the requests by the main contractor. Consequently, when he is asked whether he intends to accept any monitoring system installed in the site he is working in, he may tend to choose accept rather than resist. In fact, the relatively high unemployment rate of the construction industry (at the period when this study was conducted) may lead some workers to accept rules and practices easily, even they are not perceived as appropriate. According to a report by Hong Kong Census and Statistics Department, from year 2008 to 2010, the highest seasonal employment rate of the construction sector reached 12.0%. While the lowest unemployment rate of the industry is 5.5%, it is still higher than the average highest unemployment rate among all sectors (from 3.3% to 5.3%). Therefore, it could be anticipated that some construction workers tend to accept monitoring systems because they are fear of losing a job.

This is also consistent with the open-ended comments collected in the survey such as “have no alternative choice but to accept”, “it is higher level people’s idea so I have to accept”, and “I do not care about any monitoring system because I do not do anything wrong”.

Although the proposed moderator was found insignificant to moderate the relationship between construction workers’ attitudes towards the appropriateness of automated construction monitoring and their intention to accept the systems, the above explanations imply that other moderators may exist affecting the relationship. As discussed, construction workers’ “perceived importance of societal benefit” and / or “perceived importance of self-benefit” may moderate the strength of the relationship between the attitudes and the intention, such that the strong “perceived importance of societal benefit” may weaken the relationship. Indeed, Zweig and Webster (2003) conducted an empirical study with university students as subjects and proposed that “personality” could moderate monitoring acceptance. However, their dimensions of personality, including extraversion, emotional stability, agreeableness, openness to experience, and conscientiousness (Funder, 2001; Goldberg, 1992; McCrae and Costa, 1999) did not consist of consideration of benefits. It is noteworthy that because the construction industry is so complex, more effort has to be spent on defining “societal benefit”. Should it be in the subcontractor level, main contractor level, project level, or on the entire construction industry? Nevertheless, this thesis aims at shedding some light on future research such that self-benefit could be included as moderators. Moreover, the characteristics of an industry may also moderate or affect the intention of monitoring acceptance. This thesis suggests that the high unemployment rate of the construction industry may override some workers' attitudes such that they may treat the monitoring practice as a rule, where accepting the monitoring refers to obeying the rule. It is important to emphasize "characteristics of an industry" could be consisting of employment rate, average income, accident rate, promotion opportunities, etc., where they should appear in industrial or career level and do not overlap with organizational settings. As different industries may have different characteristics, researchers may consider including this factor on future studies about electronic workplace monitoring.

6.2 Construction Workers' Belief on Monitoring Systems for Caring Purposes

Although the hypothesis about the moderator, "construction workers' belief on monitoring systems for caring purposes" was not supported, the results of the proposed moderator have a practical implication. According to the data, if there is a construction monitoring system installed in the subjects' working site, over 90% of the them strongly agree or agree that it is used to check if they do something not appropriate, and over 85% of them strongly agree or agree that it is used to monitor their work progress. Meanwhile, there is only about 17% of subjects strongly agree or agree the system is used to prevent accidents and less than 10% of them tend to agree that it is used to check if they are overloaded. The figures imply most subject believe that if there is a monitoring system, it is used for control purposes much more than for caring purposes. As a result, the dominated result is perhaps the major factor causing the hypothesis unsupported. As mentioned, one of the reasons for this thesis to include the moderator in the research model because there was an assumption: safety and health issues are critical in a construction site so workers should somehow believe caring of workers is one of the purposes of automated monitoring. By analyzing with the dominated results, the assumption may hold when their belief is not only based on their guesses on the purposes of the system. That is, if the construction workers were told that the systems are used to prevent accidents before they discover the system, combining the common sense that construction sites are dangerous workplaces, the probability that the workers believe the system is really aimed for caring purposes may be higher. Therefore, in order to avoid misunderstanding, the management or the owner of a monitoring system could convey a strong signal to the workers of the intended usage of the system to care rather than to monitor. This approach can not only help to avoid unnecessary predictions, but also expresses the respect to construction workers. Last but not least, as previous research has demonstrated that if employees are provided with adequate, sensitive explanations for organizational policies, they are more likely to comply with those policies (Greenberg, 1990), a future comparative study could be conducted to investigate if there is a prominent difference in acceptance intentions between a group of construction workers who know the monitoring purposes and a group who do not know the purposes.

6.3 Organizational Identification and Organizational Commitment

The result shows that both construction workers' organizational identification and organizational commitment were found as two strong determinants influencing their intention to accept monitoring systems, which is also coherent with the findings of the studies about electronic workplace monitoring, such as Spitzmuller and Stanton (2006)'s work. In this thesis, organizational identification is the degree to which a construction worker experiences a sense of oneness with his current main contractor, and organizational commitment refers the workers' psychological attachment to the contractor, where it reflects his satisfaction in the cooperation with the contractor. As previous research suggested that individuals tend to identify with organizations that share similar characteristics to themselves and that they admire (Pratt, 1998). For construction workers who work for a main contractor that has a high degree of reputation, their degree of organizational identification may be high. Therefore, construction workers may be more willing to accept automated monitoring when they are cooperating with a main contractor that is famous, well recognized with good reputation, trustworthy, creditable, and with other positive characteristics that the workers admire. Furthermore, a reputable main contractor may have higher opportunities to undertake large-scale construction projects, especially government projects. If this is true, there is a possibility that project scale and type of project initiator (e.g., the government, a consortium, etc.) may have influences to workers' intention of acceptance. If construction workers admire the project initiator more than the main contractor, the "organization", that is the perceived owner of monitoring system may be shifted from main contractor to the project initiator. This type of organizational paradigm shift may be unique in construction industry, an industry that is highly fragmented and consist of so many cooperative parties in a project and therefore it may be worthy for future research. As some studies argued that organizational identification leads individuals to experience the organization's interest as the self-interest (Ashforth and Mael, 1989; van Knippenberg, 2000), if a construction worker's self-reference is more tied with the main contractor, his intention to accept automated monitoring should be higher. As a noteworthy point, "self-reference" here is different from "self-benefit" as discussed in session 6.1, where "self-benefit" is contributed from personal cost-benefit evaluations and is a more global consideration that up to the industrial level.

Organizational commitment was found to be another significant antecedent that influences construction workers' intention to accept automated monitoring. When comparing with organizational identification, organizational commitment is more related to job satisfaction, perceived organizational support, and staff turnover intentions (van Knippenberg and Sleebos, 2006). Research on job satisfaction suggested that low autonomy, high routine, and heavy workload could decrease employees' job satisfaction (Currivan, 2000). For most construction workers, while autonomy and monotonousness could hardly be improved because their works rarely rely on decision makings. Therefore organizations intending to implement any monitoring system are recommended to express that they care about the workers' workload and try to maintain the workload as reasonable as possible. Arguably true, because of the interdependence nature of the industry, such that different parties implement their own parts independently, the actual user of a monitoring system such as property owner of main contractor may have no right to alter construction workers' workload. However, through the implementation of monitoring systems, a message could be delivered to the workers that one of the aims of the systems is to collect data that is useful to analyze whether they are overloaded, and even being treated unfairly. Perhaps construction workers' perceived unreasonable workload could not be alleviated immediately, at least they may expect the systems serve some features that are useful to them and thus some credits may be given to the systems and the party that implements the systems. This is a virtuous circle because in a long run, if workers find there are improvements in workload and other employment treatments, their degree of organizational commitment may be higher and yields higher intention to accept any monitoring practices.

Chapter 7

Conclusions

There are three potential research limitations. The first one is about the number of subjects. In fact, the most challenging part of this thesis was to seek appropriate subjects for the survey. Unlike some studies that the empirical data was collected from University students or other participants who were not quite related to the research contexts, the author of this thesis insisted to question real construction workers. It was because construction is such a complicated and fragmented industry that a project is always cooperated with many organizations and professionals, but they have to work independently. With the fact that a construction site is dangerous and dynamic, if the subjects are not insiders, their data would probably be with low validity. Besides, by considering with the education level of the subjects, they were questioned in face-to-face, one-to-one fashion by three researchers with construction education background. Within limited resources, this study questioned seventy-three construction workers who were under three different subcontractors. One may challenge whether the number of subjects were sufficient to test the proposed research model. Doubtlessly the data would be more convincing if there were more subject participations, but it is believed that the validity and reliability of the collected data should be higher than the studies using email, web form, or telephone as a survey tool. It is arguable that if the sample size is large, then it would be convincing. But in this study there was a 100% response rate, with quality data, high validity and reliability. Actually, in order to recruit more subjects, a union for construction workers was approached. However the committees of the union were reluctant to let the researchers of this study to contact their construction worker members through their connections. The reason was that they believed construction workers generally dislike being monitored and therefore they were worried the survey would bring a negative impact to their relationship with their worker members. In fact, the committees rejected the request immediately after knowing the title of the survey; there were even no chance for the researchers to explain the context of the research.

The second limitation is the biased job title of the survey subjects. There are over 67% of the subjects are general workers, which implies most subjects of the survey did not have a professional skillset. When comparing with other subjects such as carpenters and concretors, their awareness of automated construction monitoring may be lower because most of their tasks involve fewer critical processes so that their fault, if there is any, may not be very influential to the entire project. In contrast, a concretor's fault in the concrete slab pouring process may induce structural problems. Since more skillful workers may be more care about what do the systems monitor and who is watching than general workers, their intention to accept monitoring systems may be different from general workers. Therefore, if there are sufficient research resources, a comparative study could be conducted in the future.

While the first two research limitations were related to survey subjects, the final one was more associated with the questionnaire items. Since the subjects may or may not have experienced automated monitoring, they were questioned with a scenario that “if there is a construction monitoring system installed in your site”. Therefore their intention to accept monitoring system was purely decided through a “what if” analysis, which may not truly reflect the situation that there was really a construction monitoring system already installed in the site they were working in. However this limitation could not be eliminated until automated construction monitoring is implemented in all construction sites. This is also a reason why this thesis focused on the intention of acceptance instead of the actual acceptance behaviors.

Nevertheless, this thesis endeavored to bridge the literature gap of automated construction monitoring and the perceptions of the workers being monitored. As there was no or very little literature concerned with construction workers’ perceptions on automated monitoring, the research model of this thesis was established by referring the existing studies about electronic workplace monitoring and behavioral frameworks. Because of the fundamental differences between the environment of a construction site and that of other workplaces, and the highly fragmented characteristic of the construction industry, previous research frameworks and models could not be applied to this study directly. Therefore, each construct of the model was carefully refined in order to accommodate the uniqueness of the construction industry. The model aimed to investigate the antecedents that would probably affect construction workers' intention to accept automated construction monitoring. In the model, there were three antecedents, namely "attitudes towards the appropriateness of automated construction monitoring", "organizational identification", and "organizational commitment" were hypothesized to influence construction workers' intention to accept construction monitoring systems. Moreover, "belief on monitoring systems for caring purposes" acted as a moderator between the attitudes and intention.

Although it was time-consuming, the survey was conducted in face-to-face, one-to-one fashion because construction workers are generally with low education level. The survey results revealed both organizational identification and organizational commitment were prominent determinants to predict the intention of acceptance. Although the two hypotheses with the construct "belief on monitoring systems for caring purposes" and "attitudes towards the appropriateness of automated construction monitoring" were not supported, it was interesting to see that the attitudes negatively affected the intention, which contradicted with other studies of workplace monitoring. This thesis attempted to explain this finding by construction workers' common misbehaviors and the low employment rate of the industry (at the period when this study was conducted). For other supported hypotheses, this thesis gave some recommendations for construction practitioners who intend to implement automated construction monitoring in due course. For instance, it is recommended that the management or the owner of a monitoring system should convey a strong signal to the workers of the intended usage of the system to care rather than to monitor. This approach cannot only help to avoid unnecessary predictions, but also expresses the respect to construction workers. The findings also imply that construction workers may be more willing to accept automated monitoring (or other policies) when they are cooperating with a main contractor that is famous, well recognized, trustworthy, creditable, and so on. Therefore reputation management may be one essential prerequisite of implementing automated monitoring.

As automated construction monitoring could shape and control the behaviors of construction workers, it is hoped that this thesis could help construction management to identify the perception of workers and the factors that affect their acceptance level. With the future research inspiration such as conducting comparative study between a group of construction workers who know the monitoring purposes and a group who do not; including new constructs like "perceived importance of societal benefit" and "perceived importance of self-benefit" in the model (as discussed in 6.1); and, considering atmosphere of the industry like employment rate, average income, and accident rate, it is hoped that this thesis could encourage more researchers to spend efforts on filling the gap.

Appendix I: Statistical Results

```
. correlate accept1 accept2 accept3 accept4 accept5
(obs=73)

             |  accept1  accept2  accept3  accept4  accept5
-------------+---------------------------------------------
     accept1 |   1.0000
     accept2 |   0.7363   1.0000
     accept3 |   0.6677   0.6727   1.0000
     accept4 |   0.7579   0.7281   0.7477   1.0000
     accept5 |   0.7076   0.7216   0.7236   0.7274   1.0000

. correlate oc1 oc2 oc3 oc4
(obs=73)

             |      oc1      oc2      oc3      oc4
-------------+------------------------------------
         oc1 |   1.0000
         oc2 |   0.6187   1.0000
         oc3 |   0.7181   0.6506   1.0000
         oc4 |   0.6787   0.4637   0.7162   1.0000

. correlate oi1 oi2 oi3 oi4
(obs=73)

             |      oi1      oi2      oi3      oi4
-------------+------------------------------------
         oi1 |   1.0000
         oi2 |   0.5515   1.0000
         oi3 |   0.6895   0.6401   1.0000
         oi4 |   0.6300   0.6038   0.6136   1.0000

. correlate att1 att2 att3 att4
(obs=73)

             |     att1     att2     att3     att4
-------------+------------------------------------
        att1 |   1.0000
        att2 |   0.6626   1.0000
        att3 |   0.7856   0.5956   1.0000
        att4 |   0.8012   0.6361   0.6974   1.0000

. correlate mod1 mod2 mod3 mod4 mod5 mod6
(obs=73)

             |     mod1     mod2     mod3     mod4     mod5     mod6
-------------+------------------------------------------------------
        mod1 |   1.0000
        mod2 |   0.6768   1.0000
        mod3 |   0.6855   0.6691   1.0000
        mod4 |   0.4740   0.5666   0.6672   1.0000
        mod5 |   0.6736   0.6505   0.6890   0.6353   1.0000
        mod6 |   0.4285   0.4340   0.5533   0.6893   0.6195   1.0000

.
. regress y x1 x2 x3 x4 x3x4

      Source |       SS       df       MS              Number of obs =      73
-------------+------------------------------           F(  5,    67) =   35.17
       Model |  72.5663522     5  14.5132704           Prob > F      =  0.0000
    Residual |  27.6473405    67  .412646874           R-squared     =  0.7241
-------------+------------------------------           Adj R-squared =  0.7035
       Total |  100.213693    72  1.39185684           Root MSE      =  .64238

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |     .33317   .1471816     2.26   0.027     .0393943    .6269457
          x2 |   .3965907    .140405     2.82   0.006     .1163411    .6768403
          x3 |  -.2992765   .1891614    -1.58   0.118    -.6768442    .0782912
          x4 |  -.0888535   .2222092    -0.40   0.691     -.532385     .354678
        x3x4 |   .0019129   .0640794     0.03   0.976    -.1259901     .129816
       _cons |     1.8204   .7604281     2.39   0.019     .3025796    3.338221
------------------------------------------------------------------------------
```

```
. regress accept1 oc oi att interactive

      Source |       SS       df       MS              Number of obs =      73
-------------+------------------------------           F(  4,    68) =   34.68
       Model |  108.860199     4  27.2150497           Prob > F      =  0.0000
    Residual |  53.3589793    68  .784690872           R-squared     =  0.6711
-------------+------------------------------           Adj R-squared =  0.6517
       Total |  162.219178    72  2.25304414           Root MSE      =  .88583

------------------------------------------------------------------------------
     accept1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          oc |   .3597448   .0987205     3.64   0.001     .1627511    .5567386
          oi |   .1728355   .0960767     1.80   0.076    -.0188826    .3645536
         att |  -.0466407   .0704016    -0.66   0.510     -.187125    .0938435
 interactive |  -.0024595   .0061032    -0.40   0.688    -.0146384    .0097193
       _cons |   .0815534   .6237187     0.13   0.896    -1.163058    1.326165
------------------------------------------------------------------------------

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of accept1

         chi2(1)      =     2.46
         Prob > chi2  =   0.1164

.
. regress accept2 oc oi att interactive

      Source |       SS       df       MS              Number of obs =      73
-------------+------------------------------           F(  4,    68) =   17.88
       Model |   58.555046     4  14.6387615           Prob > F      =  0.0000
    Residual |  55.6641321    68  .818590178           R-squared     =  0.5127
-------------+------------------------------           Adj R-squared =  0.4840
       Total |  114.219178    72  1.58637747           Root MSE      =  .90476

------------------------------------------------------------------------------
     accept2 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          oc |   .1867856   .1008304     1.85   0.068    -.0144183    .3879895
          oi |   .1366558   .0981301     1.39   0.168    -.0591598    .3324713
         att |  -.0999646   .0719063    -1.39   0.169    -.2434513    .0435221
 interactive |     -.0047   .0062337    -0.75   0.453    -.0171391    .0077391
       _cons |   1.610571   .6370488     2.53   0.014     .3393603    2.881783
------------------------------------------------------------------------------

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of accept2

         chi2(1)      =     5.08
         Prob > chi2  =   0.0242
```

```
.
. regress accept3 oc oi att interactive

      Source |       SS       df       MS              Number of obs =      73
-------------+------------------------------           F(  4,    68) =   24.63
       Model |  67.077252     4  16.769313           Prob > F      =  0.0000
    Residual |  46.292611    68  .680773691           R-squared     =  0.5917
-------------+------------------------------           Adj R-squared =  0.5676
       Total | 113.369863    72  1.57458143           Root MSE      =  .82509

------------------------------------------------------------------------------
     accept3 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          oc |   .1154652   .0919516     1.26   0.214    -.0680215    .2989518
          oi |   .2151704   .0894891     2.40   0.019     .0365976    .3937431
         att |  -.1573507   .0655745    -2.40   0.019    -.2882025   -.0264989
 interactive |   -.002722   .0056848    -0.48   0.634    -.0140658    .0086217
       _cons |   2.083055   .5809528     3.59   0.001     .9237818    3.242328
------------------------------------------------------------------------------

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of accept3

         chi2(1)      =     2.21
         Prob > chi2  =   0.1367

.
. regress accept4 oc oi att interactive

      Source |       SS       df       MS              Number of obs =      73
-------------+------------------------------           F(  4,    68) =   17.48
       Model | 63.8605392     4  15.9651348           Prob > F      =  0.0000
    Residual | 62.1120635    68  .913412699           R-squared     =  0.5069
-------------+------------------------------           Adj R-squared =  0.4779
       Total | 125.972603    72  1.74961948           Root MSE      =  .95573

------------------------------------------------------------------------------
     accept4 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          oc |    .063223   .1065103     0.59   0.555     -.149315     .275761
          oi |   .2369576   .1036579     2.29   0.025     .0301115    .4438038
         att |  -.1508343   .0759568    -1.99   0.051    -.3024038    .0007353
 interactive |  -.0063214   .0065848    -0.96   0.340    -.0194612    .0068185
       _cons |   2.212078   .6729348     3.29   0.002     .8692573    3.554898
------------------------------------------------------------------------------

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of accept4

         chi2(1)      =     4.77
         Prob > chi2  =   0.0290
```

```
.
. regress accept5 oc oi att interactive

      Source |       SS       df       MS              Number of obs =      73
-------------+------------------------------           F(  4,    68) =   21.68
       Model |  74.5537858     4  18.6384465           Prob > F      =  0.0000
    Residual |  58.4599128    68    .8597046           R-squared     =  0.5605
-------------+------------------------------           Adj R-squared =  0.5346
       Total |  133.013699    72  1.84741248           Root MSE      =   .9272

------------------------------------------------------------------------------
     accept5 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          oc |    .118209   .1033315     1.14   0.257    -.0879858    .3244039
          oi |   .2263065   .1005642     2.25   0.028     .0256337    .4269793
         att |  -.1354732   .0736899    -1.84   0.070    -.2825191    .0115727
 interactive |  -.0069212   .0063883    -1.08   0.282    -.0196688    .0058265
       _cons |   1.972577    .652851     3.02   0.004     .6698332    3.275321
------------------------------------------------------------------------------

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of accept5

         chi2(1)      =     1.14
         Prob > chi2  =   0.2849

.
. regress accept oc oi att interactive

      Source |       SS       df       MS              Number of obs =      73
-------------+------------------------------           F(  4,    68) =   44.55
       Model |  362.890451     4  90.7226128           Prob > F      =  0.0000
    Residual |  138.462106    68  2.03620744           R-squared     =  0.7238
-------------+------------------------------           Adj R-squared =  0.7076
       Total |  501.352557    72  6.96322996           Root MSE      =   1.427

------------------------------------------------------------------------------
      accept |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          oc |   .3762898   .1590264     2.37   0.021     .0589576     .693622
          oi |   .4422044   .1547676     2.86   0.006     .1333706    .7510383
         att |  -.2640749   .1134082    -2.33   0.023    -.4903774   -.0377724
 interactive |  -.0103757   .0098316    -1.06   0.295    -.0299943    .0092429
       _cons |   3.563163   1.004733     3.55   0.001      1.55825    5.568076
------------------------------------------------------------------------------

. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of accept

         chi2(1)      =     4.19
         Prob > chi2  =   0.0405
```

Appendix II: Questionnaire Items (Chinese version)

有關地盤電子監察系統的問卷調查

工種：[ ]釘板 [ ]扎鐵 [ ]落石屎 [ ]泥水 [ ]電工 [ ] 其他 ________

在地盤工作的年資：______年

		非常不同意	不同意	普通	同意	非常同意
1	利用攝影機監察工人活動會令工人的工作效率提高。					
2	利用攝影機監察工人活動不會令工人及管理層的關係變得緊張。					
3	由於工人有領工資，所以建築承辦商可以用攝影機監察工人在地盤範圍的活動。					
4	用攝影機監察工人在地盤範圍的活動並不會侵犯工人的私隱。					
假設最近顧用你的建築承辦商（不一定是現在合作中的承辦商）有一項新的地盤工程，而你亦參與其中。請回答以下問題：						
5	和我合作過的所有建築承辦商中，該承辦商是最好的一間。					
6	我對該承辦商的業務前景有興趣。					
7	我對該承辦商的評價很高。					
8	我很榮幸能夠和該承辦商合作。					
9	我認為我的表現會影響該承辦商的商譽。					
10	我會計較別人怎麼評價該承辦商。					
11	如果別人讚美該承辦商，我亦會感到自豪。					
12	如果有媒體批評該承辦商的不是，我會感到不安。					
13	如果我發現該地盤安裝了有攝影功能的監察系統，					
	a. 我認為該系統是用來防止意外發生					

	b. 我認為該系統是用來保障工人的健康安全					
	c. 我認為該系統是用來作防盜用途					
	d. 我認為該系統是用來監察工人有沒有違規行為					
	e. 我認為該系統是用來監察工人有沒有偷懶					
	f. 我認為該系統是用來監察工人有沒有工作上的錯失					
	g. 我會接受該監察系統					
	h. 我會回避系統的監察					
	i. 我會嘗試要求有關部門把監察系統關掉					
	j. 我會提醒工友們避開系統的監察					
	k. 我會向該承辦商投訴我對監察系統的不滿					

請你對以下資訊科技的認識作自我評價：

		連名稱也未聽過	未接觸過，但聽過此名稱	有使用過	間中使用	經常使用
14	a. 使用電郵					
	b. 上網或瀏覽網頁					
	c. 用 MSN、ICQ、QQ 等即時通訊軟件					
	d. 視像通訊					
	e. 用電腦作文書處理					
	f. 使用智能手提電話					

15. 最後，若你對地盤安裝有攝影功能的監察系統有任何意見，請寫下：

____

____

-- 問卷完 --

Appendix III: Purpose of Survey (a document to contractors)

Survey of Construction Site Electronic Monitoring

Background and Objectives

With the growth of information and communication technologies adoption in construction projects, it could be anticipated that more property owners and construction firms will attempt to use electronic gears and gadgets for site monitoring or surveillance purposes. As the construction workers may be the major group of project team members being monitored, from managerial perspectives and for ethical reasons, it is essential to investigate their degree of acceptance on site monitoring systems. The aim of the survey is to understand workers' perceptions in electronic construction site monitoring, as well as the critical factors that affect their compliance and resistance intentions.

Survey Conduction

1. If the survey is conducted in working area:

   One to one, face to face. Our researcher reads the questions, and the subject (worker) verbally answers them.

   Estimated time: 10 minutes / subject

2. If they survey is conducted in site office or other places, where there is a group of subjects available:

   Workshop style, multiple questionnaires is collected concurrently. Questionnaires are delivered to the subjects (workers) at the beginning. One researcher reads the questions, and the subjects check the answers themselves. Subjects are free to raise questions anytime as there are other researchers standing-by.

   Estimated time: 10 - 20 minutes / session

3. After conducting the survey, a HK$20 Maxim's Coupon (美心贈券) will be given to each subject (worker).

Detailed Information

Research on office workplace monitoring suggest that a monitoring system could shape or control the behaviors of employees, it may be valuable to explore the consequences if such systems are adopted, such as whether the workers more comply with rules and regulations, whether their performance is positively (more concentrated on work) or negatively (wasted time to show their competence to observers) affected, and so on. Although there is plenty of literatures contribute on office workplace monitoring, their research frameworks and models cannot be applied on construction environment without refinement, as the organizational structure and the work environment of the construction industry are quite unique when comparing with other fields. For instance, safety issues are critical in a construction site, where the workers may consider one of the purposes of installing a monitoring system is for safety reasons, or caring. But for office employees they may not accept safety issue as an explanation of implementing electronic surveillance. There are at least few fundamental variations between office monitoring and construction site monitoring:

1. Construction sites have more safety issues. All over the world, construction is one of the most hazardous industries due to its unique nature and therefore one major purpose of a monitoring system may be due to caring of workers.

2. Construction workers may have less privacy concern because they get used to work in public areas, where their work behaviors could be seen by the public already (e.g., residents living in the buildings nearby).

3. The construction industry is highly fragmented so the relationship between contractors and workers are always in one-off fashion. In fact, the construction industry is persecuted by some common partnering problems such as ineffective communication, limited trust, and lack of cooperation. As a result, the workers may find very little organization identification.

4. Construction workers are monitored by inspectors and foremen already, they may find electronic monitoring is just an assistance tool. Therefore they may show little awareness about the system.

It is expected that this study could bridge the above-mentioned literature gap and provide a guideline for construction firms that intend to implement monitoring systems.

Appendix IV: Survey Raw Data

(presented in the next page with landscape layout)

OBS	Accept1	Accept2	Accept3	Accept4	Accept5	OC1	OC2	OC3	OC4	OI1	OI2	OI3	OI4	ATT1	ATT2	ATT3	ATT4	MOD1	MOD2	MOD3	MOD4	MOD5	MOD6	KIND	EXP
1	4	4	4	4	4	3	3	1	2	4	1	3	3	4	4	4	1	2	2	2	2	2	2	石屎	6
2	2	2	1	2	1	2	1	2	3	1	3	2	1	3	4	3	5	2	2	1	1	1	2	雜工	18
3	4	4	2	4	2	3	4	5	2	3	3	4	2	3	3	4	4	2	4	2	3	4	2	雜工	12
4	3	3	2	3	1	2	1	3	2	1	2	3	2	3	4	2	4	2	3	4	5	2	2	雜工	14
5	2	2	3	2	2	2	1	2	2	1	3	1	3	2	2	1	2	3	4	3	3	3	3	泥水	14
6	5	3	2	3	4	2	3	4	5	3	2	3	4	2	2	3	4	5	3	3	4	2	3	雜工	8
7	4	4	4	4	4	3	4	3	3	2	1	3	1	2	2	1	1	2	2	1	1	1	2	雜工	10
8	2	2	3	2	1	2	3	1	2	3	2	2	4	4	4	5	4	5	4	5	4	5	4	泥水	5
9	1	2	3	2	3	3	2	1	4	2	3	3	4	4	4	4	5	2	1	2	1	1	1	雜工	18
10	2	3	2	1	1	2	2	2	3	1	2	1	1	4	5	3	5	2	1	1	2	3	4	雜工	21
11	4	4	4	4	4	5	1	4	5	3	1	4	4	4	4	4	4	1	1	1	1	1	1	雜工	12
12	4	2	3	2	3	3	5	4	5	3	2	5	3	2	2	2	1	2	2	2	2	1	1	雜工	16
13	3	4	4	5	5	3	4	3	1	1	2	2	2	1	1	1	1	2	4	2	2	2	2	電工	30
14	1	1	2	1	2	2	1	2	2	1	2	3	4	5	3	4	5	3	5	3	4	2	3	泥水	9
15	4	4	3	4	5	3	3	4	5	3	4	4	5	4	4	5	5	4	2	3	3	4	5	雜工	10
16	3	3	3	4	3	5	5	3	2	4	5	3	5	4	5	2	4	4	2	2	2	3	3	雜工	6
17	1	2	2	1	3	4	2	1	3	1	1	1	2	4	5	4	2	2	1	2	1	1	2	泥水	18
18	3	3	4	4	4	2	1	2	1	2	2	2	2	1	1	1	1	5	5	5	2	5	3	電工	10
19	3	4	3	4	4	3	2	3	3	4	3	3	3	2	2	1	1	4	5	5	2	4	2	冷氣	12
20	3	4	4	4	4	4	3	3	3	3	2	4	2	4	4	3	2	5	5	3	3	5	2	冷氣	8
21	1	1	1	1	2	2	2	1	1	2	2	2	1	5	2	4	5	3	2	3	3	4	1	泥水	12
22	1	1	2	1	2	1	3	1	1	1	2	2	1	5	4	3	5	5	5	4	5	5	2	雜工	11
23	5	3	4	4	4	3	4	5	4	3	4	4	4	3	3	4	2	1	1	2	1	1	1	雜工	25
24	1	1	1	2	1	2	1	1	2	3	2	1	2	4	4	4	5	2	1	2	1	1	1	雜工	22
25	3	3	3	3	2	3	3	2	3	2	3	3	2	3	4	2	4	2	1	2	1	1	2	泥水	17
26	3	4	4	4	2	4	4	4	4	2	2	4	2	2	2	2	2	2	2	2	4	2	2	玻璃幕場	30
27	2	3	4	2	4	4	3	4	4	2	2	2	2	2	2	2	2	1	2	1	3	2	2	石屎	12
28	2	4	4	1	2	3	3	3	3	4	4	4	2	4	4	2	4	4	5	4	4	3	2	泥水	15

29	2	4	4	4	2	1	4	1	1	1	2	2	4	2	2	2	1	1	1	1	1	2	2	泥水	37	
30	1	1	2	1	1	2	2	1	3	2	1	1	2	2	2	3	2	1	2	2	1	1	2	雜工	21	
31	4	5	3	2	4	4	5	4	3	4	4	4	4	3	2	3	2	4	2	3	2	4	3	雜工	13	
32	2	2	2	2	1	2	2	1	2	1	2	1	2	4	3	4	5	2	3	3	4	4	4	泥水	11	
33	1	1	2	1	1	1	2	1	3	2	2	3	2	4	4	4	5	3	5	5	5	5	5	雜工	8	
34	1	1	2	2	2	2	2	1	2	2	2	2	1	5	5	5	4	1	1	2	1	2	1	雜工	19	
35	2	2	2	2	2	5	3	4	4	2	2	3	2	3	3	3	2	2	2	2	2	2	1	泥水	20	
36	2	4	2	4	4	2	4	2	2	2	2	4	2	2	2	2	2	2	2	2	2	2	2	泥水	10	
37	5	4	3	5	4	4	3	3	4	4	5	5	4	2	3	3	2	2	1	2	2	2	1	雜工	17	
38	1	2	3	2	3	3	2	1	4	2	3	3	4	4	4	4	5	2	1	2	1	1	1	泥水	16	
39	5	3	4	3	4	3	4	5	4	4	3	4	4	2	3	2	2	2	3	3	4	4	5	雜工	4	
40	1	1	3	2	1	1	2	1	2	2	3	2	1	4	4	5	5	2	5	5	5	4	5	雜工	4	
41	1	1	2	1	1	2	2	1	2	2	2	2	3	5	4	5	5	2	1	2	2	1	1	雜工	15	
42	2	1	1	2	1	1	1	2	3	1	2	1	2	4	5	5	5	2	2	4	5	3	5	電工	9	
43	2	4	2	2	4	3	2	3	3	4	3	3	2	2	2	2	2	2	2	1	2	2	2	其他	15	
44	2	2	4	4	4	3	2	4	4	2	2	4	3	2	2	2	2	5	5	5	3	5	5	電工	1	
45	1	1	1	1	1	3	2	4	4	4	3	3	4	3	3	2	2	5	5	5	3	5	2	冷氣	3	
46	1	2	3	2	3	1	2	1	2	2	1	2	2	5	3	5	5	2	2	2	3	3	3	雜工	9	
47	4	4	5	4	4	4	3	4	4	4	5	5	4	3	3	2	3	2	2	2	4	5	5	電工	8	
48	1	1	1	2	1	2	2	2	2	2	2	1	2	4	4	5	5	5	3	5	5	5	5	雜工	7	
49	2	2	2	2	3	3	3	2	2	3	2	3	3	3	3	2	3	3	3	5	5	5	4	電工	19	
50	2	1	2	1	2	2	2	2	1	2	3	3	2	5	5	4	5	2	3	2	2	3	2	雜工	23	
51	1	1	2	1	1	3	3	3	4	4	2	2	4	2	2	2	2	5	5	3	2	4	2	冷氣	4	
52	1	2	5	4	4	2	1	4	4	1	5	4	4	2	2	1	3	2	2	1	2	2	2	其他	15	
53	1	2	2	2	1	1	2	1	3	2	2	2	3	5	5	4	5	2	1	2	2	2	1	泥水	22	
54	1	1	1	1	2	1	1	1	1	1	2	2	1	5	2	4	5	3	2	3	3	3	3	泥水	12	
55	5	4	5	5	4	5	4	5	4	5	4	4	4	2	3	3	2	2	3	2	4	4	2	雜工	15	
56	1	1	1	2	1	1	1	1	1	1	1	1	2	5	3	4	5	1	2	2	1	1	1	雜工	37	
57	5	4	4	4	3	4	5	5	4	5	4	5	4	2	1	2	3	2	1	2	1	1	1	雜工	21	
58	1	1	1	2	1	1	1	1	1	1	1	2	1	5	3	4	5	3	2	3	4	3	3	雜工	15	
59	5	4	5	4	4	4	5	5	4	4	4	5	4	2	2	2	1	1	2	2	1	2	1	雜工	9	

60	4	5	4	4	5	4	4	5	4	4	4	5	4	2	2	3	2	1	2	1	1	2	1	雑工	15
61	1	2	1	1	1	1	1	2	1	1	2	1	1	5	3	4	5	3	4	3	3	2	3	其他	1
62	1	1	2	1	1	1	1	2	1	1	1	2	1	4	4	5	5	3	4	2	3	3	3	雑工	3
63	5	3	4	4	4	3	4	5	4	3	4	4	4	3	3	4	2	1	1	2	1	1	1	雑工	22
64	5	2	5	5	4	4	4	5	4	3	4	4	5	2	1	1	2	1	2	1	1	3	1	雑工	17
65	2	1	1	1	1	1	1	1	1	1	2	1	2	5	4	4	5	2	3	3	4	2	3	雑工	30
66	5	4	4	3	5	4	5	5	5	4	5	5	4	2	1	2	1	1	2	2	1	3	2	雑工	12
67	1	2	1	1	2	1	2	1	1	1	2	2	1	5	3	5	4	3	3	3	3	2	3	其他	15
68	5	4	4	4	4	4	4	5	5	3	4	4	4	2	1	2	2	1	1	2	1	1	1	其他	37
69	5	3	4	4	5	3	5	5	4	3	4	4	5	2	1	2	2	1	1	2	2	1	2	其他	8
70	1	2	1	1	2	1	2	1	1	1	2	2	1	4	4	4	5	2	3	3	4	2	3	雑工	19
71	1	1	1	2	2	1	1	1	1	1	3	1	1	5	2	5	4	3	3	3	3	4	2	雑工	20
72	2	1	1	1	2	1	1	1	2	1	2	1	1	3	5	4	5	2	1	4	3	4	2	雑工	10
73	1	1	2	1	1	2	2	1	3	2	1	1	2	2	2	3	2	1	2	2	1	1	2	雑工	16

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