HELPING TEAMS TO ADAPT: AN INVESTIGATION OF THE INTENTIONAL TEAM ADAPTATION PROCESS

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Helping Teams to Adapt: An Investigation of the Intentional Team Adaptation Process

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CERTIFICATE OF ORIGINALITY

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_____ (Signed)

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ABSTRACT

Organisations are embedded in an environment characterised by fierce competition and constant change. In order to gain a competitive advantage, they have to be flexible and adaptive to such changes. Therefore, teams are widely used as the basic work unit in modern organisations to accomplish tasks. Accordingly, team adaptation to a dynamic environment has become one of the most important topics in businesses and management. This issue is usually addressed in this question: 'What can team members do to maintain team performance in a dynamic environment'? This means that most of the existing studies on team adaptation did not discuss 'team adaptation' and instead focused on 'individual adaptation'. This research aims to redirect this focus back to the team itself. Specifically, it discusses how teams respond to changes so that their performance is in line with necessary environmental changes. Therefore, this research builds on the theory of collective intentionality and proposes an intentional team adaptation model. It employs four studies to argue and examine the above ideas. The first study discusses the characteristics and observable instances of intentional team adaptation through a grounded theory approach. The second study develops a scale of intentional team adaptation that enables further empirical analysis. The third study examines the shared cognitive mechanism of intentional team adaptation, and the forth study explores the distributed cognitive mechanism of intentional team adaptation.

The idea of intentional team adaptation is clarified and demystified through a literature analysis. The analysis begins with studies on collective intentionality. It is believed that collectives such as organisations and teams are constructed social realities with intentions rather than merely workplaces where individual members do their jobs. Team behaviour is not only a collection of individual members' behaviours that individuals' minds determine; it can also be ascribed to a team's intentionality. Accordingly, this study proposes the construct of team intentionality as the foundation for interpreting team adaptive behaviours and terms this type of adaptation as 'intentional team adaptation'. A comparison between intentional team adaptation and reactive team adaptation is also included in the literature analysis.

A further study that employs a grounded theory-driven analysis explores the

phenomenon of intentional team adaptation in workplaces. A three-dimension model of intentional team adaptation emerged from the data of ten software development teams. Behaviourally, intentional teams carry out joint action and complete team tasks with proper coordination. Affectively, intentional teams have a positive daily tone, team climate and work relationship among team members. Cognitively, intentional teams can take advantage of team knowledge and expertise to fulfil team targets amidst uncertainties. A measurement of intentional team adaptation with high validity and credibility was developed based on the findings from this grounded study.

This research also examines the underlying mechanisms of intentional team adaptation in order to gain a comprehensive understanding. A shared cognitive mechanism (i.e. shared mental model) is discussed and analysed through a two-phase experiment study with changed tasks. A manipulation of reward structures (cooperative vs. competitive) was employed to trigger intentional team adaptive behaviours and individual members' self-serving behaviours separately. The results show that shared mental model updating was the mediator of the reward structure and team adaptive strategies. A field study was also conducted to test the distributed cognitive mechanism (i.e. transactive memory system). Production teams with experience in equipment replacement were selected as the target sample. This study demonstrates the mediation effect of a transactive memory system on the relationship between intentional team adaptation and a team's adaptive performance. In addition, the relationship was found to be more significant for highly interdependent tasks.

This research cover both theoretical analyses and empirical examinations with both qualitative and quantitative methods and examine the mechanisms of intentional team adaptation with multiple samples. In terms of theoretical contributions, this research establishes a theory of intentional team adaptation, thus enriching the research on team dynamics, especially on research problems related to team adaptation. Additionally, a grounded theory approach was employed to understand the intentional teams' affective, behavioural and cognitive manifestations. A research tool for the specific theme, i.e. intentional team adaptation, was also developed in this study, from which future empirical studies can benefit. Furthermore, this research explores the underlying cognitive mechanisms on team adaptation and discusses different situations that involve a variety of tasks to build an integrated research model of intentional team adaptation. In terms of practical implications, this research offers suggestions for teams,

managers, senior management or trainers on training content, knowledge integration approaches and task-based resource allocations for addressing uncertainties.

Keywords: intentional team adaptation, shared mental model, transactive memory system, task interdependence, collective intentionality

PUBLICATIONS

Below are the journal papers and conference papers. Among them, Journal Paper 4 and 5 was adapted from Chapter 2, Journal Paper 7 was adapted from Chapter 6 (Study III). Conference Paper 1 was adapted from Chapter 5 (Study II), and Conference Paper 2 was adapted from Chapter 7 (Study IV).

Journal Papers

1. Zhang, Yue, Lv. Impact Mechanism of Temporal Diversity on Team Performance. *Technology Economics(Chinese Edition)*, 2012, 31(5),12-17.
2. Zhang, Li, Yue. Ten Myths in Management Practices. *Chinese Journal of Management (Chinese Edition)*, 2014,11 (4), 492-501.
3. Zhang, Li, Yue. Breaking Myths in Management. *PKU Business Review (Chinese Edition)*, 2014, 7, 122-128.
4. Zhang, Yue. Reconstruction of Collective Cognition Process Based on Theory of Collective Intentionality: Using Team in Organization as an Example. *Studies in Philosophy of Science and Technology(Chinese Edition),* 2016, 33(6), 88-93.
5. Zhang, Yue. Recent Advancements in Team Effectiveness Research: A Review of Team adaptation Studies. Science & Technology Progress and Policy (Chinese Edition), 2017, 34(1), 154-160.
6. Li, Yue. Working with Creative Leaders: An Examination of the Relationship between Leader and Team Creativity. Social Behavior and Personality: An International Journal. 2019, 47(6),e8084.
7. Yue, Fong, Li. Meeting the Challenge of Workplace Change: Team Cooperation Outperforms Team Competition. Social Behavior and Personality: An International Journal. 2019, 47(7),e7997.

Conference Papers

1. Yue, C. Team intentionality: construct definition and scale development. Annual Conference of Human Resources, Guangzhou, 2015.
2. Chen Yue, Patrick S. W. Fong, Gang Zhang. Production Team Adaptation in Chinese manufactory industry. IACMR's 7th biennial meeting, Hang Zhou, 2016

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Chen YUE
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LIST OF ABBREVIATIONS

ITA: intentional team adaptation

JAI: job adaptability inventory

ICC: intraclass correlation coefficient

EFA: explorative factor analysis

CFA: confirmative factor analysis

SMM: shared mental model

SMMU: shared mental model updating

TMS: transactive memory system

n.s.: none significant

CHAPTER 1 INTRODUCTION

1.1 Research Background

Reeves, Levin and Ueda (2016) noted that 'companies operate in an increasingly complex world: business environments are more diverse, dynamic and interconnected than ever- and far less predictable' (p. 4). Such uncertainty is the stiffest challenge for organisations in the twenty-first century to survive and win. The team-based form of organising work is one of the most popular approaches to deal with such dynamism and uncertainty (Maynard, Kennedy, & Sommer, 2015; Seeds, 2016). However, this approach is not a panacea; instead, it exerts pressure on teams and individuals. Therefore, the problem of team adaptation deserves more attention in the complex business world.

Team is defined as 'a special type of group in which people work interdependently to accomplish a goal' (Levi, 2014, p. 1). This study focuses on teams that are designed to complete certain types of tasks within modern organisations. A team is recognised as an organism with the following features: 1) every team member has his/her unique specialty and common knowledge about teams, tasks and industry; 2) a team task cannot be completed without cooperation and the co-efforts of all the team members; 3) a team has goals to complete; and 4) team members as well as the environment embedded within a team influence the team. The team will have an impact on the environment and members in turn. Teams can overcome the limitations of an individual's rationality; integrate diversified expertise, cope with complexity and dynamism; and provide efficiency for organisations (Levi, 2014). This form of organising work has become more popular in recent decades due to increasing complexity and dynamics in organisational environment and the abilities of teams to respond and adapt quickly (Burke et al., 2006). Mesmer-Magnus et al. (2016) identified team adaptation as the next frontier topic in team research. Given the emerging importance of team adaptation in contemporary organisations (Ilgen et al., 2005; Randall, Resick, & DeChurch, 2011), however, there is no clear picture on what can be done to develop team adaptability, to facilitate team adaptive behaviours and to improve team adaptive performance.

Team adaptation is generally understood as reactive responses to unexpected changes in order to maintain team effectiveness (LePine, 2003). Research on team

adaptation dates back to 1967 in terms of maintaining team effectiveness in an uncertain environment (Maynard et al., 2015). Although not abundant, many factors have been confirmed as beneficial for teams functioning in a dynamic environment, such as leader sensemaking, interaction pattern change and strategic adjustment (Randall, 2008; LePine, 2003; Randall, Resick, & DeChurch, 2011). However, most of the studied mechanisms, either behavioural or cognitive ones, are reactive responses that team members carry out when confronted with changes. This is certainly an important perspective to understand team adaptation, but it should not be the only perspective. Apart from the reactive response, teams are also anticipated to carry out proactive actions that aim to identify and implement changes in work processes, products and services (Chiaburu, Lorinkova, & Van Dyne, 2013). Therefore, intentional team adaptation is proposed in this research.

1.2 Research Problem and Frameworks

1.2.1 Research problems

The main problems are as follows: When and how do teams intentionally achieve an expected performance in a dynamic environment with changes in team-related elements? To specify, this research investigates the features of intentional teams, responses of teams towards changes in team-related elements and effective outcomes of intentional team adaptation.

The first sub-problem is concerned with understanding intentional teams. Although the idea of viewing teams and organisations as intentional actors has been proposed in previous studies (Cooke et al., 2013; King, Felin, & Whetthen, 2010), it is not popularly accepted in organisation behaviour research due to the lack of theoretical foundations. In current literature, these aspects remain unclear: 1) whether teams can be considered as social actors; 2) the functions and benefits of viewing teams as intentional actors; and 3) the differences between intentional and reactive team adaptation. These aspects will be addressed through theoretical analyses. In addition, empirical studies are conducted to understand intentional teams in business and industrial settings. Related problems to be solved include the following: 1) whether teams are considered as intentional actors in daily work; 2) what teams will do to achieve adaptation within a short time; and 3) differences between adaptive teams and maladaptive teams.

The second sub-problem concerns how to achieve intentional team adaptation. The

underlying mechanisms of intentional team adaptation are complex. Many factors have been discussed in previous studies and will be included in this research. However, only some of the mechanisms are included in this study due to limited time and energy. Consistent with our theoretical perspective, as the theory of collective intentionality suggests, cognition is the proximal determinant of behaviours (Gallotti & Frith, 2013). Therefore, the related research question is, 'What is the cognitive mechanisms of intentional team adaptation?' To further specify this, the roles of the shared mental model and transactive memory system are discussed. A *shared mental model* refers to the shared cognitive resources among team members, while a *transactive memory system* refers to the distributed cognitive resources within the team. These two variables are widely used in team cognition research as classical constructs that represent the shared cognition mechanism and distributed cognition mechanism, respectively.

The final sub-problem concerns examining the boundary condition of intentional team adaptation. Since task characteristics are widely argued to be an influential factor in many critical team processes (Ilgen et al., 2005; Marks, Mathieu, & Zaccaro, 2001), it will also be considered as such in this research. The characteristic that describes the extent to which members need to interact to complete their tasks is *task interdependence* (Stewart & Barrick, 2000), which will influence the effect of cognitive processes on team adaptation. As the need for interaction increases, team actors will have more power in allocating human and cognition resources, thus promoting team adaptation. Therefore, it is argued that task interdependence should be the boundary of intentional team adaptation. Similarly, *goal interdependence*, which refers to team members' perceptions of how their goals are related to other members' goals, is also discussed as a boundary condition in this study. Members' perceptions of goals have an impact on their interactions (Deutsch, 1949) as well as on the development of intentional responses at the team level. Therefore, goal interdependence should also be the boundary of intentional team adaptation.

1.2.2 Research aims and objectives

The primary aims of this research are to understand intentional team adaptation based on the theory of collective intentionality and to propose suggestions for helping teams achieve adaptation accordingly. Team adaptation is a new and important topic within the background of a dynamic environment and competitive market. It refers to maintaining team functioning in situations when teams are confronted with

emergencies and encounter unpredictable tasks. This research contributes to the topic by introducing the theory of collective intentionality to explain how a team acts as an actor and intentionally adapts when facing with task changes, emergencies, and acute work situations. A team actor coordinates members' behaviour based on their shared cognition and solves problems based on members' distributed skills and knowledge.

In order to effectively answer the research problem, five objectives are set and achieved. The first objective is to justify the idea of intentional team adaptation. Since few studies on team effectiveness have adopted the idea of collective behaviour analysis, collective intentionality theory will be introduced to explain the joint actions of intentional team behaviours and team adaptation.

The second objective is to clarify the manifestations of intentional team adaptation. Since performance adaptation is defined as 'cognitive, affective, motivational, and behavioural modifications made in response to the demands of a new or changing environment, or situational demands' (Baard et al., 2014, p. 50), this research also seeks to understand the manifestations of intentional team adaptation from three aspects: cognitive, affective/motivational and behavioural. This objective will be achieved through a grounded study.

The third objective is to develop a mature research tool for studying and evaluating intentional team adaptation. A scale of intentional team adaptation is developed and tested in this study to fulfil this objective.

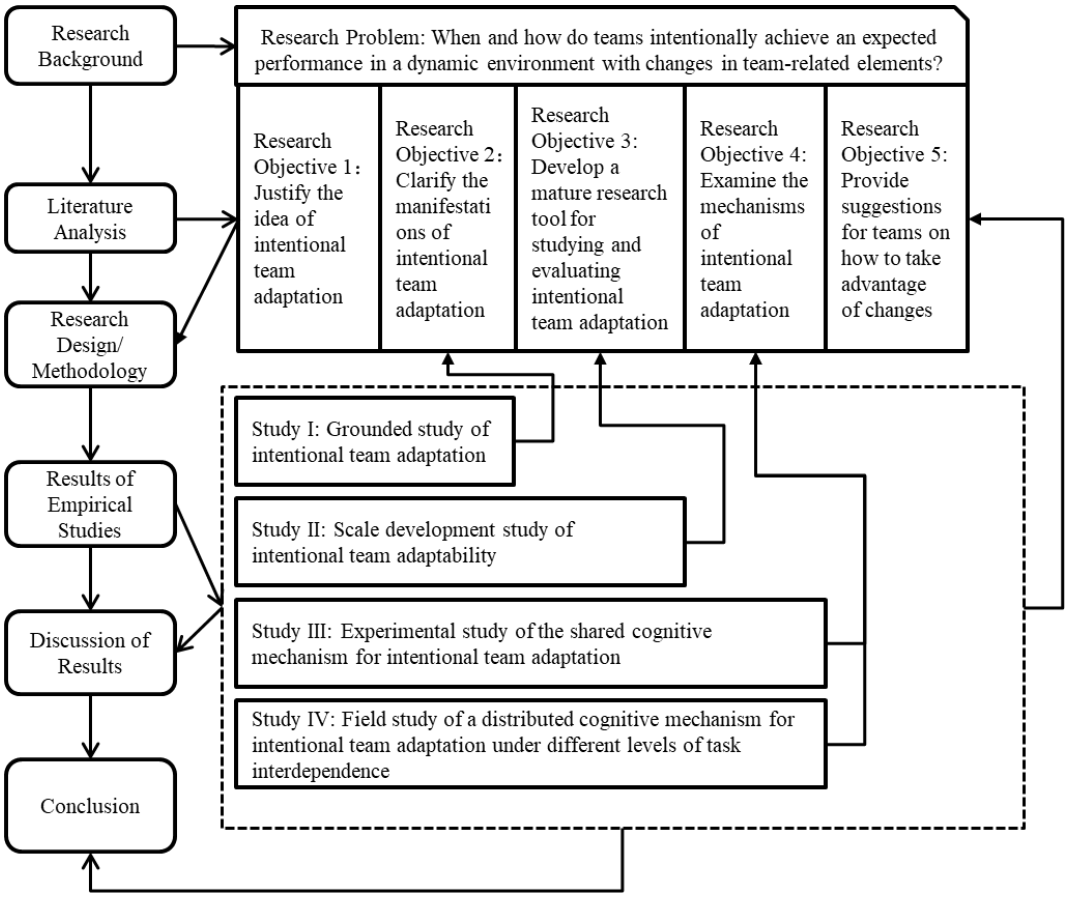
The fourth objective is to examine the mechanisms of intentional team adaptation. Generally, a comprehensive research model includes three clusters of relationships or effects: main, mediation and moderation effects. Accordingly, four relationships are examined in this research to understand intentional team adaptation: The first is the relationship between intentional team adaptation and adaptive performance; the second is the relationship between a shared mental model and team adaptive strategies; the third is the mediating role of a transactive memory system between intentional team adaptation and adaptive performance; and the fourth is the moderation role of task interdependence and goal interdependence.

The fifth objective is to provide suggestions for teams on how to take advantage of changes. Based on the results and findings of this research, suggestions are made regarding training teams as intentional actors, designing teams' goal interdependence and task interdependence, as well as promoting teams' cognitive abilities.

1.2.3 Research framework and content

Four studies were principally conducted to solve the research problems and fulfil the related objectives. The research framework of studies and objectives is presented in Figure 1.1.

Figure 1.1 Research Framework: Studies, Objectives and Research Methods



The focus problem in this research is to understand when and how teams intentionally achieve an expected performance in a dynamic environment with changes in team-related elements. The theory of collective intentionality is employed as the main theoretical perspective to analyse team behaviours. Five objectives were set to solve the research problem and fulfil the main research aims. The research design and the methodologies used are consistent with the research objectives. The relationship of the four studies and research objectives is depicted in Figure 1.1. Conclusions, implications and suggestions for management practices will be drawn based on the findings of these studies.

Since previous studies did not clearly present the idea of intentional team adaptation, a theoretical study first based on a literature analysis was conducted. The

theoretical work aims to justify the idea of intentional team adaptation. This aim consists of three aspects of the theoretical works. The first is to analyse different perspectives on team adaptation research to form a holistic picture. The second is to construct an intentional team adaptation based on the theory of collective intentionality. The third is to demonstrate the mechanisms of intentional adaptation, especially cognitive mechanisms.

Four studies are conducted to establish the research model of intentional team adaptation. The first empirical study aims to explore the manifestations of intentional team adaptation. This aim was achieved through a grounded study. Ten software development teams were interviewed to provide their understandings and expected functions of teams, especially when confronted with changes in team-related elements. A three-dimension construct of intentional team adaptation emerged when comparing the adaptive behaviours and maladaptive behaviours of teams. The findings served as empirical evidence of the manifestations of intentional team adaptation.

The second empirical study aims to develop a validated scale for measuring intentional team adaptation. According to Netemeyer, Bearden and Sharma's (2003) recommended procedures for scale development, the scale development study consisted of four parts. The first part involved the construction of a definition and content domain. The second part involved item generation based on a grounded study. After modification and polishing based on experts' suggestions, this scale was distributed to team members to complete. The collected data were used to analyse the validity and credibility of the measurement tool as well as the structure of this construct. The final step involved distributing the modified scale to different samples and obtaining data to support the criteria-related validity for this newly developed construct. This measurement development work serves as the foundation for field-based studies as well as an evaluation of intentional team adaptation in organisations.

The third and fourth studies aim to explore the mediation and moderation mechanisms for intentional team adaptation. The third study employed an experimental design to establish the causal link of the dynamic relationship between the shared mental model and team adaptive strategies with different levels of goal interdependence as well as to confirm the internal validity of intentional adaptation. The fourth study was carried out in field settings. It is designed to examine the relationship between the transactive memory system and adaptive performance with different levels of task interdependence as well as to confirm the external validity of intentional adaptation.

A general conclusion and discussion are provided at the end of this thesis so that a clearer picture of team intentional adaptation theory can be built based on the findings. This study achieves the basic aim of finding solutions to help teams achieve adaptation. It also offers a new theoretical perspective in terms of viewing a team as an intentional actor who can proactively deal with changes and uncertainty. Furthermore, suggestions on how to meet challenges of changes in team-related elements for teams are provided based on the research findings.

1.3 Significance of the Study

Teams are considered as adaptive entities by nature (Burke et al., 2006). Widespread interest in team adaptation comes at a time when global competition and changes require flexible adjustment. Therefore, it is becoming increasingly important to understand team adaptation and build adaptive teams in dynamic, fast-changing and ambiguous situations. During the past decades, organisations had experienced changes from individual-based work to team-based work, from manual-based work to machine-based work, and from physical-based commercial activities to Internet-based businesses. Project teams, production teams and top management teams, for instance, must be adaptive to deal with fast-changing working environments. Practitioners realise the necessity of building adaptive teams, and organisational researchers have identified team adaptation as a research field meriting critical inquiry (Klein & Pierce, 2001; Kozlowski & Bell, 2008).

Although a changed environment is typically considered as the research background to study team effectiveness, in recent years, following academic responses to the emerging importance of team adaptation, team adaptation as the result of a social actor's proactive behaviour was only minimally discussed. As a result, it seems that we are just skimming 'around' team adaptation rather than directly addressing it. King, Felin and Whetten (2010) encouraged viewing organisations as social actors and emphasised the unique properties of organisations in order for organisational behaviour studies to return to a focus on organisations themselves. This research is an attempt to respond to their appeal with an investigation of smaller units within organisations. It explores the adaptation of teams as social actors.

The focus shift from context to actor enables team activities to be analysed in a more predictable way. To assume a complex system, a team in this study is capable of self-reflection and self-correction; the interpretation towards environmental changes

and adjustment of team activities become ‘intentional’ and ‘selective’; and an analysis of team behaviour can be independent of members’ wills and their interests. The shared mental model is discussed in this study as a cognitive mechanism for intentional adaptation. Regardless of the certain mental model of each team member, a team’s intention will influence the degree of similarity and accuracy, thus leading to changes in team adaptation and performance. Another important team cognition mechanism is transactive memory system. Team actor intentionally takes advantage of the distributed knowledge of team members and their adaptation to changes. Since a team can be viewed as an intentional actor, the team or the interactive states at the team-level determine the communication and coordination instead of individual team members. Theory and analysis consistently support this view.

The second important contribution of this research is the clarification of the underlying mechanisms of intentional team adaptation. These three issues are addressed: 1) establishing the relationship between intentional team adaptation and effective performance change in the field; 2) exploring the change in cognitive mechanisms for intentional adaptation; and 3) setting the boundaries of intentional team adaptation. This research employs a combination of qualitative and quantitative methods to address the above issues, and it establishes an integrated research model of intentional team adaptation. Mixed methods provide strong explanatory power for the arguments and results.

Thirdly, this research builds a research tool for intentional team adaptation. The scale of intentional team adaptation is developed through a rigorous procedure with high validity and credibility. It can be used in field studies to measure intentional team adaptation, as well as for evaluating states of teams in the workplaces in terms of their adaptabilities.

Finally, benefits exist in constructing knowledge for managers in modern organisations that guide the process of selection, training and development to build adaptive teams so that teams can perform to their highest potential. Based on the grounded approach in this study, managers can obtain a general idea of the kind of team that is suitable for solving complex and dynamic problems. Advice is given on coordination and management practices in each stage of team development, as well as on the regulations of teams. In addition, a team knowledge structure and representation of the surroundings (i.e. team cognition) are emphasised as key transition mechanisms. Consistent with previous studies, behaviours such as sharing knowledge and

information are encouraged since these behaviours will smoothen team processes, promote implicit team coordination and enable teams to deal with changes more flexibly.

Another contribution exists in meeting challenges for fast-changing environments and high demand for cognitive integration through maximising the positive functions of teams. Managers can get advice on how much time should be devoted to teamwork management compared to task work management, as well as skill or knowledge development based on their task characteristics. The higher level of task and goal interdependence will in turn raise the requirement for implicit coordination; thus, the function of team intention will become more important. It is worth devoting resources to develop teamwork and build teams as intentional actors so that teams can maintain effectiveness in dynamic environments.

1.4 Organisation of Thesis

This research addresses the theoretical problem of intentional team adaptation, which is resolved by a theoretical analysis and four empirical studies. The theoretical work provides preliminary answers for the meaning of intentional team adaptation, how to achieve intentional team adaptation through team cognition, and the boundary condition of intentional team adaptation. The following four empirical studies provide further support for theoretical arguments. The structure of this thesis, which is divided into eight chapters, is as follows:

Chapter 1 introduces the background and significance of this research. The research problem and basic ideas are clarified in this chapter, along with the main content and complete structure of this thesis.

Chapter 2 is a literature analysis of intentional team adaptation. In order to clarify the idea of intentional team adaptation, works on team adaptation and collective intentionality are first reviewed. Thereafter, the concept of teams as intentional actors, with clarification of assumptions and elements, is discussed. The argument of team as intentional actors is used to solve the team adaptation problem since the intentional actor is supposed to be responsive to environmental changes in a spontaneous way. Mediation and moderation mechanisms are also introduced for intentional team adaptation. This conceptual work lays the foundation for empirical studies.

Chapter 3 is the methodology for the entire research. An overview of the methodology is introduced by comparing quantitative and qualitative methods, as a

means to show that in this mixed methods research, its design meets the requirement of alignment between methods and research objectives. Then, an overview of the research design of the four empirical studies is presented. A more detailed presentation of the samples, procedures and measurement of each study is presented in the following chapters.

Chapter 4 reports the result of study I, i.e. a grounded analysis of intentional team adaptation. In addition to a brief theoretical background and introduction of the grounded analysis method, the sample characteristics, data analysis process and results are also presented. Seven hundred original codes emerged from the grounded analysis, which were categorised into 26 codes and 8 sub-categories. These sub-categories belonged to three theoretical categories, including shared intentional behaviours, an interactive relationship and goal-directedness. Behaviourally, these teams have the intention to behave consistently and share responsibility among team members, and members of these teams achieve consistencies through performance monitoring, resource sharing and effective communication. Affectively, members of these teams have developed both work and personal relationships with each other. Cognitively, teams that have cognitive support from members solve problems and focus on team goals to achieve adaptation.

Chapter 5 reports the results of study II, i.e. the development of a measurement tool for intentional team adaptation. This study followed Netemyer, Bearden and Sharma's (2003) suggested procedures of scale development, including construct definition, item generation, measurement validation and scale finalisation. Items were generated based on findings from the grounded study; an exploratory factor analysis and a confirmative factor analysis were conducted based on data collected from different samples. The results serve as support for construct validity as well as a tool for further studies.

Chapter 6 is the experimental study on the relationship between goal interdependence, shared mental model and team adaptive strategies. An experimental study is designed to build the internal validity of intentional team adaptation, i.e. the process of intentionally achieving adaptation through shared mental model updating. Examples of intentional team adaptation through a shared cognitive mechanism emerged from the grounded study. Results of the experiment study serve as further evidence for validating related findings.

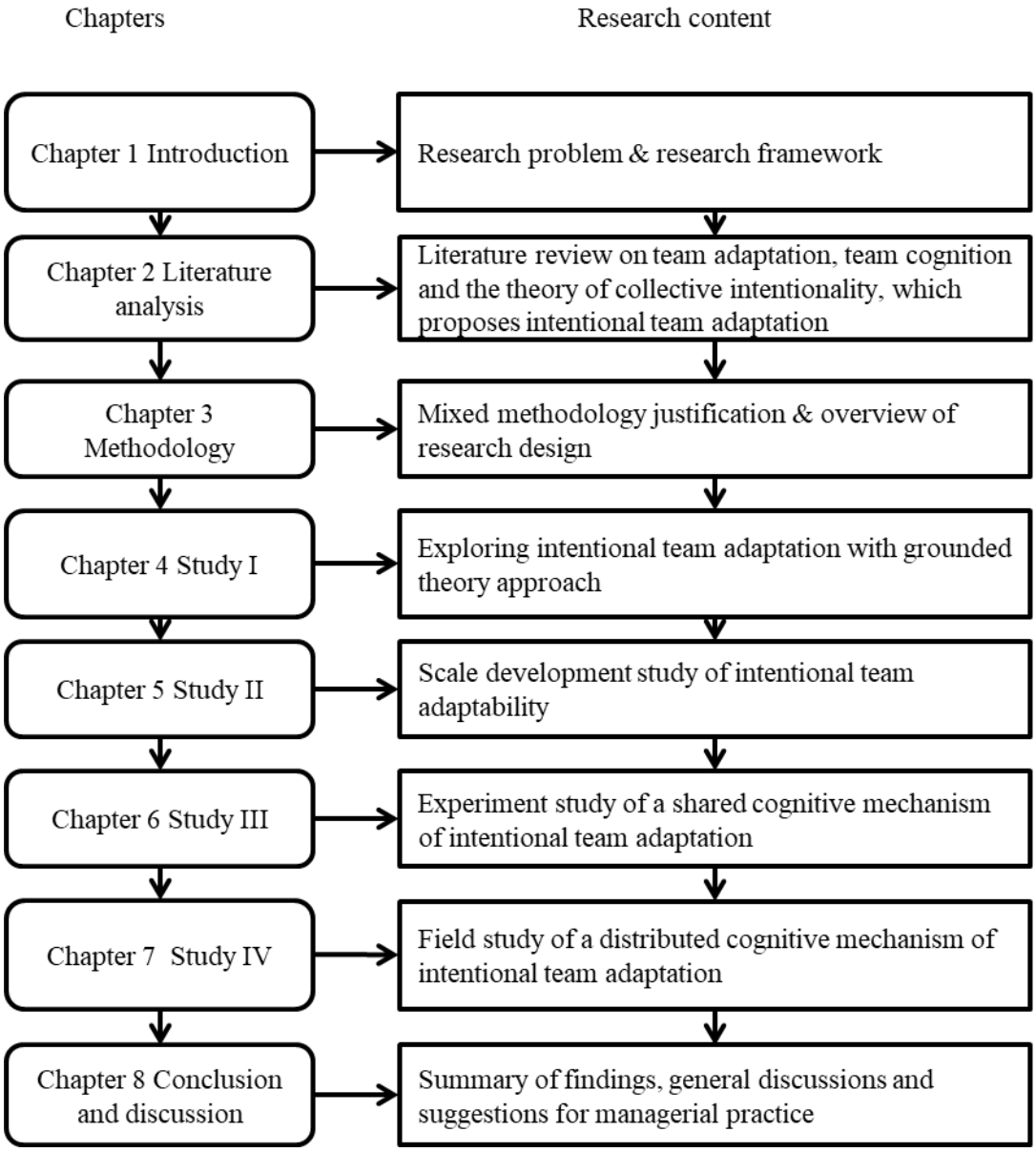
Chapter 7 reports the results of a field study that examined the relationship of

intentional team adaptation, transactive memory system, adaptive performance and task interdependence. The field design increases the external validity of the framework. A distributed cognitive mechanism of intentional team adaptation is analysed with different levels of task interdependence, which sets up boundaries for applications.

Chapter 8 is the conclusion and discussion of the research in full. It begins with a summary of the main findings as responses to the research problems. This chapter serves as a capstone for the pyramid building as well as a foundation for further research on team adaptation. Suggestions for helping teams deal with uncertainties and changes in team-related elements are also included in this chapter.

Figure 1.2 presents a brief overview of each chapter and the whole structure.

Figure 1.2 Thesis Organisation and Content



CHAPTER 2 LITERATURE REVIEW AND THEORETICAL ANALYSIS

This chapter serves as the theoretical underpinning of the whole research. It begins with theoretical works on intentionality and collective intentionality to introduce the concept of intentionality in team research. Thereafter, works on team adaptation, especially on intentional team adaptation, are reviewed. The third part focuses on the relationship between team cognition and team adaptation. Apart from general theories of team cognition, the empirical studies of two representative team cognition constructs, i.e. the shared mental model and the transactive memory system, are also reviewed. The last part of the review is related to boundary factors. At the end of this chapter, general comments on the literature and a discussion of the theoretical analysis are provided.

2.1 Introducing Intentionality in Team Research

The theory of collective intentionality is used to depict the team adaptation phenomenon for two primary reasons: Firstly, intentionality is widely accepted as the determinant of action (Searle, 2006), and collective intentionality is the determinant of collective action (Gallotti, 2012). Team adaptation can be understood as a kind of collective action, and, accordingly, collective intentionality is the determinant of team adaptation. Secondly, collective intentionality is argued to be the underlying reason for the construction of social realities such as ‘team’, ‘collective’ and ‘organisation’, to name a few. Such social realities were treated as workplaces in past research in the field of organisational behaviour, which limits the explanation of organisational behaviour and positions organisations as ‘ghosts’ instead of as key entities (King, Felin, & Whetten, 2010). The theory of collective intentionality is introduced to respond to this concern and repositions teams as the focus in team research.

This review begins with a brief introduction of intentionality, including its definitions and functions. The development of collective intentionality theory is then reviewed, and both empirical facts and theoretical considerations are presented to explain collective intentionality theory. Thereafter, research on the implications of collective intentionality theory in organisation science is reviewed. This part ends with a demonstration of teams as intentional social actors.

2.1.1 Theories of intentionality

Intentionality, which originated from the philosophy of the mind, has been considered as the property that differentiates mental states from physical states (Searl, 1983; Brentano, 1874). This discussion has a profound impact on the research of other disciplines that are related to humans. Therefore, research on intentionality in the current academic world can be roughly divided into two categories: philosophical discussion and its implications for social science research.

In general, intentionality refers to the property of mental states and events to which they are directed or about or of objects and states of affairs in the world (Searle, 1983). Intentionality is what connects an individual's mental state with the natural world. For example, if I have an intention, then the intention must be pointing to something, or if I have a belief, this belief must be about something. This property guides the function of psychological states, which further influences behaviour and the environment.

Philosophers have discussed intentionality to clarify the basis for understanding the world as well as humans (Searle, 1993), whereas psychologists have investigated intentionality to obtain a more detailed classification of mental states and behaviours (Malle et al., 2001). Malle and Knobe (1997) differentiated intentional and non-intentional behaviours and clarified basic elements for judging intentional actions, including '(i) a desire for an outcome, (ii) beliefs about an action that leads to that outcome, (iii) an intention to perform the action, (iv) skill to perform the action; and (v) awareness of fulfilling the intention while performing the action' (p. 111). Only actions that contain all five elements are considered to have intentionality without a doubt. Actions that contain one or more of the elements of desire, belief, intention, awareness and skill would be considered as intentional only in some circumstances. For example, Savage (1954) adopted a two-way belief/desire model to judge intentional actions, and Searle (1983) added intention to his model. But in some circumstances, as argued by Malle and Knobe (1997), actions such as flipping a coin to decide whether to go see a movie would be considered as unintentional because one may not have the skill to flip a certain side of the coin in comparison with a situation in which one has the skill so he can control the upside.

The common conclusions from both disciplines show the existence of intentionality and its essential status in individual cognition and development. Since intentionality is directly related to action, it is a proximal antecedent for the explanation

of behaviours.

2.1.2 Development of collective intentionality theory

Since individual behaviour is always related to intentionality, scholars have sought to determine the intentionality of collective behaviours. Tuomela and Miller (1988) were among the first to realise the limitation of individual intentionality. They argued that individual intentionality is only related to one's own actions and cannot be used to analyse social situations when others' actions are central to understanding what one was doing. In addition, Searle published an influential book in 2006 about collective intentionality, titled 'Reality and Social Construction', in which he argued that collective intentionality is the foundation of constructing social reality. Many other researchers have aimed to clarify the existence and function of collective intentionality and have developed theories about collective intentionality.

~~Collective intentionality refers to intentionality that is ascribed to the collective instead of to individual members composing the collective.~~ Although intentions are generally regarded as the property of individual mental states, they are ascribed to groups of people in our daily life language, such as the expressions of 'we intend to', 'we think', 'we want to' and 'the board claims' (e.g. Gilbert, 2009; Searle, 2006; Velleman, 1997). These expressions are termed as 'collective intention' or 'shared intention', which refers to the mental state of the collective and is used to explain joint action carried out by a group of people.

The argument for a collective mind gained support from Clark and Chalmers (1998) and their ontological clarification, which is well known as the 'theory of the extended mind'. They argued that 'the human organism is linked with an external entity in a two-way interaction, creating a coupled system that can be seen as cognitive system in its own right' (p. 8). Specifically, once the function of the mind is connected with other objects, the whole system, which includes both the mind and objects, can be viewed as having intentionality. This argument has expanded the original understanding of the human mind and proposes that the human mind is more than the boundary of skin and skull; it also includes the environment in which it is embedded. Some scholars further extended this argument to the collective (Gallotti, 2012; Rakoczy, 2006; Tollefsen, 2006) and proposed that a system of two or more people who share the same intention can be viewed as an actor with unique intentionality.

Findings in neuroscience also support the idea of an 'extended mind'. For instance,

Rizzolatti and his team (1988) found that neurons in area F5 in the monkey ventral premotor cortex code goal-related actions. Among them, a class of visuomotor neurons was activated when the monkey observed an action performed by another individual and when it executed the same action. Owing to this property, these neurons are named as mirror neurons. The mirror neuron makes the explanation of understanding others' behaviour possible and further provides a foundation for cooperation or joint action (Pacherie & Dokic, 2006).

Woolley et al. (2010) demonstrated the existence of 'collective intelligence' with two experimental studies, thus providing further evidence for collective intentionality. Collective intelligence is defined by an analogy with individual intelligence; it is the 'general ability of the group to perform a wide variety of tasks' (p. 687). This idea is quite similar with the assumption of 'group mind', but it was further empirically defined as 'the inference one [draws] when the ability of a group to perform one task is correlated with that group's ability to perform a wide range of other tasks' (p. 687). The results of the two experimental studies support the above idea that collective intelligence does exist as a property of the group itself and not just the individuals in it.

2.1.3 Implications of collective intentionality theory in organisation science

Apart from ontological arguments in philosophy, the theory of collective intentionality has been applied in organisation science to explain organisation behaviour, to justify organisations as social actors and to analyse the problem of risk and adaptation in organisations.

Tollefsen is one of the most influential philosophers who connected organisation research with philosophy. On the one hand, she used organisations as an example to explain the property and function of collective intentionality and to solve the problem of the collective mind (Tollefsen, 2002a, 2006). On the other hand, she applied the theory of collective intentionality to interpret organisational behaviour and phenomena in organisations (Tollefsen, 2002b). She presented organisations as intentional agents that can behave intentionally and undertake related responsibilities on their own. She defined an organisation as 'collectives oriented to the pursuit of relatively specific goals and that exhibit a high degree of formalization' (Tollefsen, 2002b, p. 49). An organisation is different from general collectives since it can have its own intentional states that can be differentiated from organisational members' intentional states. The high degree of formalisation enables labour to be distributed appropriately within

organisations. This is the premise for completing difficult and complex organizational tasks with individuals' bounded rationalities. Organisations are responsible for task allocation and prioritisation, for setting up goals and for providing necessary information and equipment to limit the decision scopes of individual members. Therefore, an organisation guides individual members' behaviour; individual members' behaviours do not compose organisational behaviour.

King, Felin and Whetten (2010) proposed collective intentionality as assumptions to conceptualise organisations as social actors. Based on the same observation by Tollefsen (2002b), they found that it was natural to treat organisation as an intentional agent in our daily language, such as 'A company declares X', or 'B company claims Y'. Collective intentionality in organisations is manifested in three aspects: uniqueness of an organisation's identity, goal-directed organisational activity and multifaceted nature of both identity and goal. Organisations have unique identities to make them recognisable as well as distinguishable from similar others; the organisational goal is the basic guide for members' behaviours and referent of accountability mechanism. Although identity and goal are inherent, members may have different interpretations of them, which can be resolved through members' interactions. Such diversity also attributes to the organisational agency through free individual agency and their wills. King, Felin, and Whetten (2010) proposed collective intentionality to be the ontological foundation for organisational behaviour. They further called for research on an organisation itself rather than organisational behaviours that are decomposed into individual members' behaviours.

Steel and King (2011) explored the process that enables collective intentionality in organisations based on King, Felin and Whetten (2010)'s work. They maintained that organisation identity provides an organisation with 'internal self-view' which guides members behaviour and decision-making. By adopting the method of meta-ethnography, they found that an organisation has its distinctive identity that influences and is influenced by organisational strategising and decision-making. This identity lays a foundation for coherence of organisational activities. Collective intentionality, as is consistent with the argument of King et al. (2010), is the basic property of an organisational actor and directly influences the development of an organisation's identity. The process model of collective intentionality development they proposed include three main domains: organisational style, external audience and organisational identity; the processes among the three domains are strategising and decision-making,

reinforcement and ambiguation, and situated interpretation of the perceived external image and other factors. These three processes interact with each other under the guidance of collective intentionality in forming an organisational identity.

Felin and Foss (2009, 2011) have published two papers on the implication of collective intentionality in the research fields of organisational capability and organisational routine. Recent studies on routines and capabilities have simply examined the input-output relationship (or the 'stimulus-response' relationship). They argued that studies adopting such a paradigm only explain random heterogeneity but ignore the 'intentional and choice-related actions of individuals and organizations' (Felin & Foss, 2011, p. 241). Therefore, they suggested exploring the role of intentionality related to both individual members and organisations in future studies.

Busby and Bennett's paper (2008) is the only one that adopts the theory of collective intentionality to solve problems empirically. Their research aimed at evaluating risks in complex systems. Conflict among different intentions is argued to be the key reason for organisational dysfunction. Risk assessment is conducted based on four processes: (a) to identify main social objects in the system; (b) to identify the collective intentions for these objects in terms of functions; (c) to identify the obligations and powers of actors in the system; and (d) risks are analysed based on incongruence between obligations and contingent actions. Organisational dysfunction arises when the intended function is not achieved because of intention diversity caused by contextual reasons. Their study emphasises human intention and socially constructed reality, opening up a new avenue for behaviour analysis within organisations as well as diversity research.

Above all, existing research on the applications of collective intentionality for organisational science is limited. An emerging trend is an emphasis shift from individual behaviour to collective intention in analyses of collective behaviour. Apart from micro-level research, studies are increasingly focusing on higher-level analyses in organisation science. Top-down research is has become popular in recent years with the introduction of collective intentionality.

2.1.4 Teams as intentional social actors

The theory of collective intentionality lays the foundation for viewing teams as intentional social actors. According to King, Felin and Whetten (2010), the underlying assumptions that conceptualise teams as social actors are external attribution and

intentionality.

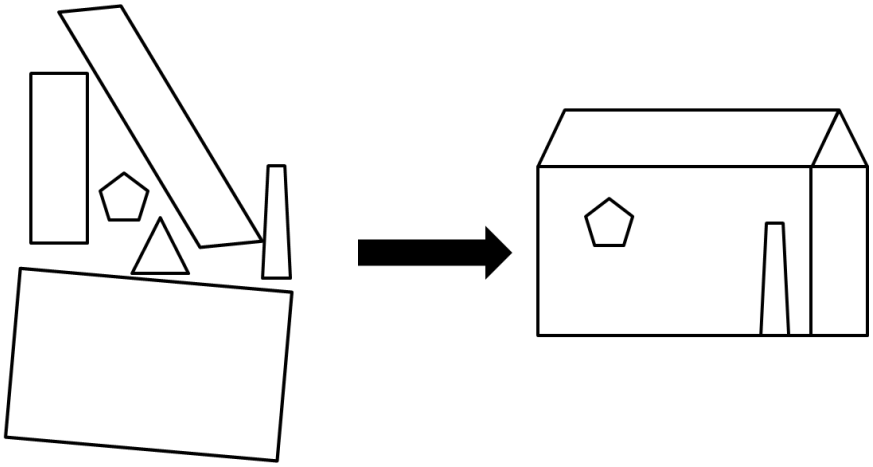
According to the external attribution assumption, other actors should consider a social entity as a capable actor. Teams' members and leaders naturally consider teams as having action capability and responsibility (Kozlowski & Bell, 2003). Teams are analysed as performers in empirical studies (Salas, Cooke, & Rosen, 2008). Intentional states and cognition abilities are ascribed to teams, such as team learning (Kozlowski & Bell, 2008), team reflexivity (Konradt et al., 2015) and team potency (Hu & Liden, 2011). Moreover, most of the team-level phenomena, such as team cognition, cannot be ascribed to individual actors since the primary drivers of team cognition include at least three levels: individual members' interactions, a team level's motivation and an organisational level's constraints (Cooke et al., 2013). Therefore, giving a team the status of a social actor is conceptually consistent with analyses in team research.

Intentionality assumption refers to the underlying reasons for actors' behaviours (King, Felin, & Whetten, 2010). A team is an intentional social actor not only because it is considered to be but also because of its intentionality that characterises its mental states and directs its behaviours. Team intentionality refers to the following three aspects: (i) the underlying reason for balancing between team diversity and goal uniqueness, i.e. goal direction; (ii) the underlying reason for members' coordinated behaviour, i.e. team interaction; and (iii) the shared content of members' intention, i.e. shared intention.

Therefore, a team, as an intentional social actor, is constructed based on members' shared intention, team interaction and goal direction. In other words, team intentionality refers to the common mind of individual members that is consistent with team goals and is developed from their interactions and shared intention. The differences between the collective of independent individuals and the team with intentionality are shown in Figure 2.1. Different shapes are used to represent the expertise of independent individuals; the unintentional collective seems meaningless while these shapes can be combined with a certain kind of mode as a house. The right side of Figure 2.1 is the analogy of an intentional team actor, which can be described in the following ways: 1) The intentional actor is not alone; rather, the actor is within a system of different individuals who rely on the similar intention of all the individual shapes to form a certain figure, e.g. a house; 2) Individuals within the team are placed in certain locations with special intentions. In other words, each shape has its direction within the collective intentionality; 3) Individuals embedded within each other comprise the figure. Without

these relationships, there will only be some independent shapes on the left side.

Figure 2.1 General Collective vs. Teams As Intentional Social Actors



To conclude, a team can be viewed as an intentional social actor when it meets the following requirements:

a) A team can be an intentional actor if and only if team has unique intentionality, originated from:

i. The responsibility burdened from the organisation;

ii. Individual members' original intentions.

b) All the members align their own intentions with a team's intention. These intentions may include:

i. Reaching agreements on functions and task responsibilities, goals to be achieved, the sub-goals in each stage and the allocation of resources and their usages;

ii. Making a joint commitment to act as a body and take responsibility for the team's action;

iii. Developing interdependent and interactive relationships in accordance with their roles and rules.

2.2 Intentional Team Adaptation

Researchers who studied the phenomenon of team adaptation adopted different terms according to their research problems and emphases. These terms include 'team adaptability', 'adaptive teams', 'adaptive coordination', 'structural adaptation', 'adaptive performance', 'team adaptiveness', 'strategy adaptation', to name a few. Although termed differently, they refer to the same phenomenon, i.e. responding to

changing environments in order to maintain team effectiveness and expected function (Burke et al., 2006; Maynard et al., 2015). Therefore, those related studies are all included and analysed in this research to obtain a holistic picture of team adaptation. In this section, the main conceptual works on team adaptation are reviewed first, followed by a review of empirical studies of team adaptation with a 'change-response' typology-based framework. An analysis of the reviewed work is provided at the end of this section, based on which intentional team adaptation was selected as the focus of this research.

2.2.1 Conceptual works of team adaptation

Since Burke et al.'s (2006) initial conceptual work, more than a decade has passed and increasing effort has been put into research on 'team adaptation'. In 2008, Kozlowski and Bell published their work on the creation of an adaptive team. In addition, Baard et al. (2014) discussed team adaptation as one approach to performance adaptation research. Moreover, the *European Journal of Work and Organizational Psychology* published a special issue on team adaptation in 2015; it contained a review of ten years of research on team adaptation (Maynard et al., 2015). Further, Frick et al.'s (2018) conceptual work has shifted the focus from team adaptation to maladaptation and proposed a 'four Rs' framework. Five conceptual works on team adaptation are reviewed in this section to reveal the research progress and research focus shift. Table 2.1 presents the main argument of each conceptual work.

Table 2.1 Summary of reviewed conceptual works on team adaptation

Article	Main Arguments
Burke et al., 2006	Team adaptive cycle has four phases: situation assessment (Phase 1), plan formulation (Phase 2), plan execution (Phase 3) and team learning (Phase 4).
Kozlowski & Bell, 2008	Team adaptation is achieved through four phases: team formation, task compilation, role compilation and team compilation.
Baard et al., 2014	Research on performance adaptation can be classified into four approaches: performance construct approach, individual difference construct approach, performance change approach and process approach. Research on team adaptation mostly involves the performance change approach and the process approach.

Maynard et al., 2015	Empirical studies on team adaptation conducted from 1998 to 2013 can be classified into a 'Input-Mediators-Output' model. More research should be conducted on team-based triggers and interpersonal team processes that contribute to team adaptive outcomes.
Christian et al., 2017	Theories of team adaptation are extended based on adaptive stimuli. An IMOI framework is used to examine the process model of team adaptation performance with two distinct contextual moderators: (a) internal versus external changes (i.e., origin), and (b) temporary versus sustained changes (i.e., duration). The meta-analysis approach was used in this study to examine the processes, emergent states, and inputs that lead to effective team adaptation in general, and in specific contexts.
Frick et al., 2018	Activities that may lead to team maladaptation are analysed based on a 'four Rs' framework: recognise, reframe, respond and reflect.

Burke et al. (2006) developed a nomological model of team adaptation based on an 'Input-Mediator-Output-Input' (IMOI) framework. They defined team adaptation as 'a change in team performance, in response to a salient cue or cue stream that leads to a functional outcome for the entire team' (p. 1190). They recognised four phases in the adaptive cycle: situation assessment, plan formulation, plan execution and team learning. Team members will gather information in the situation assessment phase, which leads to the development of a shared mental model and team situation awareness. The shared understanding of a current situation provides a cognitive framework for plan formulation, determining the course of action, goals and prioritising tasks. Plan execution is the phase in which members carry out a plan that involves coordinated individual behaviours that may emerge as team behaviour, including monitoring, backup, communication, leadership and coordination. The final phase (i.e. team learning) is conceptualised as 'an ongoing process of reflection and action, characterized by asking questions, seeking feedback, experimenting, reflecting on results and discussing errors or unexpected outcomes of actions' (Edmondson, 1999, p. 354). Apart from core elements of the adaptive cycle, they also discussed factors that influence the four phases: individual characteristics, cues, job design characteristics and emergent states, i.e. the shared mental model, team situation awareness and psychological safety.

Kozlowski and Bell (2008) further clarified how to achieve team adaptation through team learning and development. They postulated four phases in which individual members develop into an adaptive team: team formation, task compilation, role compilation and team compilation. In the team formation stage, members socialise into a team as an entity. In this stage, they develop knowledge of interpersonal relationships and team orientation. After forming the team, members begin to acquire knowledge of tasks and skills to complete the jobs. Role compilation is the focal level transition to dyads when team members identify their role sets and boundaries. During the last phase, i.e. team compilation, team members finally develop a reconfigurable network of role linkages that enables capabilities for adaptation.

Baard et al. (2014) reviewed works on performance adaptation in organisations and summarised the works of Burke et al. (2006) and Kozlowski and Bell (2008) as the 'process approach'. They identified four theoretical approaches based on extant research on individual and team performance adaptation: a performance construct, an individual difference construct, a change in performance and a process. The performance construct approach defines performance adaptation as a set of dimensions that characterise adaptive job performance; the individual difference construct approach defines performance adaptation as a set of broadband, relatively stable traits; the performance change approach conceptualises performance adaptation as a change in performance from routine to novel tasks; and the process approach conceptualises the performance approach as a cycle that unfolds over time. The extant studies on team adaptation are mainly classified as applying the performance change approach and the process approach.

Maynard et al. (2015) focused on empirical studies of team adaptation and reviewed related works published from 1998 to 2013. They employed the 'input-mediator-outcome' (IMO) model to frame the literature. Factors that serve as antecedents of team adaptation include three levels: organisational level factors (e.g. supportive context, organisation climate, resource access), team-level factors (e.g. task features, team structures, team resilience, team adaptability, task interdependence) and individual-level factors (e.g. member characteristics, member flexibility, member adaptability). Maynard et al. (2015) classified team adaptation process factors into action process and interpersonal process but noted that only action process factors had been studied in previous research. Mediators to the relationship between team adaptation process and adaptive outcomes include communication and information

sharing, coordination activities and team cognition. They suggested future research should pay attention to team emergent states and team empowerment. Team adaptive outcomes usually refer to consequences of the adaptation process, including team cognition, team members' affective reactions, team effectiveness and team performance. After sufficient review of empirical works on team adaptation, they proposed a new research agenda of team adaptation based on type and severity of team adaptation triggers, calling for more research on team-based triggers and the interpersonal team process that contributes to team adaptive outcomes.

Frick et al. (2018) built a concise heuristic of team maladaptation based on previous research on team adaptation, summarised as the 'four Rs': recognise, reframe, respond and reflect. Similar to the four phases Burke et al. (2006) proposed, the recognise phase refers to the period during which a team gathers information from an internal or external environment; the reframe phase refers to the period during which team members make plans based on the identified cues; the respond phase consists of the team's actions; and the final phase is the reflection of the whole adaptive cycle. They identified 13 activities that may lead to maladaptation based on the 'four Rs' framework: misallocation of the time for each phase; wrong sequence of each phase; failure to share information; ignorance of cues and emphasis on irrelevant cues in the recognition phase; failure of shared mental model updating; improper course of action in the reframe phase; absence of required resource and actions that do not match with the formed plan in the respond phase; and failure to learn from the adaptive cycle in the reflect phase. They called for empirical studies to examine the components of activities that lead to team maladaptation.

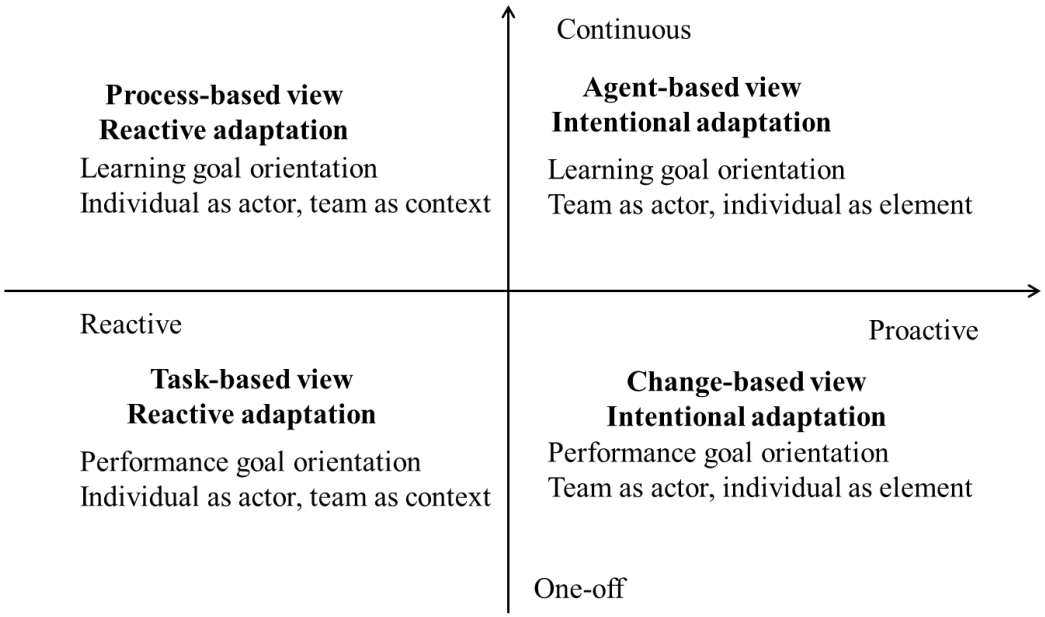
In summary, the above five conceptual works analyse team adaptation from different aspects, identify several gaps in the extant research and offer suggestions for future research. The common idea of their work is to define team adaptation as a response to changes. Burke et al. (2006), Kozlowski and Bell (2008) and Frick et al. (2018) clarified the development phases of team adaptation, beginning with the assessment of changes in the environment to taking actions as a response to the identified changes. Frick et al. (2018) further classified changes as internal and external; similarly, Maynard et al. (2014) classified changes as team-related and task-related. Different types and the severity of changes are argued to arouse different responses (Maynard et al., 2014) cause teams to suffer from maladaptation (Frick et al., 2018). Accordingly, in the following section, empirical studies of team adaptation are reviewed

with the typology of ‘change-response’. A proactive response to change, which is termed as ‘intentional team adaptation’ in this research, is focused on as well.

2.2.2 Review of team adaptation based on a ‘change-response’ typology

A typology of ‘change-response’ is employed to review team adaptation research. A change acts as the stimulus for adaptation. A change can be either internal (LePine, 2003, 2005) or external (Randall et al., 2011) in terms of origin (Christian et al., 2017). Moreover, a change can be evolutionary or radical and evaluated based on the magnitude of the change (Uitdewilligen et al., 2013), the degree of environment novelty (Marks et al., 2000) or the duration (Chistian et al., 2017). Responses can also be internal or external (Klein & Pierce, 2001), as well as effective (Burke et al., 2006; Randall et al., 2011) or ineffective (Johnson et al., 2006; Klein & Pierce, 2001; Frick et al., 2018). In this research, change is classified according to two indicators: type (internal vs. external) and magnitude (radical vs. evolutionary). In order to get adapted, a team must respond to changes in corresponding ways, which are classified based on two indicators: one-off/continuous and reactive/proactive. One-off response refers to a temporary adjustment for dealing with radical change while continuous response is a long-range adjustment for dealing with evolutional changes. A reactive response refers to taking actions when something wrong has been realised and put back on track, whereas a proactive response refers to taking actions before change has happened and the readiness to deal with possible threats to team effectiveness. Therefore, four types of team adaptation are identified based on this classification. Figure 2.2 shows the classification of team adaptation based on the change-response alignment.

Figure 2.2 Typology of Team Adaptation Based on Response to Change



The first type is a proactive and continuous response towards evolutionary internal change, which is termed as an ***agent-based view of intentional adaptation***. The key property of this type of team adaptation is a learning goal orientation with a team as a social actor. The learning goal orientation of an agent refers to the belief of mastery and learning for the achievement and completion of tasks (Wolters, Shirley, & Pintrich, 1996). In the agent-based view of intentional adaptation, a team carries out its activities as a unit instead of individually. It is learning-oriented in order to make modifications and predictions prior to changes, thus contributing to team development under evolutionary internal change. Previously studied activities include information collection, planning and task-related design or allocation.

Information collection is a temporary starting point for an intentional team adaptation response. Scholars have used different terms to describe this activity in order to make sense of environmental changes or to detect abnormal cues in the environment. Waller (1999) suggested that collecting information about members, tasks, goals and other team behaviours enables the realisation of change in an environment and help teams achieve adaptation. Information collection is also an important behaviour in Burke et al.'s (2006) four-phase model of adaptation, which is mainly carried out in the situation assessment phase and provides a basis for activities such as plan formulation, plan execution and team learning.

Planning is another proactive and continuous response that occurs in transition phases, including both strategy-oriented planning and in-process planning. The former refers to the deliberate planning activities that occurs before a task is carried out, and

the latter refers to the organisation of activities to coincide with situations or cues that are recognised during information collection. Lei et al. (2016) provided empirical evidence on the function of planning activities and found teams achieve adaptation by planning behaviours. 'Heedful interrelating', which Grote et al. (2010) proposed, is another related term. It refers to a team's intentional efforts to judge actions in relation to goals and interrelationships.

Waller (1999) described task-related design or allocation together with information collection as adaptive behaviours), which include task prioritisation and task distribution. The former refers to arrangement of task sequence, and the latter refers to the arrangement of task responsibility. Since internal changes may alter existing resources within teams, task prioritisation and distribution enable teams to be adaptive through focusing on the most important tasks and making full use of human resources in teams. Teams that are ready for change or even anticipate a change occurrence may adopt the design of low task interdependence. Moon et al. (2004) conducted an experimental study to prove that divisional structure was better fit for an unpredicted environment since team members are independent from others' work.

The second type of team adaptation is the continuous but reactive response towards evolutionary external change, which is termed as a ***process-based view of reactive adaptation***. The key property of this type is a learning goal orientation with individuals as actors. A key difference between a process-based view and an agent-based view is the actor (team vs. individual). Although these two types of team adaptation are both learning goal-oriented, the actors in the process-based view are individuals, which means that individuals who are responsible for themselves carry out the process activities (e.g. interactive communication, coordination). Typical activities that researchers have studied include reactive coordination, shared cognition and communication.

Reactive coordination is a team process activity; it has been referred to as 'orchestrating the sequence and timing of interdependent actions' (Marks, Mathieu, & Zaccaro, 2001, p. 363) and as the alignment among members' actions for effective goal achievement (Bedwell, Ramsay, & Salas, 2012). There are two types of coordination: implicit and explicit. The former is active and involves overt communications with clear intentions whereas the latter involves latent communications based on shared understandings. Implicit communication is argued to be important when confronted with environmental changes. For example, Han and Williams (2008) identified

coordination as a critical factor that influences team effectiveness in a complex and dynamic environment. Further, Entin and Serfaty (1999) demonstrated that implicit coordination is the primary adaptation mechanism for teams burdened with increasing pressure. Similarly, Bedwell, Ramsay and Salas (2012) reviewed research on the problem of membership fluidity and found that implicit coordination helped to improve adaptive performance associated with non-routine events. A representative example is medical teams, for which emergency is non-controllable and frequent. Burtscher et al. (2010) recorded 22 anaesthesia teams' behaviour and found increases in task coordination were related to higher adaptive performance. Backup behaviour is also a specific type of coordination activity that individuals carry out; it is suggested to boost plan execution and team adaptation (Burke et al., 2006).

Implicit coordination is supposed to be based on a shared understanding among team members. A shared understanding indicates the degree of similarity among team members. A variety of variables are discussed under the umbrella of shared understanding, such as shared mental models, shared knowledge and shared information. According to Entin and Serfaty (1999), developing a shared mental model of an environment, task and team members is beneficial for improving effectiveness under uncertainty. Bedwell, Ramsay and Salas (2012) also contended that shared mental models or common cognitive representations of tasks enabled implicit coordination, thus contributing to team adaptation. It is even more popular in the research field of training, in which scholars have argued that shared cognition is the foundation of adaptivity. Moreover, Marks, Zaccaro and Mathieu (2000) conducted experiments to confirm the role of mental models in novel situations, while Chen, Thomas and Wallace (2005) conducted a multi-level examination to support the above argument. Further, Randall, Resick and DeChurch (2011) demonstrated that mental model accuracy and similarity enable teams to determine strategic needs and make adaptive decisions.

In order to develop shared cognition, communication among members is a necessary step. The general forms and communication are discussed as a reactive but continuous mechanism. Bedwell, Ramsay and Salas (2012) asserted that sharing information, as the function of communication, facilitates the development of team cognition and enables a team to be adaptive when confronted with task changes.

The third type of team adaptation is a one-off and reactive response towards radical external change, which is termed as a ***task-based view of reactive adaptation***. The key property of this type is performance goal orientation with individual as actor. This type

of team adaptation is consistent with traditional team effectiveness research, which generally adopts the 'Input-Mediator-Output' paradigm and views a team as a context. The performance orientation of an agent refers to the belief in demonstrating one's ability compared to others for the completion of tasks (Wolters et al., 1996). In the task-based view of reactive adaptation, individual members tend to carry out activities that are recognised as important for bringing a current state back on track from their own standpoint. Factors studied in this quadrant include team leadership (e.g. external sensegiving, rotational leadership, leader briefing) and team interaction patterns.

A leader is considered as the one who is responsible for a team's behaviour. One of the functions of team leadership is external sensegiving, which is considered as the source of epistemic motivation for team members (Randall et al., 2011). During disruptive events, teams with leaders who make sense of the environment and change in an appropriate way can provide the whole team with the right direction, thus contributing to the adjustment of temporary activities and maintaining team performance (Morgeson, 2005). Leader briefing, which is another function of team leadership, refers to information that leaders convey to team members about the task environment (Marks et al., 2000). Leadership briefing contributes to team adaptation through accurate information transferred to team members, which enables their one-off response activities. Rotational leadership is a leadership structure that was designed in response to unpredictable changes for expert teams. The one-off activity refers to the rotation of leadership to the one who is more familiar with and experienced in dealing with the current change, therefore facilitating the function of briefing and sensegiving (Bedwell et al., 2012). A similar term used in literature is 'shared leadership', which has been defined as an interactive process among individuals that leads towards the achievement of team goals (Burke et al., 2006; Grote et al., 2010). Therefore, the function of sensegiving and briefing is not concentrated on a certain individual but rather shifts to another individual according to the situation requirement as an instant response. In regard to the team leader's function in promoting team adaptation, Day, Gornn and Salas (2004) contended that team leaders, whether formally appointed or emergent, enable adaptation through effective monitoring, support and encouragement.

A change in interaction patterns or an adjustment in the team role structure is considered as another reactive and one-off response. It has been defined as the behavioural pattern of team members who interact to complete a task (LePine, 2003; Uitdewilligen et al., 2013). Empirical evidence in relevant literature has confirmed the

adaptive interaction patterns. For example, Stachowski et al. (2009) found fewer, shorter and less complex interaction patterns in adaptive teams during crisis situations than in ineffective crews. Moreover, LePine (2003) discovered newly developed interaction patterns immediately following change was positively related to post-change team performance. Lei et al. (2016) further demonstrated that matching team interaction patterns to fit novel situations promotes team adaptive performance.

The last type of team adaptation is one-off and proactive response towards radical internal change, which is termed as a ***change-based view of intentional adaptation***. The key property of this type is performance goal orientation with a team as an actor. The team itself pursues performance when confronted with radical change. The aim of behavioural adjustment and modification is to maintain effectiveness rather than achieve development. Due to the complexity and non-repeatability nature of such change, empirical studies have only minimally addressed adaptive mechanisms. Only a handful of theoretical works on team adaption have discussed some possible proactive and one-off mechanisms, including team situation awareness (Burke et al., 2006), team cognition updating (Uitdewilligen et al., 2013) and transactive memory system (Christian et al., 2014).

Team situation awareness, which is another certain form of team cognition, refers to a shared understanding of the current situation at a given point in time (Burke et al., 2006). In Burke et al.'s (2006) proposed four-phase model of team adaptation, team situation awareness is proposed to be positively related to plan formulation. It is considered as a change-based intentional adaptation mechanism since it lays a foundation for a correct direction for one-off response activities. By assessing the situation with a shared understanding that is directed to novel task situations among team members, a team can achieve adaptation when going through a radical change.

Shared mental model updating is also viewed as a proactive mechanism for dealing with radical changes. According to Burke et al. (2006), situation assessment and plan formulation are positively related to the development of a shared mental model, and updated shared mental models contribute to plan execution and team learning during the adaptive process. Uitdewilligen et al.'s (2013) empirical results also support the argument that shared mental model updating contributes to adaptive outcomes (i.e. post-change performance).

Christian et al. (2014) observed the situation of member loss and found that a transactive memory system positively affected team performance following the loss of

a member. This effect was reduced for the loss of a critical member who contributed to the effectiveness of plan formulation. In other words, when a team is confronted with member loss, the effectiveness of the transactive memory system is reduced due to difficulties with forming an appropriate plan of action in response to the change.

2.2.3 Intentional team adaptation as the focus of this research

The above review of team adaptation research provides us a clear picture. Most of the present team adaptation studies focused on reactive responses to external changes in environments and paid little attention to the dynamic and developmental nature of the process. Since teams in contemporary organisations are experiencing internal changes with the requirement of learning and development (Christian et al., 2017; Uitdewilligen, Rico, & Waller, 2018), the appropriate response to internal changes should also be emphasised. The alignment of response and internal changes is the content of intentional team adaptation. To specify, intentional team adaptation is defined as a team's intentional/proactive response to internal changes in team-related elements, thus leading to adaptive outcomes.

This research argues for the importance of intentional adaptation and seeks to understand team adaptation as the intentional activities of teams that aim to maintain and develop team effectiveness when confronted with internal changes. Specifically, the research problem is framed as follows: 'When and how do teams intentionally achieve an expected performance in a dynamic environment with changes in team-related elements?'

Ascribing intentionality to teams enables us to understand the proactive response of teams to internal changes. In this review, information collection, planning and task-related design or allocation have been argued as the proactive response to continuous and internal changes, while team situation awareness, shared mental model updating and a transactive memory system are demonstrated as the proactive response to one-off and internal changes. However, most of the present studies that are classified as intentional adaptation are theoretical works; there is a lack of empirical studies on the above factors. Therefore, empirical methods are adopted to study intentional team adaptation in this research, especially in regard to cognitive underlying mechanisms. Scenarios of continuous change and one-off change in team-related elements will be designed and selected to study intentional team adaptation, with team cognition as the underlying mechanism.

In summary, this research focuses on understanding intentional team adaptation and provides suggestions for managerial practices. Team cognition is studied as the main mechanism for intentional adaptation. Consistent with the theoretical foundation of this research, i.e. viewing teams as intentional social actors, the shared mental model and transactive memory system are discussed as specific team cognition constructs since both were proposed as operationalised constructs of a 'group mind' (Klimoski & Mohammed, 1994; Wegner, 1987). Related works will be reviewed in the following sections.

2.3 Team Cognition as the Underlying Mechanism of Intentional Team Adaptation

Team cognition is an emergent state that refers to how information is collectively processed to enable team functioning (Kozlowski & Ilgen, 2006). It is one of the most important mechanisms for achieving team adaptation and is also viewed as laying the foundation for other team processes such as coordination (Manser et al., 2008). Both shared cognition and distributed cognition are beneficial for team adaptation. Shared cognition contributes to team adaptation through implicit coordination with a common ground and the same expectation for each other's behaviours (Marks et al., 2000; Resick et al., 2010); distributed cognition contributes to team adaptation through the quick realisation of problems and newly developed strategies by integrating different perspectives and analyses (Mell, Van Knippenberg, & Van Ginkel, 2014; Christian et al., 2014). However, Gevers, Uitdewilligen and Passos (2015) asserted that the dynamics of this relationship are poorly understood despite the growing number of studies. Intervention studies are also needed to provide support for causal relations as well as practical suggestions for improving teams' adaption.

In this section, team cognition and its relationship with team adaptation, especially intentional team adaptation, are reviewed. Two specific constructs are reviewed and discussed as representative of each category of team cognition: The shared mental model is presented as the typical construct within the umbrella of shared cognition; the transactive memory system is presented as the typical construct within the umbrella of distributed cognition.

2.3.1 Shared mental model as the shared cognitive mechanism

A mental model refers to the structured knowledge that is used to describe, explain

and predict situations and events (Rouse & Morris, 1986). Shared cognition approach enables the property to be similar or shared across levels. Therefore, a shared mental model (SMM) is defined as the shared structured knowledge that exists among team members who use it to describe, explain and predict team situations and events (Cannon-Bowers, Salas, & Converse, 1990). To specify, a shared mental model is the bottom-up emergent state that originated from individual mental models and emerges through a compositional process in which individual-level elements are similar in both forms and functions to a team-level manifestation (Kozlowski & Klein, 2000). In this section, studies of shared mental model will be introduced from three aspects: the development of a shared mental model construct, the measurements of a shared mental model and the relationship between a shared mental model and team adaptation.

2.3.1.1 Development of a shared mental model construct

Klimoski and Mohammed (1994) initially termed the mental model shared within teams as the 'team mental model'. This construct is proposed as a development of collective mind theory. This theory is used to explain mental states that are 'based on individual members' perceptions, thoughts, beliefs, and expectations, but was more than just the sum of such individual properties' (p. 403). Although this theory had a limited influence since it was so amorphous that no operationalised notion could be developed, it experienced a resurgence in organisational science due to the emerging group-level phenomenon known as the 'group-mind' construct. Klimoski and Mohammed (1994) proposed the construct 'team mental model' as a response to the deficiency of group mind theory by addressing the content, form, functions, antecedents and consequences. After 15 years of development, Mohammed, Ferzandi and Hamilton (2010) further clarified the definition, function, content, properties and measurement of the team mental model, in turn making this construct the most popular and valid form of team cognition.

The most widely examined properties of the shared mental model are similarity and accuracy. The former refers to the degree of overlapping of members' mental models, and the latter implies the degree of adequacy for representing the specific content, such as team members' expertise and skills, team structure, task allocation and time management (Mohammed, Ferzandi, & Hamilton, 2010). Randall, Rescick and DeChurch (2011) suggested that similarity is a dispersion construct that reflects the degree of congruence, whereas accuracy is an additive construct signalling the average degree of members' mental model accuracy disregard of their agreement. Both

indicators can represent the quality of a shared mental model, i.e. to what extent is it shared, and to what extent is it accurate. They are independent dimensions that depict different aspects of shared mental models (Mohammed, Ferzandi, & Hamilton, 2010).

2.3.1.2 Measurement of the shared mental model

Although there is no consistent measurement across studies of the shared mental model due to its context-dependent nature (Mohammed, Ferzandi, & Hamilton, 2010), some principles have become widely acknowledged with the development of more than 20 years of empirical studies. For instance, Mohammed et al. (2010) identified four important characteristics of the measurement: (i) content; (ii) elicitation of content; (iii) mental model structure; and (iv) representation of emergence. *Content* refers to the focus of the mental model, such as tasks, strategies and team interactions. *Elicitation* means measuring the degree of members' understanding of the content. *Mental model structure* describes the modelling of the cognitive organisation of the content. Finally, *representation of emergence* refers to the approach used to represent the team-level mental model. Examples of measurement include paired comparison ratings, concept mapping, card sorting and qualitative methods. Mohammed, Ferzandi and Hamilton (2010) compared these methods and suggested employing a measurement according to the research questions.

Paired comparison ratings are the most popular adopted method for eliciting mental models. The original data obtained through this method describe the network of relationship among recognised decisions regarding team goals. Randall, Resick and DeChurch (2011) adopted this method in their research. They identified 10 decisions as key decisions for completing the team task. Participants were required to rate the correlation between each decision and the remaining decisions. The network analysis software Pathfinder Networks was used as the tool for data analysis, which produced a closeness of metrics to represent the similarity between two mental models. Therefore, members' mental models were compared with one another to calculate SMM similarity; each member's mental model was compared with the expert mental model and the average score was obtained to calculate SMM accuracy. Uitdewilligen et al.'s (2013) study adopted a similar method to produce association metrics and calculated similarity through the quadratic assignment proportion correlation of the two mental models.

Concept mapping is used to link related concepts in a hierarchical structure. Generally, participants are asked to choose from a variety of pre-labelled concepts that the researchers determine; they are then required to place the chosen concepts in a tree

structure. Shared mental models are measured as the overlap of team members' concept maps. One of the representative works is Marks, Zaccaro and Mathieu's (2000) study. In their study, participants were asked for three members to select 24 pre-labelled concepts (with each member assigned eight concepts) that they believed were necessary actions to complete the team task. Similarity was calculated by assessing the overlap of the concepts selected; accuracy was first assessed individually by experts and was then was averaged to the team level.

Card sorting is used to sort critical incidents written on cards. Researchers determine the critical incidents. Each pair of cards is assigned a value of one or zero; it depends on how each participant sorts them into a pile. One of the representative works is Smith-Jentsch, Cannon-Bowers, Tannenbaum and Salas's (2008) study, in which participants were asked to sort 33 index cards with each describing a critical incident. Similarity was calculated by comparing each member's string of zeros and ones with other members; accuracy was calculated by comparing each member's string of zeros and ones with the expert's model.

Qualitative methods are the least used method to elicit shared mental models. The specific method and calculation vary according to the study context. The basic idea is to measure the mental model of participants directly through analysing each member's cognitive content. One of the representative works is Waller, Gupta and Giambatista's (2004) study, in which two independent coders recorded and analysed participants' behaviours. The coders were asked to record occurrences of a shared understanding of a situation and responses as representations of shared mental model development. Accuracy was not measured.

Different measurements of the shared mental model are confirmed to have an impact on the magnitude of its effect. Resick and his colleagues (2010) compared three measurements of the shared mental model, i.e. structural networks, priority ranking and importance ratings, and found significant differences among them in predicting team adaptation. The structural network method was examined as the most effective way of measuring shared mental models. Structural networks are similar to the paired comparison rating. The priority ranking method measures the mental model as a metric of relative importance rankings among key decisions regarding a team goal. Similarity is calculated as the average score of the Spearman rank-order correlations. The importance rating method measures the mental model as a metric of the overall importance of key decisions in relation to the team goal. It also measures the importance

metric by independently evaluating each team member's decision importance for the team goal. SMM similarity is calculated as the average of correlations between each of the two team members' ratings, and SMM accuracy is calculated as the average of correlations between each team member's ratings and the expert's ratings. DeChurch and Mesmer-Magnus (2010) conducted a meta-analysis on the influence of four measurements, i.e. similarity ratings, concept maps, rating scales and card sorting, and the results revealed a significant impact on the magnitude of the effects between mental models and outcomes.

2.3.1.3 Shared mental model and team adaptation

The shared mental model has been studied for many years as the cognitive underpinning of effective teamwork (DeChurch & Mesmer-Manus, 2010), but only limited studies with inconsistent results have focused on its impact on team adaptation. In terms of similarity, it is argued that a common understanding of the tasks enables team members to anticipate one another's needs and behaviours, thus contributing to coordination in dynamic contexts (Burke et al., 2006). Moreover, in their theoretical work on team adaptation's cognitive underpinnings, Zajac et al. (2014) argued that mental model similarity allows team members to reduce task representation gaps and to differentiate interpretations that may cause conflicts among team members and be harmful to team performance in ill-defined situations. Further, Gorman and Cooke (2011) found that the greater the task shared mental models predicted, the smoother the team process and the better the performance when confronted with member loss problem. Randall, Resick and DeChurch (2011) had similar results based on an experimental study that examined the relationship between a shared mental model and team adaptation for a changing task environment. Similarity was found to be the driver for adaptation by enabling the arrival of consensus on what to do and how to do it quickly. However, not all the conclusions are in the same direction. Cannon-Bowers et al. (1993) warned that similarity may also limit an individual's unique contributions; thus, teams may have a higher possibility to be rigid. Additionally, Resick et al. (2010) did not find a significant relationship between mental model similarity and team adaptation using the methods of structural network, priority ranking and importance rating.

In terms of accuracy, inconsistent findings also exist for the impact of shared mental model accuracy on team adaptation. Entin and Serfaty (1999) examined the function of mental model accuracy and found that teams can perform better under stress

and have more accurate mental models. Randall, Resick and DeChurch (2011) found that accuracy contributes to adaptation with the effective evaluation of potential strategic adjustments for novel situations. Resick et al. (2010) found a significant relationship between mental model accuracy and team adaptation with an insignificant relationship between mental model similarity and team adaptation, indicating that accuracy was more important than similarity. However, other scholars have expressed different views. Zajac et al. (2014) contended that being 'on the same page' was required in ill-defined situations to maintain effectiveness while accuracy may not be a necessary condition for success since if there is no single task strategy. Moreover, Marks et al. (2000) discovered that the shared mental model similarity predicts team performance in novel situations while accuracy predicts team performance in routine situations. They explained that teams with similar mental models may form accurate ones in novel situations as they exchange information and cues on the same page. Yet, this effect was limited to a team's development; only novice teams may have such an effect.

The inconsistency is explained as the dynamic relationship between the shared mental model and team adaptation, in that once a shared mental model can be updated, its positive impact on team adaptation holds. However, extant research on this proposition is mainly conceptual. According to Entin and Serfaty (1999), by updating mental models of the situation and leader, a team can improve implicit communication and coordination, which helps to maintain effectiveness under high pressure. The idea is that a shared mental model should be changed to align with novel task situations so that it can maintain its function for explanation and prediction. Maynard and Gilson (2014) proposed a conceptual work that explains the development of a shared mental model for meeting team effectiveness, which task interdependence would moderate. Uitdewilligen et al. (2013) conducted the only one empirical study of shared mental model updating. They designed a two-phase experiment and found that shared mental model updating predicted team adaptation through interaction patterns.

Overall, research on the shared mental model has suggested that there may be a dynamic relationship between shared mental model and team adaptation. However, it is not clear whether this proposition holds for the empirical world. This proposition will be examined in this research as a sub-study of the underlying mechanisms for intentional team adaptation.

2.3.2 Transactive memory system as the distributed cognitive mechanism

Transactive memory system (TMS) refers to the cognitive architecture of encoding, storage and the retrieval of task-related information from different domains (Peltokorpi & Hood, 2018). According to Tortorillo, McEvily and Krackhardt (2015), TMS describes both the unique knowledge individual members hold and the meta-knowledge the team holds, i.e. the knowledge of 'who knows what'. This construct gained its popularity due to understanding distributed cognition within teams (Ren & Argote, 2011). In this section, studies of transactive memory system are reviewed from three dimensions: the development of TMS theory, the measurements of TMS and the relationship between TMS and team adaptation.

2.3.2.1 Team as a transactive memory system

The 'group mind theory' also nourishes the idea of transactive memory. In other words, transactive memory draws on the analogy of an individual's memory and developed as a group-level construct. It is first proposed by Wegner (1987), who framed the study of transactive memory as 'the prediction of group behaviour through an understanding of the manner in which groups process and structure information' (p. 185). Teams are analysed as the transactive memory system that operates similarly to individuals' memory.

Memory has the function of encoding, storage and retrieval at the individual level. *Encoding* refers to the stage when information gets into the memory; *storage* refers to the stage when information becomes part of the memory and stays there; and *retrieval* refers to the stage when information is recalled for usage (Anderson & Reder, 1979). The transactive memory system at the collective level also has these three stages, but it functions differently. During the encoding process, members discuss incoming information and determine where and in what form it should be stored. During the process of transactive retrieval, members should know where to find the related information and ask for the information from the one who stored it. Sometimes several members may store the related information; when retrieving such information, all related members should be involved (Wegner, 1987). In conclusion, *transactive memory* describes the connection among team members' memories in which transaction is realised through communication and interpersonal interactions (Peltokorpi & Hood, 2018).

Mell et al. (2014) identified two types of knowledge in a transactive memory

system. The first type is the specific knowledge about what to do and how to do it, which relates to concrete tasks. This type of knowledge is used to solve problems when changes happen or when teams are confronted with novel situations. It functions similar to individual memory. In other words, it codes in a certain type, stores in a certain place and retrieves certain knowledge when needed. Individuals hold it, although each of them is merely a part of the whole memory system. The other type is the so-called meta-knowledge which concerns who knows what. An entire team holds this type of knowledge, and it is the core of the memory system. Team members share meta-knowledge.

As a distributed cognition, the theory of transactive memory system emphasises taking advantage of different expertise within a team rather than shared knowledge. In order to make full use of different expertise within the team, the knowledge of knowing who knows what (i.e. meta-knowledge) as well as the transactive process are important. The Wegner (1995) further clarified the latter with a computer network metaphor: 1) learning who knows what in the team (i.e. directory updating); 2) assigning new information to members (i.e. information allocation); and 3) planning how to find items in a way that takes advantage of who knows what, i.e. retrieval coordination. Liang, Moreland and Argote (1995) also sought to understand the distributed nature of the transactive memory system. They analysed videotapes of teams performing a radio assembly task and found three manifestations of a transactive memory system: 1) members developed a labour division of remembering different aspects of the assembly task, i.e. memory differentiation; 2) members trust each other's expertise, i.e. task credibility; and 3) members coordinate their activities effectively, i.e. task coordination.

2.3.2.2 Measurement of the transactive memory system

The measurement of the transactive memory system is developed based on its definition and manifestations. Accordingly, two sets of measurements are formed: One is used in the laboratory and is based on the task content; the other is used in the field, which is developed according to its manifestations.

Liang, Moreland and Argote (1995) first developed the measurement used in the laboratory setting. Its inclusion of three behavioural indicators in consistent with the manifestations of transactive memory systems, i.e. memory differentiation, task credibility and task coordination. Experts watched videotapes of teams who conducted the assembly tasks and rated the scores of the three behaviours. Similarly, Ellis (2006) and Christian et al. (2014) assessed transactive memory system based on the coding

behaviours of directory updating, information allocation and retrieval coordination at the team level.

The more commonly used tool is scale-based measurement. Lewis (2003) developed a questionnaire that can be used in the field based on Liang, Moreland and Argote's (1995) study. The originally developed scale has 15 items that cover the three dimensions of TMS. It measures the extent to which (a) team members' knowledge is distributed, (b) members' credibility and dependence is on their teammates and (c) knowledge is retrieved in a coordinated fashion. Empirical studies adopted this scale showed consistent validity and credibility (Lewis, 2004; Zheng, 2012). Ren and Argote (2011) suggested using the standard measurement of a transactive memory system based on the review of more than 15 years of studies of TMS. They determined that standard measurement enables comparisons of studies and promotes the accumulation of knowledge.

2.3.2.3 Transactive memory system and team adaptation

Although the theory of transactive memory system had been proposed for more than 30 years, the effect of transactive memory system on team adaptation is scarce. Most of the extant studies examined factors related to team adaptation as moderators, such as membership change or loss (e.g. Lewis et al., 2007; Christian et al., 2014), task change (e.g. Lewis et al., 2005) and environmental turbulence (e.g. Ellis, 2006; Akgun et al., 2006).

Lewis et al. (2007) examined the effects of membership change on the relationship between TMS and team performance. They designed a two-phase experiment with members. In the first session, the members were trained to develop TMS; in the second session, they worked together to complete a telephone assembly task. However, not all teams experienced the two sessions with the same members. Three conditions were designed: The intact groups consisted of members who were originally trained in the same group; the partially-intact groups consisted of two members who were trained together and one who trained in another group; and the reconstituted groups consisted of three members who had been trained in different groups. The results showed that the partially intact groups gained the lowest score on completing the assembly task due to relying on the inefficient TMS the original teams had developed. They also conducted a supplemental study that indicated members' reflection prior to task execution decreased the detrimental effect of membership change. According to the results of their study, teams adapted to membership change through reflection that contributed to the

efficient functioning of TMS.

Similarly, Christian et al. (2014) examined the problem of member loss within a team. They also designed a two-session experiment that began with the training session, which was followed by a task session. The member loss was manipulated between the two sessions. The results showed that teams adapted to the problem of member loss through well-developed transactive memory. However, the criticality of the lost member influenced the quality of the transactive memory system. The more critical the lost member is, the greater the deficiencies of transactive memory and plan formation, which influenced the task performance.

Lewis et al. (2005) tested the efficiency of previously developed TMS on the performance of a subsequent task, also termed as 'learning transfer' in their study. However, no significant relationship was found between the developed TMS on a previous task and the performance of a later but different task. This result indicated that, once a task changed, the originally effective TMS lost efficiency in helping members to achieve performance. They further discovered that such deficiency can be reduced through regrouping with expertise stability.

In terms of environmental factors, existing studies have not achieved consensus. Ellis (2006) investigated the influence of acute stress on the relationship between TMS and performance. He determined that acute stress causes performance loss due to the inefficiency of TMS. However, in a later study, he and his colleagues (2009) found different effects related to the different types of stress: Specifically, challenge stress (time pressure) contributes to team performance through the development of TMS while hindrance stress (role ambiguity) prohibits the development of transactive memory systems and reduces performance.

A more general situation for teams in modern organisations to adapt is the changes in technology development, preference of customers, which is termed as 'environmental turbulence' in Akgun et al. (2006)'s study. They found significantly weakened relationship of TMS and team learning with the situation of environmental turbulence. However, Ren, Carly and Argote (2006) found that TMS was more beneficial for groups in environments with high task volatility or high knowledge volatility. The inconsistent findings of environmental turbulence are ascribed to the usefulness of original knowledge within the team, as knowledge in Akgun et al.'s (2006) study needs to be updated while knowledge in Ren, Carly and Argote's (2006) study is still valid (Ren & Argote, 2011).

Zajac et al. (2014) provided a logical argument for the relationship between TMS and team adaptation: Specialisation contributes to effective situation assessment, plan formulation and team learning. Credibility contributes to effective plan formulation, and coordination contributes to effective plan execution. However, empirical studies have yet to examine the above propositions.

A review of the TMS studies revealed the following conclusions and some directions for the current work: Firstly, TMS is an efficient cognitive mechanism for achieving team effectiveness. However, whether it holds the effectiveness for the changed task or within environmental turbulence is not definite. Secondly, TMS contributes to team effectiveness through an explicit knowledge structure and smooth communication process. Nevertheless, the mechanisms of TMS's efficiency for intentional adaptation were minimally addressed. These gaps will be investigated in this research through a field study.

2.4 The Boundary of Intentional Team Adaptation Theory

Although not emphasised, several scholars have considered the effects of some boundary conditions of team adaptation. In the special issue on team adaptation research in the *European Journal of Work and Organizational Psychology*, Gevers, Uitdewilligen and Passos (2015) noted a need for more research on the contextual environment factors. They suggested viewing teams as open systems and called for research that examines the interactions between teams and environmental factors. Additionally, introducing boundary conditions may help to explain previous studies' inconsistent findings regarding the relationship between team cognition and team adaptation. After reviewing more than 15 years' worth of studies on team adaptation, Maynard et al. (2015) suggested examining whether teams can adapt when they are more (or less) interdependent. Two types of interdependent have been discussed in relation to teams: task interdependence and goal interdependence (Zhang et al., 2007).

Task interdependence refers to the degree to which team members believe that they need information, materials and support from other members in their teams to complete their tasks (Zhang et al., 2007). In other words, task interdependence determines the necessity of cooperation and coordination for task accomplishment. Apart from coordination requirements, task interdependence may influence the formation of collective states in a general sense. For example, researchers have argued that task interdependence is related to the transactive memory system by nature, so that the

increase in interdependence requires more systematic memory (Wegner, 1987; Ren & Argote, 2011). According to Kozlowski and Ilgen (2006), task interdependence is an important moderator of cognition-team performance relationships, which suggests different conceptualisations of team cognition with different task requirements. LePine (2005) proposed a rationale for the moderation effect of task interdependence: High interdependence requires the increased attention of members towards their own and others' works, which hinders the tendency to develop a thorough plan for meeting challenges. Zajac et al. (2014) argued that task interdependence influences the requirement of information sharing. Moreover, Maynard and Gilson (2014) proposed a moderation effect of task interdependence for the relationship between shared mental models and team performance. In addition, Ariff et al. (2013) examined the moderation effect of task interdependence for the relationship between the transactive memory system and team performance. It can be inferred that task interdependence may influence the function of team cognition to team adaptation when changes happened since they require more information to be exchanged and explained. Their arguments show the boundary effect of task interdependence on achieving team adaptation through cognitive mechanisms.

Goal interdependence refers to the degree to which team members perceive their goals as related (Zhang et al., 2007). Deutsch (1949) maintained that individuals' perception of how their behaviour related to others in terms of their goals guides their behaviour. He identified two situations with the opposite relationships of goal interdependence: cooperative goal interdependence and competitive goal interdependence. In a competitive situation, one strives against others for an unequal amount of a result; in a cooperative situation, one strives with others for a goal that is equally shared among team members. Accordingly, team members take different actions for different goal interdependence. Those in the cooperative situation are more likely to be supportive, to share information with others, to provide help to others and to limit their own needs to free others. Those in the competitive situation are more likely to inhibit others' behaviour, hide valuable information and place emphasis on their own needs (Johnson et al., 2006). The empirical results of Johnson et al.'s (2006) and Beersma et al.'s (2009) studies support the above argument. They found the phenomenon of 'asymmetrical adaptation' that the transition from a cooperative goal to competitive goal interdependence is much less disruptive than the opposite transition. According to them, the underlying mechanism for asymmetrical adaptation is the trust

and reciprocal norm developed in the cooperative structure that makes the transition easier. It can be inferred that goal interdependence will have an influence on the mechanisms of intentional team adaptation, thus serving as a potential boundary factor.

In the light of the above arguments, the moderation effect of task interdependence and goal interdependence for intentional team adaptation will be examined in this research.

2.5 General Comments and Discussion

This chapter reviews literature on collective intentionality, team adaptation and team cognition. It also proposes an intentional team adaptation theory based on the literature analysis and extracts research problems by identifying gaps and inconsistencies in previous studies. The conclusions and discussions based on the above works are clarified in this section.

Firstly, teams are demonstrated as intentional social actors with external attributions and intentionality by theoretical arguments. Properties that differentiate teams as general collectives of individuals are identified with three aspects: shared intention, interaction and goal direction. In order to empirically examine this proposition, this research will involve the following: 1) finding evidence of external attributions and collective intentionality that lay the foundation for team actors; 2) describing manifestations of team actors in the organisation field; and 3) developing tools for evaluating a team's capacity to be an intentional social actor.

Secondly, the typology of team adaptation research is built based on the relationship of two key elements that are used to define team adaptation: change and response. Team adaptation research is thus classified into four categories: agent-based intentional adaptation (proactive, continuous response to internal, evolutionary changes); process-based reactive adaptation (reactive, continuous response to external, evolutionary changes); task-based reactive adaptation (reactive, one-off response to external, radical changes); and change-based intentional adaptation (proactive, one-off response to internal, radical changes). This research focuses on both agent-based intentional adaptation and change-based intentional adaptation in accordance with the theoretical foundation of viewing teams as intentional social actors. The main research problem developed based on the framework of intentional team adaptation is 'When and how do teams intentionally achieve an expected performance in a dynamic environment with changes in team-related elements?' The underlying cognitive

mechanisms and boundary conditions will be examined in this research.

Thirdly, works on the shared mental model and transactive memory system are reviewed, including the development of constructs, measurements and their relationship with team adaptation. Two constructs were proposed with the resurgence of 'group mind' theory and were developed as evidence for viewing teams as actors with minds. The shared mental model as the shared team cognition and transactive memory as the distributed team cognition have been universally acknowledged as key predictors of team effectiveness (DeChurch & Mesmer-Magus, 2010). However, the relationship between SMM/TMS and intentional team adaptation has often been overlooked in research. Three problems have been identified in existing literature: 1) a lack of evidence on the dynamic change of shared mental models; 2) inconsistent findings on the relationship between SMM/TMS and team adaptation; and 3) unclear mechanisms of intentional team adaptation. These problems will be answered with empirical studies in this research.

Lastly, a discussion of the potential conditional factors of intentional team adaptation is provided. Task characteristics have been shown to affect both team-oriented behaviour and team performance (Johnson et al., 2006). Specifically, task interdependence and goal interdependence are supposed to influence the relationship between team cognition and team effectiveness (Burke et al., 2006; Kozlowski & Ilgen, 2006; Zhang et al., 2007). However, research has rarely investigated the mechanisms of intentional team adaptation with different types of tasks. This limitation will also be addressed in the following research design chapter.

CHAPTER 3 RESEARCH METHODOLOGY

This chapter introduces the research methodologies employed for the whole study as well as the research design for each study. Mixed methods are adopted in this research. Since there is an argument on whether data that come from a single source but are analysed in both qualitative and quantitative ways is regarded as mixed methods (Bryman, 2006), a *mixed methods design* in this study refers to different methods (e.g. experiment methods, survey methods, interview methods) with different data sources (e.g. software development teams, production teams, students teams, archival data). Moreover, *research methodology* refers to the underlying reasons for the selection of mixed methods. Two main arguments are made to justify the methodology of this research: One is the advantage of integrating qualitative and quantitative methods; the other is the alignment of the research object and research method. In addition to the justification of the research methodology for the whole research, the design of each empirical study is briefly presented and explained.

3.1 Research Paradigm: Integration of Qualitative and Quantitative Methods

In recent years, a trend to adopt both quantitative and qualitative methods in research has developed. It is regarded as a 'different' methodology and termed as mixed methods(Bryman, 2006). Since both quantitative and qualitative methods have their advantages and disadvantages, an appropriate combination can enhance the validity of a research design. In order to better understand the advantages of qualitative, quantitative and mixed method research designs, a three-element framework from Creswell (2003) is adopted in this section. This framework includes 1) what constitutes knowledge claims, i.e. philosophical assumptions; 2) general procedures of research, i.e. strategies of inquiry; and 3) detailed procedures of data collection, analysis and writing, i.e. methods. The comparison is shown in Table 3.1.

Table 3.1 Comparison of Quantitative and Qualitative Research Designs

Research design	Philosophical assumption	Strategies of inquiry	Methods
Quantitative	Post-positivism	Experimental Survey	Questionnaire Numeric coding
Qualitative	Constructivism	Discourse analysis Ethnographies Grounded theory	Interview Focus group

A quantitative design is based on the philosophical assumption of post-positivism, which reflects a causal link. The knowledge studied, based on this stance, can be divided into a small, discrete set of ideas that simple hypotheses can test. A quantitative design is suitable for testing a theory by specifying hypotheses deduced from the theory. However, it can only be used to test theories; it cannot be used to build theories. Among all the quantitative methods, surveys are the most frequently used, followed by experiments (Bryman, 2006). Surveys are conducted based on questionnaires or structured interviews with either a cross-sectional or longitudinal design. Researchers who adopt a quantitative design may collect data through an instrument or review behavioural indicator lists. Usually, the data collected with quantitative methods are numeric or transformed into numeric values for quantitative analysis. The selection of a specific approach and methods, i.e. an experiment, a survey or a second-hand study, depend on the research problems and measurement tools, which will be introduced in detail in the following sections.

A qualitative design is mainly built on the philosophical assumption of constructivism, which assumes individuals will construct and seek an understanding of the world. Other philosophical assumptions are participatory and pragmatic assumptions (Creswell, 2003). The knowledge studied, based on this stance, is subjective and embedded in situations. General, suitable topics for qualitative design are process issues and interactions among individuals. It is also suitable for studying novel problems with few assumptions. The strategies of a qualitative approach include ethnographies, grounded theory, case studies, phenomenological research and discourse analysis (Creswell, 2003). They differ from each other in terms of the data collection process and analysis strategies. General data collection methods include interviews, observation and photography. Among all the qualitative methods, the interview is the most frequently used. The ways to conduct interviews include a traditional face-to-face interview, a focus group, a structured interview, a semi-structured interview and an

unstructured interview (Bryman, 2006). Accordingly, data collected in a qualitative study can include images, texts, words and/or conversations. The selection of specific approaches and methods depends on the research problems, which will be analysed in detail in the following sections.

Several advantages of a mixed method design are recognised. Functions of the mixed methods design cover both explanation and exploration. The mixed method design is further served for triangulation, complementarity, development, initiation and expansion (Greene, Caracelli, & Graham, 1989). It is noted that either qualitative or quantitative methods have their own limitations, but when employed together, they can be complementary to each other (Creswell, 2003). In other words, one method can be nested with another method to provide insights on the same phenomenon. Creswell (2003) identified three strategies for mixed methods, including sequential procedures, concurrent procedures and transformative procedures. *Sequential procedures* refer to the combination of qualitative and quantitative methods by sequence. Sequential procedures usually begin with a qualitative method for exploratory purposes and are followed by the use of quantitative methods to generalise the results. *Concurrent procedures* refer to the integration of qualitative methods with quantitative methods which researchers collect both types of data at the same time and then use both methods to interpret the same research problem. A theoretical lens guides *transformative procedures*, which contain both types of data. Within this lens, the data collection can be sequential or concurrent.

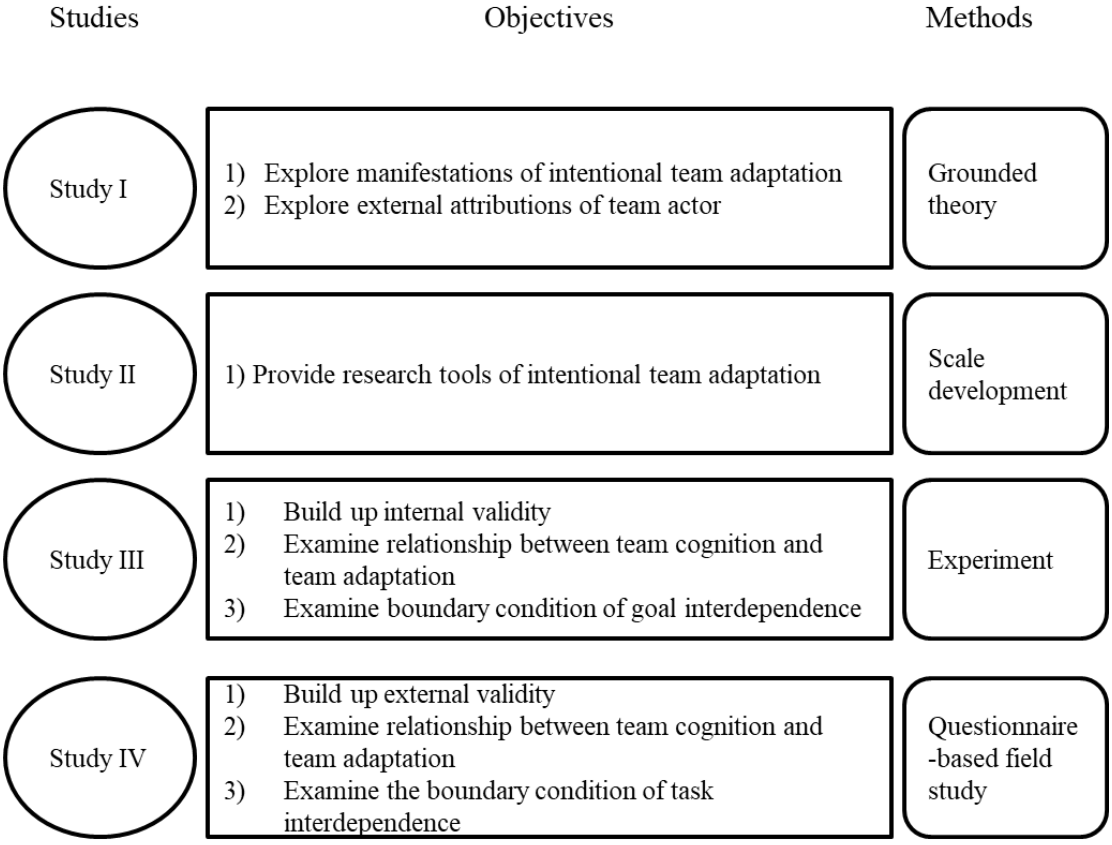
In this study, the sequential procedure is used to integrate qualitative methods with quantitative methods. By beginning with explorative methods, the phenomenon in this research becomes clearer; thus, more precise predictions and small pieces of knowledge on relationships can be proposed. A mixed method design guides the whole research, from question formulation to data interpretation. During the research process, quantitative and qualitative data are used to complement each other when depicting and explaining the mechanisms of intentional team adaptation.

3.2 Choice of Methods: Alignment Between Research Objectives and Research Methods

Creswell (2003) proposed three criteria for selecting an approach: 1) a match between the problem and the approach, 2) the personal experience of the researcher and 3) the research work's related audience. According to these three criteria, three

strategies were selected within the mixed methods approach, including experiments, a survey and the grounded research method. Among these three criteria, the first is a foci consideration in this section. Apart from the match between the problem and the approach, the validity and credibility of each method are also considered to select appropriate methods to meet the research objectives. The justification of the alignment between the research objectives and the research methods is shown in Figure 3.1.

Figure 3.1 Alignment Between Research Objectives and Research Methods

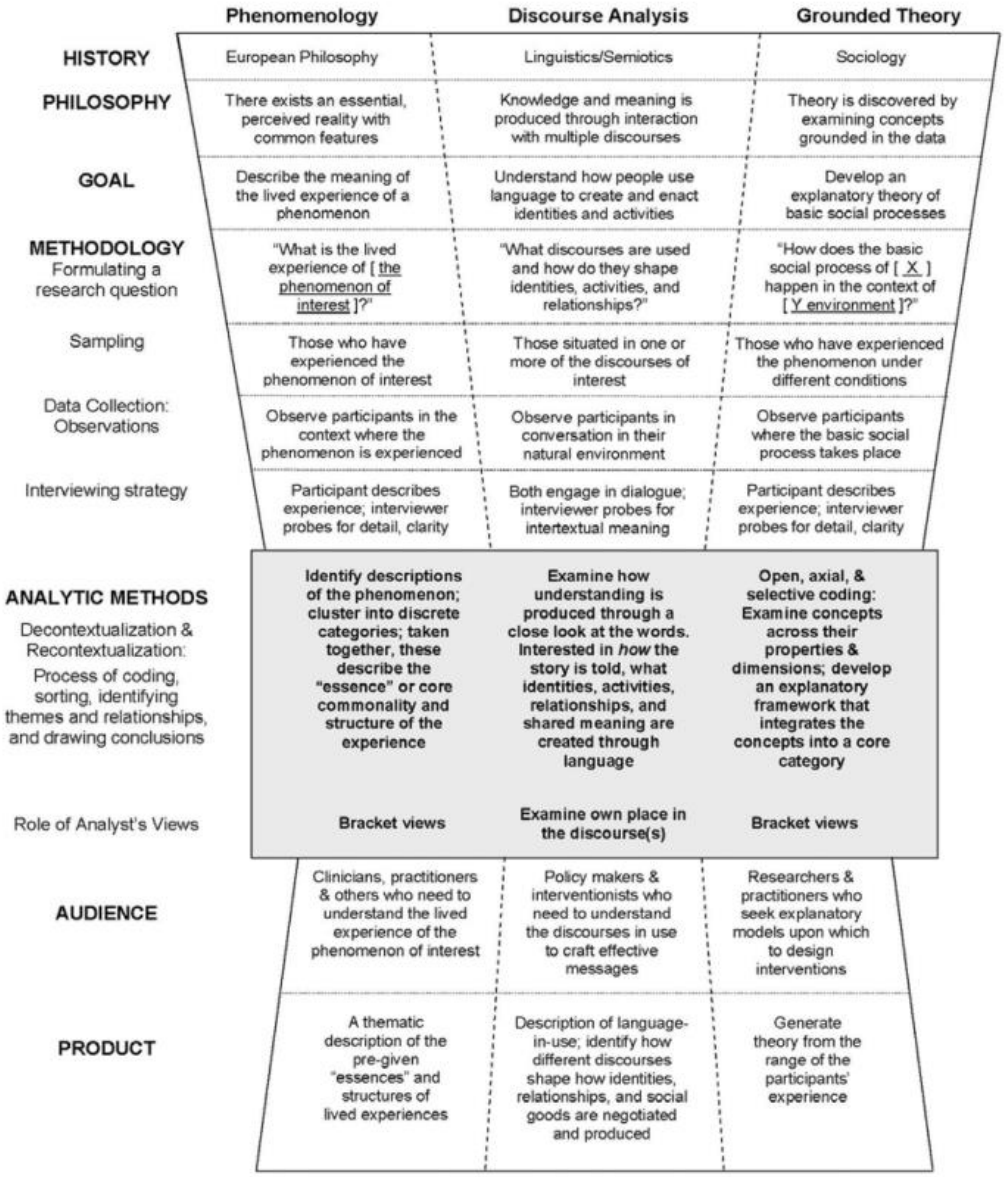


Matching problems with specific methods are the main consideration for each study. According to Creswell (2003), a *research problem* is the issue or concern that needs to be addressed. As discussed in the previous section, a quantitative approach is suitable for theory-based research problems that can develop hypotheses with a clear relationship among variables, while a qualitative approach is suitable for phenomena-based research problems that are novel and important. A quantitative approach is adopted to identify indicators' function and utility of an intervention; a qualitative approach is adopted to identify process mechanisms, dynamic relationships and underdeveloped concepts. A sequential mixed method design is applied in this research because testable hypotheses on intentional team adaptation phenomena can be built

based on clarification through a qualitative approach.

Study I explores the manifestations of intentional team adaptation. Due to the process-based nature of the team adaptation phenomenon, a qualitative method is more suitable than a quantitative one. In order to find an appropriate qualitative method, three main methods are compared: phenomenology, discourse analysis and grounded theory. According to Starks and Trinidad's (2007) analysis, these three approaches have different goals, methods, audiences and products. Phenomenology focuses on how meaning is created through embodied perceptions; discourse analysis considers language usage when completing personal, social and political projects; and grounded theory addresses social interaction processes. A figure adopted from Starks and Trinidad (2007) that depicts the similarities and differences of these approaches is shown in Figure 3.2.

Figure 3.2 Comparison of Three Qualitative Approaches: Phenomenology, Discourse Analysis and Grounded Theory



(adopted from Starks & Trinidad, 2007, p. 1373)

According to the research objectives, i.e. identifying manifestations of intentional team adaptation and exploring the external attributions of team actors, the grounded theory method is the most suitable. Grounded theory originates from symbolic interactionism, which emphasises processing understandings. Within this approach, knowledge of social realities is achieved through observation and the analysis of behaviour and speeches. Therefore, interview and focus group methods will be used to collect the data. The manifestations of intentional team adaptation and the language used by members as well as others external to the teams to describe the attributions of

teams will be explained. Since intentional team adaptation is manifested through interactions among team members (Steele & King, 2011), the grounded theory approach is more suitable than the other two approaches.

Study II develops a research tool for intentional team adaptation. Specifically, it develops a scale to measure intentional team adaptation based on findings of manifestations of intentional team adaptation. The scale development procedures follow the suggestions of Netemeyer, Bearden and Sharma (2003). This study connects the implicit idea of intentional team adaptation with an explicit examination of the function and importance of intentional team adaptation. Only by developing a suitable measurement can we conduct a quantitative study to test the hypothesised relationships. The precise procedures for developing a scale with high validity and credibility enable further research as well as an evaluation of intentional team adaptation in workplaces.

Study III explores the shared cognitive mechanisms of intentional team adaptation with different goal interdependence. The experimental design is used in this study for the following reasons: Firstly, two main features of experiment study are randomisation and manipulation. *Manipulation* enables the observation of different conditions, i.e. different factor level of the predictable variables, while *randomisation* decreases measurement errors (Turner, Cardinal, & Burton, 2015). Secondly, an experimental design has high internal validity and can make causal inferences (Highhouse, 2009). Since the objectives of this study are to build internal validity and to examine the shared cognitive adaptation mechanism with different goal interdependence, a laboratory-based experiment is more suitable than qualitative or survey methods. Thirdly, measurement of the shared mental model is mostly based on an experimental design according to Mohammed, Ferzandi and Hamilton's (2010) review. It has been demonstrated that team adaptation and shared mental models are difficult to measure through other research designs except for experiment one (LePine, 2003; Resick et al., 2010).

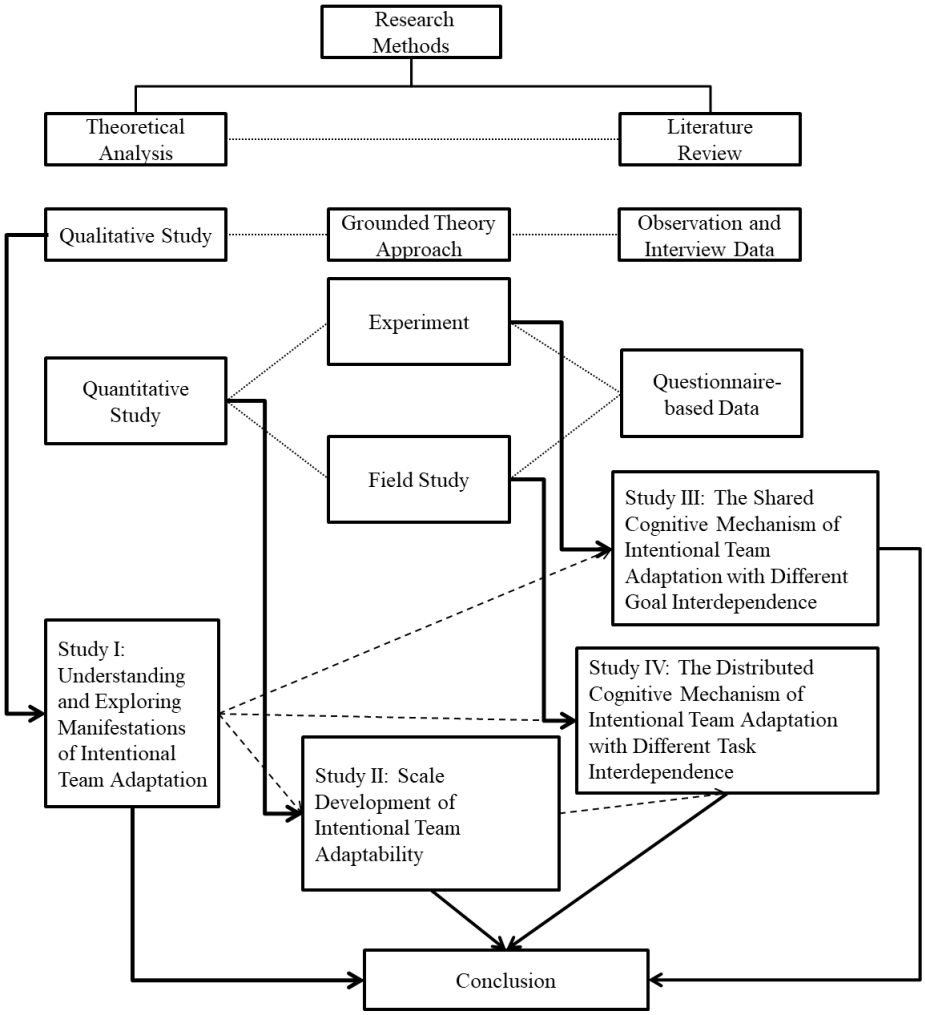
However, internal validity alone is not enough to validate the research on intentional team adaptation. A field design is employed to improve external validity in Study IV. In addition to building external validity, Study IV also examines the distributed cognitive mechanism of intentional team adaptation. Based on the scale developed in Study II, a measurement of intentional team adaptation is used to examine its relationship with team performance under field conditions. In addition, distributed team cognition, i.e. TMS, is examined in this study as well as the moderation effect of

task interdependence. A questionnaire-based survey meets the requirements of a relatively large sample, generalisability and a theory verification function.

3.3 Summary of Research Methods

Both qualitative and quantitative methods are a double-edged sword. When appropriately integrating them, they can be complementary to each other. Qualitative methods are suitable at the beginning stage of theory development as well as for providing important insights into complex phenomena; quantitative methods are suitable to test a clearly defined relationship among recognised variables. In this research, the fit between research objects and methods for each study is achieved. As for explorative studies, qualitative methods are used; for confirmative studies, quantitative methods are used. A brief summary of the methodology and methods in each study is presented in Figure 3.3.

Figure 3.3 Summary of Research Content and Methods



CHAPTER 4 STUDY I: GROUNDED THEORY OF INTENTIONAL TEAM ADAPTATION

This chapter reports the results of Study I. This study primarily explored empirical evidence for the external attribution and collective intentionality of team actors, along with manifestations of intentional team adaptation. Grounded analysis based on data from 10 teams resulted in eight subcategories with 26 main codes. The subcategories were further categorised into three dimensions: 1) team members' behavioural consistency; 2) team members' interactive relationships; and 3) team members' directed cognition. This chapter contains three parts: It begins with introduction of the study design based on the grounded theory approach. Thereafter, an overview of the sample characteristics and the data analysis procedures is given. Finally, the findings are analysed in response to the research problem.

4.1 Research Design Based on the Grounded Theory Approach

The main objective of Study I was to understand and explore manifestations of intentional team adaptation. The grounded theory approach was adopted to fulfil this aim since it effectively captures process issues and focuses on interactions among team members. Two main traditions of grounded theory were developed in the literature: Glaser and Strauss's positivistic and interpretive traditions (Glaser & Strauss, 1967) and Charmaz's constructivist tradition (Charmaz, 2003). The former contains systematic techniques that are consistent with positivism, and the latter emphasises human actions and intentions that are consistent with interpretationism. Both traditions highlight the objectivity of the researcher when collecting and analysing data. Charmaz's method allows researchers to interpret and construct theories based on their own experience and understanding, in consideration of their interactions with respondents. This study followed Charmaz's methodology to develop a grounded theory of intentional team adaptation. Charmaz (2006) provided a brief framework for conducting grounded theory research: 1) identification of the preliminary research problem and the development of research questions; 2) an initial stage of data collection and coding, which involves generating initial memos and assigning codes to tentative categories, 3) a second stage of data collection and focused coding, which includes generating advanced memos and refining conceptual categories; and 4) a final stage of

data collection and coding to ensure data saturation and no new data.

4.1.1 Step 1: Identification of the preliminary research problem and the development of research questions

According to Charmaz's (2006) view, the initial research problem may emerge from rich data in the field and develop as data become richer. In the tradition of constructivism, there is no hypothesis of the phenomenon of interest before entering into a situation. A limited amount of literature should be taken to the research site. The aim in this step is to begin research and open up an avenue to get to the research site where interesting phenomena take place. The initial research problem may be just a piece of an interesting idea with no clear relationship or hypothesised answers. Answers will be gained from the research site through data interpretation. Subsequent questions will emerge from the site when writing memos and conducting an initial analysis. This step involves the following: 1) defining the domain of interest or the general research problem, 2) selecting the appropriate sample, i.e. theoretical sampling, and 3) getting into the research site and beginning the study.

In this study, the phenomenon of interest was intentional team adaptation. This basic problem needed to be answered through this study: whether teams can be viewed as social actors. According to King, Felin and Whetten (2010), a social entity can be viewed as a social actor based on two requirements: external attribution and collective intentionality. In order to find evidence for external attribution, the folk understanding of teams was explored through interviews. Based on the justification of team actors, manifestations of team adaptation based on collective intentionality can be discussed. Therefore, the criteria for selecting suitable types of teams were as follows:

1) Teams that were embedded in a dynamic task environment and may have experienced changes frequently;
2) Teams with high interdependence that compelled members to rely on each other to complete tasks; and
3) Teams with distributed and diversified knowledge, which means that members may have had different work domains.

Accordingly, software development teams were selected as the focus of the study, as they met these three criteria:

1) Software development industry has been characterised as fast developing technology with changing demands. People in this industry consider their

work to be uncertain before the end of the software life cycle;

2) Although different sub-tasks may exist in a large software development team, their goal is to develop a single software. This software may have many functions, but it is a whole unit. Programmers should work together to ensure the connection among all the funciton modele not go wrong. pair-coding is a very often used way to complete the development of software.
3) There are at least six very different roles in a software development team: Architecture Engineer, User Interface Engineer, Quality Assurance Engineer, Database Engineer, Programmer and Operation and Maintainance Engineer. They have different backgrounds and different responsibility, participated in the different stage during software life cycle.

Initial personal interviews were conducted on the topic of teams and team adaptation during a sudden change or crisis, such as the absence of a key member in an activity. A general understanding of efficient teams and a comparison of individual work and teamwork were also covered. These general conversations led to a more specific research problem and a set of questions. These questions became a list for conducting semi-structured interviews and a focus group. The outline of the interview is provided in Appendix I.

4.1.2 Step 2: Generating initial memos and tentative categories of coding

Initial memos and coding were carried out along with research problem verification. According to Charmaz (2006), ideas and insights emerge when writing initial memos and categorising. Memo writing is important throughout the research process, serves the function of comparison and results in the generation of new insights about the research problem. Two main types of coding will be conducted in this phase: initial line-by-line coding and focused coding. The former is a strategy used to ensure important information is not omitted, and the latter serves as the strategy of categorisation. Materials collected in this phase included interview data, personal notes for project plans and the team's demographic data. Interview data comprised more than 90% in our dataset since it is regarded as an effective means to achieve an 'in-depth exploration of the particular topic or experience' (p. 25).

Initial memos were written according to Charmaz's (2006) suggestions. The main issues covered in the memo included observation data and preliminary analysis. Several questions are considered when writing initial memos (e.g. 'What is going on in the

setting?', 'What are people doing?', 'How do structure and context serve to support, maintain, impede or change the actions and statement?', p. 80). Additionally, memos provide materials for further comparison and act as theoretical pieces that connect with existing literature.

4.1.3 Step 3: Generating advanced memos and conceptual categories

After obtaining initial codes and categories, a further step is needed to generate conceptual categories and create a theory. Advanced memos are assigned to theoretical categories and show the relationships among related elements. Advanced memos are established based on those initial memos, mainly through making judgements and comparing statements. Comparisons include people, time, context, behaviour and results. Axial and theoretical coding are the two main types of coding at this stage. Axial coding specifies properties and dimensions of a category that have been summarised through focus coding, whereas theoretical coding specifies relationships between categories. These two types of coding serve to develop grounded theory on a more abstract level.

During this stage, works were carried out with the basic materials of initial coding and categories. Memos were written to compare different categories and to make sense of the relationship among them. For example, the categories of 'same goal' and 'work together' were integrated into the same label of 'joint action'. Each category was defined based on the initial codes, and the more abstract-level category was defined based on both initial codes and the relationship among the first-level categories. Axis and theoretical coding were important at this stage. Specifically, categories were correlated and sorted through axis and theoretical coding. A concept structure was also generated at this stage.

4.1.4 Step 4: Finalise the structure and theory

The aim of finalisation is to determine the concept structure and build theories based on the six Cs, i.e. causes, contexts, contingencies, consequences, covariance and conditions. At this stage, a new wave of data should be collected to refine and fill out the conceptual categories. Theoretical saturation should also be met in this phase, which means that no new category of data will emerge from the research problem. *Finalisation* refers to the temporary end of this theory-building process, which is concluded with two main aims: One is to determine the elements in the theory, and the other is to test

the credibility of the concept structure with other related data.

At this stage, four people from two extra teams were interviewed to obtain the testable data, which were coded independently and compared with the defined structures. As there were no other emerging new categories, the grounded theory process was treated as completed.

4.2 Sample Characteristics and Data Analysis Procedures

Based on the sample selection criteria, 10 software development teams participated in this study. Eight of them provided initial codes, and two of them provided data that served as complementary and for the purpose of verification. After coding the final two teams, no new codes emerged, thus theoretical saturation was met. Basic description information of the sample is provided in Table 4.1 and Table 4.2.

Table 4.1 Background Information on Selected Software Development Teams

Team Number	Number of interviewees in the team	Focus group interview	Leader interview	Project content	Gender composition	Project state
1	2	No	Yes	Game development	2 males	Completed
2	5	Yes	Yes	APP development	4 males and 1 female	In progress
3	3	No	Yes	Software development	2 males and 1 female	Completed
4	5	Yes	Yes	Software development	5 males	In progress
5	8	Yes	Yes	Software development	6 males and 2 females	In progress
6	6	Yes	Yes	APP development	5 males and 1 female	In progress
7	4	Yes	No	APP development	4 males	In progress
8	5	Yes	Yes	Game development	5 males	Completed
9	2	No	Yes	Software development	2 males	In progress
10	2	No	No	Software development	2 females	In progress

As Table 4.1 indicates, seven of the 10 teams were based in Hangzhou, and the other three came from Shanghai, Shenzhen and Beijing. Eight of 10 teams' leaders were interviewed, and six teams had focus group interviews. Forty-two people were interviewed in total with 51.2 hours interview time. Those teams worked on three types of software: game development, application (APP) development for mobile phones, and software development for Personal Computers (PC). Three teams have completed their projects and seven of them were still in progress. Team members and leaders expressed their understanding of teams and team activities as well as team adaptation to sudden changes.

Table 4.2 Background Information on the interviewees

Indicators	Information	Number	Proportion
Gender	Male	35	83%
	Female	7	17%
Experience	Average	2.2	NA
(year)	Standard Deviation	1.1	NA
Role in the team	Team Leader	8	19%
	Team Member	34	81%
Total number		42	NA

As Table 4.2 indicates, thirty-five of the 42 interviewees were male while only 7 of them were female, which was consistent with the gender ratio in software development industry. The average experience of interviewees was 2.2 years with standard deviation of 1.1 year. As for the role in the team, eight of 42 were team leaders and the remaining 34 were team members.

Eight teams and 38 people were interviewed in initial stage based on the semi-structured questions. The interview time was around one hour. The interview process was recorded for further analysis with brief memos labelling each piece of information. Line-by-line coding was used in the first stage to obtain initial codes. However, this coding strategy was not rigorously conducted since not every single line matched with the research problem. Sometimes more than one code appeared in one line; sometimes a whole story or event was categorised as one code. The initial eight teams' interviews generated about 700 initial codes that described intentional team adaptation. Examples of line-by-line coding and focus coding are presented in Appendix II. After the second phase's coding and comparison, the initial 700 codes were categorised into 26 primary codes and eight subcategories. The eight subcategories were further extracted as three core categories used to describe intentional team adaptation. In the finalisation stage,

two more teams and four people were interviewed to obtain testable data, which were coded independently and compared with the defined structures. As there were no other new emerging categories, the work was completed.

4.3 Findings on Intentional Team Adaptation

4.3.1 Overview

The data revealed a team is more than a workplace for its members. Teams were usually referred to in terms of ‘we’ (938 citations), ‘our team’ (698 citations) ‘this project’ (279 citations) and ‘the project team’ (21 citations). Discussions about their teams usually involved comments about the work with which the members were busy. They typically defined ‘team’ as teamwork and as their roles within the team. One may not be a team member due to his/her own will, but rather was required to be a member due to external demands (such as a higher-level leader, colleagues or a team leader). After admitting to be a team member, the member usually defined himself or herself as part of the team in terms of his/her responsibilities for the project.

Furthermore, ITA is mainly manifested in three aspects:

1) Team actors carry out appropriate actions with members’ coordinated behaviours (i.e. coordinated intentional behaviour);

2) Members are highly connected; thus, they can be act as a body when confronted with changes (connected relationship); and

3) Team behaviour is highly correlated with the problem and has the cognitive ability to solve problems (i.e. directional cognition).

The process of ITA is depicted in Figure 4.1. Team actors who are defined as having external attribution and collective intentionality can achieve adaptive outcomes based on coordinated intentional behaviour, connected relationships and directional cognition. A team’s adaptive outcomes may include team effectiveness, team continuity and members’ commitment. The process of intentional team adaptation, i.e. coordinated intentional behaviour, connected relationships and directional cognition, is detailed in Table 4.2, which includes interviewee excerpts.

Figure 4.1 The Process of Intentional Team Adaptation

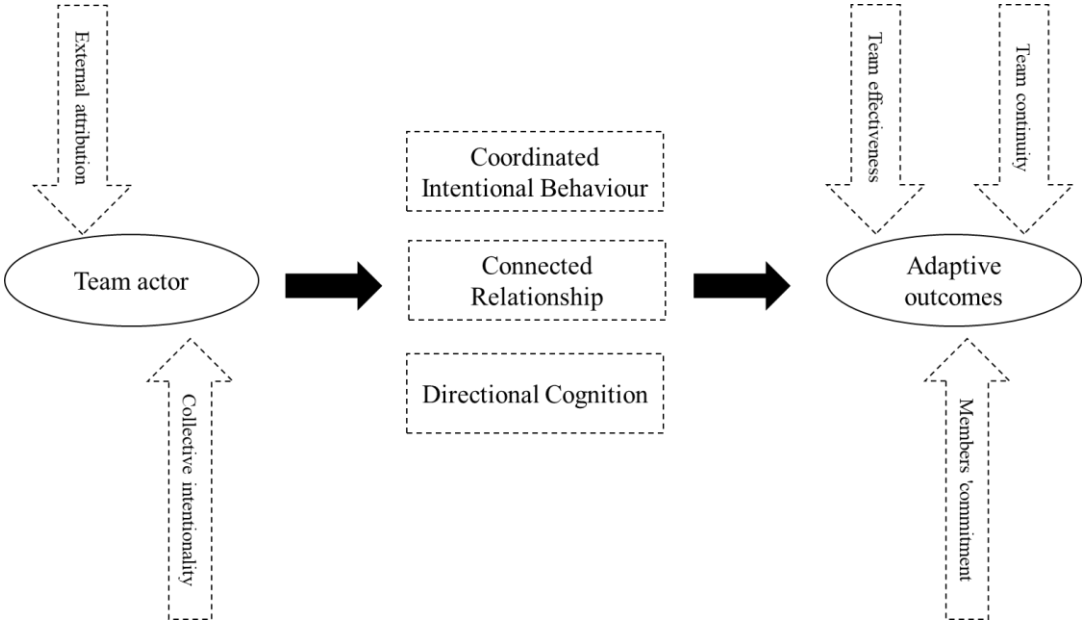

External attribution
Team actor
Collective intentionality
Coordinated Intentional Behaviour
Connected Relationship
Directional Cognition
Team effectiveness
Team continuity
Adaptive outcomes
Members 'commitment

Table 4.3 Manifestations of Intentional Team Adaptation

Core category	Subcategory	Codes	Description	Excerpts
Coordinated Intentional Behaviours	Behavioural consistency	Joint action	Alignment among members' actions for the same goal.	'Teamwork is what we do together; we have to be at the same pace to achieve team efficiency' (A2-65).
		Achieving consensus	Reaching consensus through discussions and compromise.	'It's common to have different opinions… Certainly, it is good to have the same idea, but even when it is different, we can make adjustment[s] and come to consensus through discussion. Sometimes a better idea may come out. It's really common to have [a] discussion during our cooperation' (A1-26).
		Setting standardisation	In order to deal with problems related to team diversity, a standardisation of procedure, task completion and criteria should be set.	'We will take consideration of industrial standard[s] when beginning our work. We all know it's unnecessary to spend much effort on rendering, so we usually skip this problem and spend more time on solving other problems, such as user interface design and content design' (A1-20).
	Division of responsibility	Share responsibility	Members have the awareness to be a team and are responsible for the team's behaviour and related consequences.	'We complete this work together; if there is anything [that] goes wrong, . . . then it's a failure for all' (A3-53).
		Self-regulation	Everyone can be responsible for and complete his or her part as well as the related communal part.	'…This project is in his charge, so usually, I follow his suggestions first. Of course, I would share my idea if I have better proposal, but not insist on it. The most important part for me is to solve user interface problems; I would do my best in user interface design' (A1-52).

Table 4.2 Manifestations of Intentional Team Adaptation (Continued)

Core category	Subcategory	Codes	Description	Excerpts
Coordinated Intentional Behaviours	Division of responsibility	Appropriate task allocation	Every team member can understand his or her part through discussions on task assignment, including time, content, milestones, sub-goals and responsible personnel.	'Task distribution is the precondition for good cooperation. Clear task distribution and responsible relevant personnel are important when any uncertainty happens' (A2-89).
		Task prioritisation	Sub-tasks should be arranged and completed according to the importance and availability of relevant resources.	'In this project, the parts I joined include my own work and others' work. I have to arrange my work time according to the importance and prioritisation to complete both' (A3-98).
		Plan in advance	Justify feasibilities and make plans for potential problems before starting the project.	'Most of the programmers like to think while writing the program, but I like to make a detailed plan before starting. [The] design stage should be more than a third in the whole program, and writing and debugging should cost less. We need to find out the potential problem before it threatens the whole program' (A2-2).
	Approaches to share	Performance monitoring	Everyone has his or her own approach to monitoring others' work and knowing the progress and work they are doing.	'There's a problem when we outsourced some part of our work, for example, the 3D design…It took us a long time to fix the problem. I think the main point in this case is lacking [a] monitor. We cannot know what they are doing and how they are doing…Finally, we abandon their design, and it wasted a lot of time and money' (A1-27).

Table 4.2 Manifestations of Intentional Team Adaptation (Continued)

Core category	Subcategory	Codes	Description	Excerpts
Coordinated Intentional Behaviours	Approaches to share	Resources sharing	Taking advantage of all the existing and potential resources within the team to complete relevant tasks.	'When there are some emergent problems that we can't solve within [a] limited time, we transfer our work to colleagues in America since they are in the daytime when we are approaching the deadline, usually in the night' (A4-48).
		Effective communication	Bring one's idea to the public through media (e.g. language, text, models) to make others understand, contributing to the formation of a team's idea.	'I prefer to use e-mail to share my ideas. It can be proved when there is something wrong. Personal communication is very common when something needs to coordinate…It is also very useful when you want to find partners to work together with you on the new project' (A1-15).
Connected Relationship	Private relationship	Affective links	Encouragement and support for others, recognition of others' abilities.	'Both positive and negative links exist within teams...No matter [if] it's useful or not, we always show respect to others' opinion[s]; that's a positive link' (A1-8).
		Personal links	Members interact in their private time and develop friendship.	'We are friends and have many common interests. For example, we often go to play computer games or watch a movie together. Sometimes we even have brilliant ideas when we play together. We can know each other better through these activities' (A1-50).
		Team links	Positive experience and feeling of being a team member.	'I came here after my graduation. I am satisfied with my team. I think it can give me a feeling of belonging. I can also learn a lot from other senior colleagues' (A2-70).

Table 4.2 Manifestations of Intentional Team Adaptation (Continued)

Core category	Subcategory	Codes	Description	Excerpts
Connected Relationship	Work relationship	Task-based interaction	Work-related interactions that happen within the same time and space and aim for specific problem solving.	'In my team, developers, architectures, [the] project manager [and the] technical manager share the same space so that they can communicate frequently, and it's convenient to have conversations and share ideas' (A5-82).
		Cooperation tendency	The attitude and willingness to solve problems together and compromise for the benefit of a team when confronted with emergencies.	'Everyone on the team should be good at cooperation. That is to say, one needs to be accustomed to working with others, work within team…For example, when bug detected, those who are related should be responsible for solving it apart from their own work at that time…Teamwork is highly important' (A8-12).
		Mutual respect	Everyone shows respect and trust towards others, has positive attitude towards their work and is willing to learn from others.	'Trust is important in teamwork. Sometimes we have to be frank about our shortcomings and learn from others. It is easy to say so but difficult to do so…For example, a specific function can be achieved through various programs…It's really important to let your team know admitting shortcomings is of great value and it should be appreciated' (A3-7).
Directional cognition	Problem-solving	Caring for the facts	Discuss and share information based on facts within the scope of a related problem, and do not extend to comments on personal issues.	'I almost had a fight with my colleague one time [about] a problem concerning the realisation of the key function. However, we know clearly about the consequence and the rule of no personal fighting in our team. We can only be allowed to discuss the problem. So, we stopped that day and continued the discussion the second day after we had calm[ed] down. The problem was finally solved after our analysis' (A1-33).
		Try all the possible ways	Make use of all potential resources and try all possible ways to solve the problems.	'[Do] all that you can to solve the problem…If he has [a] better solution, I will adopt. All we want is to solve the problem, not to show your advantage…Similarly, if he does not want to do [it], I will do [it]. The final result is [the] completion of the team task.' (A1-12)

Table 4.2 Manifestations of Intentional Team Adaptation (Continued)

Core category	Subcategory	Codes	Description	Excerpts
Directional cognition	Problem-solving	Frank communication	Talk with others about the shortcomings, point out others' problems and ask for help whenever in need.	'…At that time, we didn't realise the problem. After a period, we found our cooperation [had become] difficult with [an] implicit bottleneck. I noticed some facial expressions on others' face[s] when talking with them. They nodded with reluctance, expressed agreement with fake smile[s]. I knew something was wrong' (A8-37).
		Accumulating evidence for tracing problems	Check the details of the problem, including the origin, the methods that have been used and the responsible person.	'.. Especially when something has changed, paperwork should be done to keep the evidence. Even when we had solved the problem temporally with the changed plan, e-mails about the changed plan should be kept. Otherwise, when a bug is found in the next stage and we do not have any evidence to show the change, the bug will not be found easily. It will take a lot of time to detect the bug' (A8-65).
	Focusing on team goal	Emphasising key points	Recognise the most important and emergent work and focus on it, giving up inferior parts if needed.	'We only keep the core part in our team. We look for outsourcing and other open source platforms to complete most of the unimportant but necessary parts. We are only responsible for the key parts. By doing so, we can save money on coordination and management, focusing on the most important point' (A6-2).
		Goal-directedness	All works should be directed towards the completion of a team goal; goals should be clarified, progress should be monitored and sub-goals should be completed on time.	'… (As a project manager,) I will check for the progress of our team, check for their work direction [and] help them to adjust if anything goes wrong. I always spend time on monitoring and making suggestions, making sure that our work is on track' (A6-16).

Table 4.2 Manifestations of Intentional Team Adaptation (Continued)

Core category	Subcategory	Codes	Description	Excerpts
Directional cognition	Focusing on the team goal	Commitment to the goal	Team members know what they are doing, and they should also be devoted to what they are doing.	'We know this is hard and difficult, we have prepared for the potential challenges. After all, we come together to do what we want to do, what we think is important and meaningful. We all feel it be worthwhile to do these. That's enough' (A6-40).
		Interpersonal knowledge	Members are knowledgeable about others, their abilities and the environment.	'The first representative of our client preferred to deliver his idea several times. We did not know at first and [had] begun the work after the first conversation. Later we had to adjust our plan several times to meet his requirements' (A3-46).
		Skill acquisition	Members should have related skills to complete the work, including technical and interpersonal skills.	'The quality of teamwork is related [to] one's ability. For example, whether a programmer understands the project's content and transfers the content into codes largely depends on his professional skill[s]. An experienced programmer can translate the intention into [a] program easily while a new-hand will have difficulty even in understanding' (A2-25).

4.3.2 Behavioural manifestation: Coordinated intentional behaviour

The most frequently mentioned aspect of ITA was behavioural manifestation, since it is easy to observe and describe. In general, members of adaptive teams conduct joint action and share their responsibilities in order to make coordination easy when confronted with changes, while members of maladaptive teams work independently and even have the idea of being 'free riders', which leads to a waste of resources. Thus, such teams cannot appropriately and effectively address changes. This manifestation is termed as 'coordinated intentional behaviour', which refers to the process of intentionally coordinating team members' behaviour. This core category is composed of three subcategories: behavioural consistency, division of responsibility and approaches to sharing.

4.3.2.1 Behavioural consistency

Behavioural consistency reflects the similar work pace of team members, indicating a type of 'team pace'. 'Team pace' is developed from the members' consensus and manifests as joint actions and shared responsibilities. Furthermore, setting standardisation is necessary to achieve consensus due to the members' diversity.

Joint action. *Joint action* refers to team discussions, decisions and actions with alignment among team members. They join in the execution of a task together and put forth the effort to complete the same task. In our analysis, mainly three characteristics are mentioned in the interviews to describe joint action: the same goal or task or things to be done (Team 2, 3 & 5-10), working together (Team 1-3, 5, 6, 8-10) and cooperating with each other (Team 1-10). The same goal is actually the team goal; this is also what their behaviours are directed towards. *Working together* refers to team behaviour associated with the participation of all members. *Cooperation* here is the individual behaviour in the team emphasising the idea that members are working interdependently to support each other in order to take joint action. There is no doubt that joint action is the basic behavioural manifestation of adaptive teams. It enables team adaptation by reducing coordination costs and conflicts. Teams that carry out joint action behave as a flexible body to respond to any detected problems. They can quickly adjust, even when a warning sign was not noticed.

Examples can be drawn from Team 1, such as this team leader's claims: 'The best of our team is to know other's work pace and try to keep it similar. We can, therefore, solve the problems on time to avoid snowballing disaster' and 'We work together, or in

other words, we work in harmony'. One of the team members who was responsible for the project's user interface (UI) design shared his experience on cooperation, describing it as a process of working together. They kept their working progress at the same pace so that they could get their work fitted together. Similarly, in Team 2, they used the whiteboard and daily short meetings to ensure everyone's participation and understanding of the team goals. Team 2 was once confronted with a change in the market situation that almost resulted in the failure of their project, but quickly made an adjustment and produced a new APP. The keys to such an adjustment were taking joint action in accordance with their original schedule, analysing the programming codes and trying to salvage some of them for reuse in the new APP. Other teams also frequently mentioned that sharing ideas and working together were determinants for efficient teamwork. Some of them also mentioned an unpleasant experience when encountering a lack of joint actions. For example, members in Team 5 complained about members who always worked alone and did not communicate with each other. Problems occurred when they mistook the intention and had to rewrite the software program, leading to the progress delay of the whole team.

Achieving consensus. *Achieving consensus* refers to reaching an agreement on a specific theme through compromise, discussions and communication. It also refers to forming similar ideas and opinions based on common interests, benefits and backgrounds. The function of achieving consensus has been empirically studied when interpreting the role of shared mental models, which is argued to be an important predictor for team adaptation (Zajac et al., 2014). Achieving consensus is the premise for taking joint action. Members in a team usually have diverse ideas regarding a project and how to achieve a team goal. It is not easy for a team to act as a body due to such diversities. Therefore, it is necessary to achieve consensus before taking team action. For teams that are confronting with troubles or unpredictable changing events, it is especially important to achieve consensus as soon as possible to avoid unnecessary costs, time and wasted energy.

An example can be drawn from Team 8 when there was conflict related to designing the game. Two opinions co-existed and both gained support from other members, resulting in two sub-groups. However, they had to choose one direction to continue the development work since resources were limited and could not cover both suggestions. Building initial models for both designs finally resolved the problem; the team found the leverage point for integrating both ideas but at the cost of extra time and

expenses. One of the members gave this explanation:

Achieving consensus is a big problem in our project … not all of us are in the same direction. We have our own idea on this project, caused the problem … when we saw the opportunity to integrate both designs, we changed our original idea and tried to find a way to cooperate and realised our ideas together technically. We had discussions many times on the integration and devoted time to the issue, we felt very happy to join this program; although it was delayed, I think it was important to do so.

In terms of the project, it actually failed due to the delay, which the consensus problem caused. If Team 8 had been able to achieve consensus quickly, they could have met the deadline. Problems related to divergence are common in software development teams. In Team 6, they solved problems by making this a daily task. The project manager created a Weibo account to announce the project's progress, forcing the team to achieve consensus before each day's social media announcement. This measure enabled them to make progress on their project in a timely manner.

Setting standardisation. As previously addressed, achieving consensus through discussions is not an easy task. Therefore, standardisation is frequently referred to as a measure to help to achieve consensus. Standards for task completion, procedures, and steps have to be established in order to conquer diversity-related problems and divergence.

Standardisation can be drawn from industry. As members in Team 1 commented, 'Since we have been working in this industry for a long time, it's quite natural to know the standard that we should achieve'. The second origin is cooperation experience: 'It's easy to write the program, but hard to add them up, especially for different styles of writing. If we work together long enough, we can understand each other's style and try to make sure we use the same style before writing' (Team 3). Standardisation '[means] to make something clear through paperwork to minimise individual differences' (Team 5).

Sharing responsibility. Sharing responsibility is the outcome for joint action. Taking joint action means no one is individually responsible for the results; rather, the whole team should be responsible for its behaviour. Team members consistently mentioned the necessity to share responsibilities or at least had the intention to take responsibility that may not be directly related to their part in the whole team.

For example, members in Team 5 mentioned a programmer who was overly confident in his own program writing, which led to his ignorance of others' work. Since

all programs needed to be added up coherently before being tested, the problem started to become apparent. Yet, he insisted that his own programme was right and refused to take responsibility for the whole program, leading to the delay of the project. Team 7 adopted general unit tests to avoid such problems. In other words, every member has access to rewrite and modify the whole program after its completion. As Team 7 explained, 'The owner of the program is the team, not individuals on the team'. Accordingly, evaluation is based on the team as a unit, and the team also takes on the responsibility and honour, that is, members are equally rewarded for their completion of the project.

4.3.2.2 Division of responsibility

Division of responsibility refers to assigning different parts of a team's work to individuals and then combining all the parts to complete the team's task, which lays the foundation for behavioural consistency. Without the division of responsibility, behavioural consistency is impossible. Four main ways of dividing the responsibility emerged in this grounded study: self-regulation, appropriate task allocation, task prioritisation and making plans in advance. These four behaviours are similar to task compilation in Kozlowski et al.'s (1999) model.

Self-regulation. *Self-regulation* is defined as 'the process of guiding goal-directed activities over time and across changing circumstances' (Kozlowski et al., 1999, p. 252). In this study, the term is used to emphasise the completion of one's own part of a task across changing circumstances. The absence of a team member during a teamwork process may lead to maladaptivity (Christian et al., 2014).

A member in Team 3 complained about her partner's absence during an emergent part of the software development. She called several times through different departments to find her partner to solve the problem but failed; finally, she found another person in the same project to fix the problem. She was in bad mood that day due to the irresponsible behaviour of her partner and asserted the importance of self-regulation in the interview. The leader of Team 4 gave his opinion on managing such problems. As he proposed, 'During a software's development life, everyone in our team should be in his position to check if there is any problem. Once problem or bug is detected, the person in charge should fix it as soon as possible. If he needs any support, others should give him a hand'. Moreover, a Team 7 member described his opinion regarding self-regulation: 'Everyone on the team can do his part well; besides, we are willing to help others. We are focusing on our job and devoting [our time to] it because

we think it's interesting. We do all that we are able to do.'

Self-regulation is the foundation for the division of responsibility. If one cannot do his own part, the division will certainly be ineffective. This is an essential requirement rather than merely a condition. The other two conditions are task allocation and task prioritisation, which enable the division so that members on the team can know what to do and what they are in charge of doing.

Task allocation. Task allocation is not the result of dividing a team task into sub-units; instead, it is the process of discussions and compromises. It is an important step in the division of responsibility through which team members will know and accept their work content and deadline, their partners and their work relationship. When interviewees talked about appropriate task allocation as an important behavioural manifestation of adaptive teams, they meant the following: On the one hand, it is about work division so that each member will have his or her part of the work. On the other hand, it is about appropriateness, including dividing a team's work clearly and assigning the divided work to members who are experts in related fields. Additionally, standards for task allocation include workload balancing and preventing exhaustion.

Team 8 members pointed out a problem in the focus group interview that was related to task allocation. When they were allocating tasks, they did not take UI designer's time schedule into consideration, so the work of the programmer did not match with the UI designer's schedule. They had to delay the project at that time. The programmer was trying to learn to do UI himself to avoid such problems in the future, but it took time to learn. The Team 5 leader had realised the problem, so he put great emphasis on task allocation and defined the work target. He created a detailed plan to avoid the problems of confusing responsibilities and overlapping areas. However, the Team 5 members complained about the detailed plan, stating that it restricted them. Sometimes, it may not be easy to clearly define the problem, thus leading to confusion. Moreover, a regular work style may cause the problem to remain unresolved until other issues are addressed. Therefore, when referring to 'appropriate task allocation' or 'clear task allocation', they mean what is accepted and recognized by the whole team rather than the leader alone. The whole team should complete this allocation process should.

Task prioritisation. Task prioritisation is a way to use limited resources to complete tasks. It is always discussed alongside task allocation (e.g. Kozlowski et al., 1999). As in the case mentioned above regarding Team 8, the problem of task allocation was related to the UI designer's prioritising of others' project and his own project. *Task*

prioritisation refers to rank orders according to tasks' importance and resource availability. There are two types of task prioritisation: task subdivision and ranking order. Task subdivision is different from task allocation in this study: the former emphasises the matching of a team task and limited resources (including human resources); the latter emphasises the definition of each members' task boundary and role in the team.

During the focus group interview with Team 7, they mentioned their understanding of a software project and emphasised task subdivision and ranking order. One member stated, 'It is a must to divide the huge project into pieces that can be managed and completed'. Another commented, 'We should be careful when using [a] team to do the software project because when the task is not divided properly, there are ignored areas that no one is responsible for'. A member in Team 8 mentioned an even worse possibility involving different sub-projects and the fight for limited resources when the whole team cannot approve the ranking order. Team 4 provided a solution to solve such problems, i.e. to use a detailed decision list with which one can check the person who is in charge of the specific sub-task. However, doing this requires a previous project plan and documents that detail who is responsible for which task and relationship between these sub-tasks.

Planning in advance. Planning in advance is a way to avoid potential problems. It refers to justifying the feasibility of a project through information collection, material preparation and reasonable planning regarding team resources, which contributes to work subdivision and task assignment. For instance, a software team is generally required to make a plan before they move on to write a program. Since demand changes quickly and making adjustments to a completed program is time consuming, supervisors want to see a potential product that can meet the requirements of the market and that will not demonstrate any issues in the execution stage. Planning in advance is not confined to the beginning; rather it occurs throughout the whole program development. Sub-tasks also need to be planned in advance. As confirmed in the literature, planning is one manifestation of a team's adaptive capacity (DeChurch & Haas, 2008).

Team 5 pointed out the importance of having a plan: 'It can give us a clear target and time map which will show us where we are now and how far we are to complete the task. A plan may change due to some emergency … but it gives us a map to go and adjust'. According to Team 4, a typical step that occurs before starting the program

writing involving making a record of the client's demand after they develop a plan. Team 10 is now in the beginning stage of a program. They were asked to prepare initial models and records of their temporary work, and all these were part of the plans for the whole project. Making a plan in advance can avoid problems such as an unnecessary revision of the program and wasting resources, as indicated by Team 3.

4.3.2.3 Approaches to share

Behavioural consistency and the division of responsibility are achieved through certain team processes termed 'approaches to sharing'. These approaches include performance monitoring, resource sharing and effective communication.

Performance monitoring. Performance monitoring is the process of knowing others' work and progress. Burke et al. (2006) defined *performance monitoring* as 'keeping track of fellow team members' work while carrying out their own…to ensure that everything is running as expected and…to ensure that they are following procedures correctly' (p. 1195). This term is used to indicate two aspects: On the one hand, it refers to an approach for members to know others; on the other hand, it refers to the result of knowing others' work and performance. Performance monitoring here put more emphasis on the process of team monitoring than on knowing others. Therefore, it is a behavioural manifestation rather than a cognitive manifestation of adaptive teams.

Team 1 used outsourcing to solve the problem of three-dimensional (3D) design, but it turned out to be a failure since they could not monitor the quality and progress after outsourcing. This team valued daily communication: 'I love to chat with my colleagues. We discuss the hottest games in the market and our related ideas to see whether we can cooperate to realise it. These discussions can also stimulate creative ideas, and we will know what to do next'. A more formal approach was adopted in Team 2. They used their daily meetings to stay informed of work progress and problems. Team 4 used e-mails to record any changes or progress related to their work, and Team 5 used the pair code review method to monitor performance. The interviewees frequently referred to the importance of performance monitoring, as it pushes teams to make progress, keeps team members at a similar work pace and puts them on the same page.

Resources sharing. A team has advantages over individuals in terms of diversified expertise. Therefore, it is important to take full use of team diversity to achieve

adaptation. The way to do so is resources sharing, so that any member of the team can find an appropriate team member to perform the work. Resources that are shared among members include expertise, information and time. Sharing expertise and information is similar to the function of the transactive memory system (Wegner, 1987). In other words, it involves deriving specific knowledge or information from the node in the network (e.g. a specific team member who owns related knowledge or information) when needed. *Sharing time* refers to helping with others' work in one's spare time.

It is almost common sense that team members should help each other with their work. As a Team 4 member commented, 'We should solve problems proactively. If others need help, you should give him a hand; do not always try to find excuses'. In one of the emergent situations that Team 4 experienced, they could not meet the deadline during the work time. Accordingly, they took advantage of time difference and asked colleagues in the United States to help with their work. In addition to the time resource, other common resources that are shared among team members are information and knowledge. A Team 3 member said, 'Foreign stones may serve to polish domestic jade. The problem that troubles you may easily be solved by others.' In Team 7, a whiteboard is used to address problems and propose solutions. Team 7 members also mentioned the concept of 'information convection', which refers to exchanging and transferring information at the same place and time. Resource sharing promotes the efficiency of resource usage and facilitates the process of responsibility subdivision.

Effective communication. Communication is the conduit that transforms an individual's voice to team intention. Both performance monitoring and resource sharing rely on the effectiveness of communication, which is considered to be the most basic approach to share. Communication enables individual intention to be publicised, thus contributing to behavioural consistency. The following phrases were articulated in interviews: communication media, communication process and communication result.

The communication media used differs from case to case. Software development teams that have to spend time on requirement clarification with clients may use cases. In addition, e-mails, face-to-face communication, documents and prototypes are widely used as communication media, as all 10 teams mentioned these types of communication. Apart from communication media, the communication process should also be emphasised. A bias may emerge from indirect communication, such as asking a third person to pass on a message (Team 9). In addition, interviewees also talked about the result of no communication: There was one time that we had no discussion before our

work began. We thought there would be no other way of understanding and realisation despite our own ideas. But it turned out to be a total mess that his program and my program could not match. We finally had to abandon what we had completed and began from scratch.

Therefore, effective communication involves the use of appropriate media to express ideas clearly so that members' behaviour can be coordinated.

4.3.3 Affective manifestation: Connected relationship

In addition to behavioural manifestations, team members also frequently mentioned their feelings, relationships and emotions. In general, adaptive teams are more positive than maladaptive teams, as manifested in the tone of daily conversation, the team climate and the relationships among team members. In adaptive teams, members trusted each other, had mutual respect for one another and supported each other, while members of maladaptive teams usually had poor private and work relationships and experienced subgroups or isolation. Moreover, these members ensured benefits for themselves and were reluctant to share information or resources with others. This manifestation is termed as 'connected relationships', which refers to the relationship quality among team members, including two subcategories: private relationships and work relationships.

4.3.3.1 Private relationship

By 'private relationships', it means that the relationships in this category are non-work related. People involved in the same project not only develop work relationships with each other but may also develop friendships and other relationships due to having similar interests and the experience of working together. This kind of relationship can be described as having three types of links: affective links, personal links and team links.

Affective links. Positive affection links contribute to maintaining a team's structure and facilitate members' interaction. Such links manifested as encouragement, support and recognition among members. Encouragement and support are what a team can give members when they are experiencing difficulties; recognition is what a team can give members when they achieve something. The three types of affective links can enhance team cohesion and facilitate team adaptation.

As the Team 2 leader stated, 'It is the project manager's responsibility to encourage and support team members. They should be allowed to make mistakes, but also should be encouraged to do their best'. Such links can contribute to problem solving.

Encouragement and support also mean to offer assistance when someone encounters difficulties. A Team 6 member commented on the function of affective links: 'It's great to have someone as your backup. Whatever pressure we are facing, we can be together to deal with it'. Agreement is also considered useful, while being supportive can reduce conflicts among team members. However, negative affective links may harm team cohesion and team performance. For instance, Team 7 had a new leader who was critical of others and was incompatible with the team. As a result, the original team's links were broken down. Silence was common: Proactive communication was not present among the team, and mistakes increased during his stay. Eventually, the problem was discussed and solved, the leader left the team and they began to repair the broken affective links. The importance of respect and recognition are also included in affective links. In Teams 5, 7 and 9, respect and recognition are mentioned as indicators of a cohesive team. Such affective links enable a team to be an integral whole as is said by a member in Team 8.

Personal links. Personal links are those relationships that are distributed within dyads or among sub-group members. Such links can be detrimental since a faultline can develop due to personal links. However, in situations of emergency and unpredictable events, personal links can contribute to resource accessibility and team performance maintenance. Interviewees described it as having two dimensions: relationship quality and functional outcomes. The former includes subjective evaluation of personal links one member has with others, and the latter includes potential positive results due to personal links.

For example, a Team 2 member commented, 'I would like to find the one I'm familiar with. As I can know his expertise and personality, we can solve problems together with less bias and conflict.' A case in Team 5 demonstrated the importance of personal links. During the software development process, a bug was found to influence the result. Due to the wrong operation, this bug expanded into five, which affected many programs. All the members were trying to fix the bug, but no one could fix it alone. Since a member had personal links, he asked his friend on the team to help, and the problem was eventually solved. Personal links can also contribute to better cooperation. Team 9 member gave this explanation:

"Those who cooperate well usually have good personal relationships with each other. They are friends both in work and in daily life. This kind of relationship can solve many problems in teams. For example, some sticky problems are caused by bias and different understandings. If you can understand your partner well, you will know

exactly what he wants and get to the point that satisfies both of you."

Team links. Team links are the relationship between members and their team, or feelings associated with being part of the team. It emphasises team members' positive experiences. Having positive personal links does not necessarily mean having positive team links; however, having positive team links means central members have good personal links with at least one other team member. Both personal links and team links contribute to positive affection links.

Team links are built upon experiences of working together that require all team members to have the same goal and share responsibility for the team outcome. A Team 5 member stated the following:

"When we were a small team, we had strong and common goal that enabled us to have the feeling of belonging. At that time, everyone was devoted to the work. We took the team task as our own task, taking other members' tasks as our own task. Once you had difficulty, I would help you to solve it; once I had difficulty, you would help me to solve it. It is the team link that guided our work.

In addition, according to Team 7, evaluating performance on the team level also contributes to the construction of team links. However, simply working together is not enough. Members of Teams 8 and 9 put great emphasis on positive work experiences within the teams throughout their interviews: 'The most important thing in the game development team is having fun … If everyone is happy in the team, there will be less conflict' (Team 8); 'We are having fun during working with the team. We can learn many things' (Team 9).

4.3.3.2 Work relationship

Work relationships were mentioned more frequently during the interviews and were observed in the field more commonly than private relationships. This category describes task-based interactions and attitudes, cooperation experience and the potential benefits of positive work relationships, coded as task-based interaction, cooperation tendency and mutual respect.

Task-based interactions. Interactions among team members may lead to conflict and inefficiency due to diversified ideas and demand. Therefore, it is necessary for a team to have an appropriate foundation for interactions, including cooperation experience and a suitable workplace design for interaction. Moreover, interaction frequency can also indicate the quality of task-based interaction. A higher frequency

implies good interaction quality, which can contribute to team adaptation.

According to the interviewees, the experience of cooperation or working together has a positive effect on daily work as well as adaptation. They referred to these particular effects: developing similar ideas (Team 1), facilitating problem-solving (Team 2), experiencing positive affection (Team 6) and reinforcing coordination (Team 10). Task-based interaction is developed based on a shared space, i.e. the same office or even the same table, or a public zone. The latter is designed for work-related discussions. Interaction frequency differs depending on the work stages. As indicated by members of Teams 4 and 10, higher interaction frequency was required in the software online and demand clarification stages, while during the development stage, interaction frequency was relatively low.

Cooperation tendency. *Cooperation tendency* refers to members' willingness to cooperate and compromise when confronted with environmental changes and conditions that the team provided for cooperation. Task-based interaction is the basis for developing cooperation tendency, while cooperation tendency improves the quality of task-based interactions.

Cooperation is encouraged in all the teams interviewed. In Team 1, members achieved cooperation through consulting and invitations to join the same project; after committing to the same project, they had to compromise for the team's goal. For example, a member who was responsible for the 3D design in Team 1 tried his best to complete a project he was invited to work on despite having a lengthy to-do list. In Team 4, members involved in the same project were located in different countries around the world. Therefore, they had to hold meetings at the cost of others' sleeping time, especially when confronted with emergencies. This tendency is enhanced during teamwork, leader briefing and daily work discussions.

Mutual respect. In order to enhance the cooperation tendency in teams, mutual respect is required during task-based interactions. This term describes the positive interaction process among team members, including members' own proactive attitude as well as their trust in and respect for others. 'Mutual' is emphasised here for equal status among members within work relationships. During interviews, members mentioned the feedback they obtained through interactions, i.e. perceived trust and perceived respect, and they also expressed the importance of one's work attitude, i.e. taking responsibility and proactive learning.

The Team 2 leader commented on the importance of proactive learning for

newcomers: ‘The quality of cooperation is partly determined by members’ abilities … If a new member has the attitude of learning from others, they can be part of the team in a much shorter time’. A Team 3 member added, ‘Only by admitting your own shortcomings [can you] learn from others’. Moreover, a Team 7 member mentioned that ‘learning from each other through pair working contributes to team adaptation’. Learning within a team is possible based on trust and respect. Without trust and respect, a person who admits his own shortfall may be criticised or laughed at, as one Team 4 member worried about.

4.3.4 Cognitive manifestation: Directional cognition

Apart from behavioural manifestation and affective manifestation, the interviewees also mentioned the importance of skill and competency, problem solving, perceptions and understanding a team’s goals. In general, adaptive teams have better cognitive skills and better usage of stored knowledge. Members discuss problems based on facts and focus on targets and related sub-goals when completing team tasks. On the other hand, maladaptive teams act as information filters; thus, changes in an environment will be ignored since insufficient information is exchanged within the team, causing changes to go unnoticed. This manifestation is termed ‘directional cognition’, which refers to a specific direction of the shared intention and interactions. The three subcategories included in this core category are problem solving, focusing on the team goal and cognitive support.

4.3.4.1 Problem-solving

Problem solving is the most important part of team adaptation. In order to efficiently solve problems, the teams interviewed took various measures and set up different rules. The four ways the interviewees commonly mentioned are caring about the facts, trying all possible ways, frank communication and accumulating evidence for tracing problems.

Caring about the facts. Caring about the facts is the most basic principle in problem solving. It means that discussions and information processing should be based on the task and problem itself and should not expand to other factors, especially personal abuse. Jehn (1997) found that task conflict could trigger relationship conflict under certain conditions. However, this negative effect can be controlled through setting rules, establishing norms and creating a positive atmosphere. This conclusion is further enhanced in this study, as task conflict was encouraged during work while relationship

conflict was avoided through different measures by different teams.

For example, Team 1 members were nearing a fight in relation to solving their problem. Thanks to the reminder to focus on the facts, they avoided an expansion of the conflict. They agreed that conflict was unavoidable due to different opinions, especially when competing for resources for the same project. However, personal abuse was forbidden in their company. All disputes must be based on facts. This is especially important in re-determining a team's direction when confronted with unpredictable changes in the work environment. According to Team 8, the redirection process involved numerous unpleasant experiences due to endless conflict during the initial stage. The problem was solved after they focused on the realisation of their ideas. As a member of Team 2 said, 'Caring about facts is the principle for dealing with conflict. It is quite common to have different opinions. But we should focus on the tasks, encouraging all members to give suggestions on the task rather than on the person who does the task'.

Trying all possible ways. In order to solve problems, all potential plans should be tried using all possible resources inside and outside of the team. These potential plans and resources can be individual- or team-based, such as expertise, past experiences and personal relationship outside the team. The aim is to solve problems as soon as possible with the highest quality.

The principle of 'trying all possible ways' indicates that solving problems is the aim, not the process. Members in Teams 1 and 2 agreed with this point. In Team 3, members proposed another way to resolve disputes that involved asking a third party (e.g. leader, colleague) to be the judge in selecting a better problem-solving plan. Team members viewed experience as another potential problem-solving resource mentioned. As a Team 4 member explained, 'You may collect problem-solving plans during daily work since bugs are everywhere and solutions are everywhere. You can keep such plans as potential resources. When you experience the same problem, you can know the possible solution'.

Frank communication. Frank communication is the key to solving problems. In terms of oneself, one should not be afraid of being criticised for his or her shortcomings or mistakes. An individual is encouraged to search for help when confronting problems that are outside one's abilities. In terms of a team, one should not try to hide problems due to being afraid of damaging relationships with other team members. Timely resolving and preventing problems from happening are aims of frank communication.

Therefore, frank communication is also a premise for the principle of caring about the facts and trying all possible ways.

The importance and functions of frank communication are often mentioned along with the former two principles. For example, when referring to the principle of caring about the facts, Team 1 mentioned the need to admit one's own shortcomings. If team members are not frank, they may hide facts and shift their focus to personal abuse. Similarly, when referring to the principle of trying all possible ways to solve problems, the premise is to present the advantages and disadvantages of each plan, which requires frank communication, as proposed by Team 2 members. Frank communication also facilitates cooperation. As the Team 5 leader stated, 'Those members who work alone, pretend to know everything and do not communicate with others will be excluded from teamwork [the] next time … They will be arranged to take responsibility for the routine work'.

Accumulating evidence for tracing problems. In order to make potential plans for solving a problem, a team needs to know the origin and development that led to the current situation. Therefore, apart from the principles of caring about the facts, trying all possible ways and frank communication, another factor that facilitates problem-solving and team adaptation is the accumulation evidence for tracing problems. The evidence should be accumulated during the work process and should be available for the team when needed.

During interviews, several teams proposed the importance of document updating and maintenance. For example, a member of Team 2 said, 'An obvious advantage of document-based design is to trace the problem'. A Team 4 member commented, 'Document[s] can be referred to when problems happen … Keeping a large number of documents and examples to ensure the availability of cues'. Another member of Team 4 expressed his concern about documents: 'Although it is supposed to provide the origin and development of the problem if you trace to the document that builds the current software environment, it is rarely the truth. The problem is, not every step of revision is recorded in documents, and documents will be too large to maintain at a later stage if everything is recorded'. Therefore, Team 5 adopted a daily check to ensure the quality of the program; Team 8 adopted e-mails to record some important revisions. Although it is difficult to maintain and update all development documents, software development teams are encouraged to do so to preserve related cues and knowledge.

4.3.4.2 Focusing on the team goal

Apart from problem solving, another key category mentioned in interviews that is important for team adaptation is focusing on the team goal. The aim of problem solving is to return the team to its normal track, and the criterion for 'normal' is to be in aligned with the team's goal. Therefore, the aim of intentional team adaptation is to guide the entire process back on track so that it is directed towards the team's goal. Two principals are included in this core category: emphasis on key points and goal directedness.

Emphasis on key points. Emergent situations or unpredictable changes that trigger the process of team adaptation usually share the property of limited resources and time pressure. Therefore, the first step is to identify and analyse key problems and try to solve them to bring the team back to its normal track. By emphasising key points, a team allocates limited resource to solve core problems and gives up secondary parts to some degree. An emphasis on key points refers to an understanding of sub-tasks' importance and allocating resource accordingly.

The Team 2 leader solved conflicts among team members according to the degree of importance and urgency: 'We have to focus on the most important tasks. The whole team has to serve for these tasks.' Other teams expressed the same opinion. For example, the task goal of Team 6 is to develop a new system for phones based on Android, but they have limited experts in the initial stage as an entrepreneurial team. They outsourced most of their business and focused on the core parts, such as the UI design, new function development and revision of the fluency of the system. Keeping the team slim can allow for flexibility when confronted with change, such as the emerging demand in the phone market for Team 6. Emphasising key points helps a team do their best in their strong areas.

Goal-directedness. In regard to 'goal directedness', 'a system's behaviour is controlled by explicit representations of a goal' (Trestman, 2012, p. 208). There is no doubt that all team behaviour should be beneficial for completing team tasks and achieving a team goal. Three tasks should be included to fulfil the above requirements. The first is to clarify the team goal through various channels to enable all members to know the current situation of completion, the progress and their own part in the process. The second is to update the task on time. This means sub-tasks should be completed within the planned period, the process should be controlled to monitor the progress, and target maps should be updated to show statuses. The third is to achieve the team goal despite disruptions.

It is widely accepted that goals are the most important aspect of teamwork. Team goals guide team behaviour to ensure behavioural consistency, the appropriate division of responsibility and work interactions among team members. As the Team 1 leader stated, 'All [that] we have done [is] directed to[wards] the goal. We try every possible way to solve problems'. Therefore, a team solves problems with the team goal in mind. There are many ways to announce a team goal and clarify it, according to the interviewees. The most common way is to draw maps (Teams 2, 5 and 7). These maps focus on progress and describe current statuses and the distance to completion. The other ways include holding meetings (Teams 2 and 10), referring to documents (Team 4) and sending updates via e-mail (Team 3). Such updating contributes to all team members' understanding of team situations. It provides the basis for identifying potential problems and provides opportunities to solve them at initial stages.

4.3.4.3 Cognitive support

Adaptive teams are directional and efficient when problem solving, and they also have cognitive support that contributes to efficiency under the guidance of the team's goal. Such cognitive support is manifested as individual members' commitment to the goal, interpersonal knowledge and skill acquisition. These three types of cognitive support serve as building blocks for the effective functioning of teams and contribute to effective problem solving and coordination among team members to focus on the team goal.

Commitment to the goal. Members of adaptive teams understand their tasks and the team's task, and they are also committed to the team goal. They have consistent goals with other team members and avoid biases and misunderstandings of the team goal.

For example, it is highly common for teams to experience divergence towards the realisation method in software development. The maintenance of team effectiveness depends on the congruence between individual member's methods and the team task. The more congruent their realisation method is, the higher the possibilities to integrate their methods to complete team goals. In Team 6, divergence on redirection almost resulted in failure for the team, but since they were all committed to the goal and their realization method was congruent with the team task, they finally found a way to integrate both ideas. However, Team 7 had a difference experience, where the whole team abandoned an engineer due to divergence on the basic idea for development: short-

period iteration or a waterfall approach. Team 7 returned to their norm after the engineer was removed from the team.

Interpersonal knowledge. Congruence can be gained through developing knowledge about other members, the environment and oneself. Interpersonal knowledge is gained based on similar backgrounds such as knowledge of the industry and expertise. It is argued to be essential for structuring interactions (Kozlowski et al., 1999). Knowledge of other members may include their personalities, habits, expertise, and task content; knowledge of a work environment may include general features, task distribution and progress, task priority and a time map; and knowledge of oneself may include one's shortages and abilities, roles in a team and relationships with others.

Understanding others provides a foundation for cooperation. A member of Team 1 stated that an understanding of others and having a similar background enabled cooperation and avoided unnecessary conflict. Moreover, a member of Team 2 commented that knowledge of partnered members' habits facilitated the communication process and in turn led to better cooperation. Knowledge of the work environment provided a foundation for problem solving since such knowledge contributed to identifying potential cues in the initial stage and full use of work equipment. Knowledge of oneself contributed to situating one's work and searching for help from appropriate partners.

Skill acquisition. Although knowledge of others, the environment, and oneself is quite important for judging a current situation and making plans, one's skills contribute to solving problems. An individual's *skill acquisition* refers to an acquired specific ability and techniques that are related to completing tasks. This is related to but different from task mastery, which Kozlowski et al. (1999) proposed. Task mastery is the process of developing task routines, priorities and strategies for how to perform and how well they are performing. Skills are acquired partly through the process of task mastery, including experimentation and practice. Skill acquisition provides support for dealing with difficult problems, emergencies and achieving a team goal.

The importance of skill was mentioned throughout interviews from several aspects. Firstly, the Team 2 leader described it as a necessary condition for team cooperation: 'I think team cooperation is related to team members' abilities. Whether the programmer can understand the project and translate it into programming language depends on his skill and ability'. Secondly, an adaptive team consists of members with technical skills who are sensitive to market changes. Team 2 members viewed skilled members as able

to solve the most difficult problem both for partners and for themselves. Diversified skills are required as the third manifestation of skill acquisition, as revealed by Teams 3, 4 and 8.

4.4 Summary

This study aimed to explore empirical evidence for external attribution and the collective intentionality of team actors, along with manifestations of intentional team adaptation. The former is a response to King, Felin and Whetten's (2010) social actor proposition. They called for a shift from 'behaviour' to 'organisation', which involves finding meaningful features that make an organisation unique from other social entities and talking about the organisation itself rather than what is 'around' it (King, Felin, & Whetten, 2010). This study focused on the uniqueness of a team and described the features that make a team adaptive. It is argued that the property is inherent within the team; various factors, including members' cognitive support and their interactions, determine it. Further studies are needed to clarify the functional mechanism of team actors both theoretically and empirically.

The second theoretical contribution of this study is its building on the theory of intentional team adaptation. Although team adaptation has been viewed as a research field since the publication of Burke et al. (2006), most of the current studies have focused on team members' reactive responses towards changes and uncertainty (e.g. LePine, 2003; Christian et al., 2014). This is certainly an important perspective to understand team adaptation, but it should not be the only perspective. Apart from their reactive responses, teams are also anticipated to carry out proactive actions that aim to identify and implement changes in work processes, products and services (Chiaburu et al., 2013). Therefore, this study proposed intentional team adaptation. It demonstrates that adaptive teams have unique intentions that guide members' behaviour and interactions so that they are suitable for a situation. This property determines the adaptation process and outcomes. It can be inferred that a lack of coordinated intentional behaviour, connected relationships and directional cognition may lead to maladaptation when confronted with changes or uncertainties. Actually, evidence has been found in the grounded process for such maladaptive manifestations, such as the empirical evidence from Frick et al. (2018) who proposed the theory of maladaptation.

In summary, the main research problem was answered using a grounded theory approach, thus building a theory of intentional team adaptation. Teams with members

with similar behavioural intentions towards team goals through interactions are adaptive and can respond to environmental changes in a proactive way. The processes include analysing and recognising environmental cues, making adjustments based on an original plan, carrying out a new plan according to responses and achieving performance. These processes are facilitated by members' directed interactions based on shared intentions. An adaptive team is an actor who can act relatively independent from the individuals who comprise it. Members behave not only on their own intention and ideas but also gain intention and motivation from their teams. Thus, an adaptive team is proactive instead of merely providing a context for individuals to work.

A whole picture of intentional team adaptation has now been obtained, but more research is needed to support this theory. Therefore, the next chapter focuses on the development of a measurement tool to study intentional team adaptation.

CHAPTER 5 STUDY II: SCALE DEVELOPMENT FOR INTENTIONAL TEAM ADAPTATION (ITA)

This chapter reports on the results of the scale development for intentional team adaptation (short as ITA). In the previous chapter, it is clear that intentional team adaptation is manifested in three aspects: coordinated intentional behaviour, connected relationship and directional cognition. Findings from the grounded study lay the foundation for understanding the construct definitions and content domains, which, according to Netmeyer et al. (2003), is the first step of scale development. Before applying it to field settings, two additional steps were necessary: 1) generating and judging measurement items and 2) designing and conducting studies to develop a scale. The results of these steps are reported in this chapter. Accordingly, this chapter contains five parts: 1) an overview of the study design; 2) provide a definition of the 'construct' and content domain identification based on the literature review; 3) item generation and judgement based on findings from the grounded study; 4) scale development and verification; and 5) an examination of construct validity and scale validation.

5.1 Overview of the Study

In order to provide empirical evidence for intentional team adaptation in the field, an effective measurement is needed. Results of grounded study shed light on developing a measurement for intentional team adaptation (ITA). Therefore, the development of the scale for ITA followed procedures suggested by Netmeyer, Bearden and Sharma (2003). These procedures include four steps: Step 1 involves a definition of 'construct'; Step 2 involves generating and judging measurement items; Step 3 focuses on designing and conducting studies to develop a scale; and Step 4 involves finalising the scale. Initial items were written to cover all of the main subcategories and codes revealed in the grounded study as well as in the literature review. After generating the initial scale, two sub-studies were designed to verify and validate the scale. The first study employed exploring factor analysis and item analysis methods to revise the scale. The second study employed confirmative factor analysis and hierarchical regression analysis to examine construct and measurement validities. Finally, this scale was applied to study the distributed cognition mechanism of intentional team adaptation in the field, and the results are reported in Chapter 7. In this chapter, the results of item generation and

judgement, scale verification and validation are reported.

5.2 Construct Definitions and Content Domains

A sound construct is the foundation for good measurement; therefore, developing measurement should always be theory-based. In this step, construct definitions and content domains are identified through an extant literature review.

In this research, *intentional team adaptation* (ITA) is defined as a team's intentional response to internal changes of team-related elements, leading to adaptive outcomes. Since the researcher aimed to develop a scale of ITA, literature on team adaptability and teams' intentional responses were reviewed.

Stagl et al. (2006) addressed the situation of conceptualising team adaptability as a 'lack of inter-effort coordination' that 'ultimately results in chaos' (p. 120). Exemplar definitions of 'team adaptability' are as follows: Fleming, Wood, Dudley, Bader and Zaccaro (2003) suggested that team adaptability is the ability to make 'functional change in response to altered environmental contingencies' and that it 'emerges from an integrated set of individual attributes' (p. 3). Moreover, Burke, Hess and Salas (2006) identified it as the general ability 'to adjust to potential damage, to take advantage of opportunities or to cope with the consequences' (p. 176). Klein and Pierce (2001) defined *adaptive teams* as those that can 'make the necessary modifications to meet new challenges' (p. 3). No one defined 'team adaptability' from a social actor perspective, but according to the typology proposed in Chapter 2, ITA can be understood as similar to the descriptions found in the extant literature since these researchers did not specify the types of changes that teams face.

There is no doubt that team adaptability is by nature an inherent ability of teams. Though it is hard to observe directly, its manifestation can be observed through the process of adaptation so that indicators can be derived through an analysis of the adaptation process. Works on team adaptation were reviewed in Chapter 2, and the outcomes of the intentional team adaptation process are summarised below.

Behaviourally, intentional adaptive teams conduct coordination activities, maintain coordinated interdependence and execute plans according to judgements regarding environmental changes. Specifically, adaptive coordination involves changing coordination activities in response to changing situational demands (Burtscher et al., 2010). Coordinated interdependence maintenance is achieved through changes in interaction patterns that align with changed task requirements (LePine, 2003,

2005; Uitdewilligen et al., 2013). Team plan execution is the most important phase during team adaptation; it involves monitoring, backup and communication (Burke et al., 2006).

Information sharing is the key function for communication in teams (Randall et al., 2011), and it is one of the cognitive manifestations of ITA. Apart from information sharing, an adaptive team actor also frequently gathers information from a changing environment to assess situations and derives new strategies and plans to deal with the novel environment (Marks et al., 2000, Day et al., 2004). Additionally, individual members' cognitive talents are regarded as the content of ITA (Han & Williams, 2008). Members' cognitive talents are the premise for the appropriate utilisation of knowledge and skills to deal with complex and novel task situations (Kozlowski et al., 2001; Chen et al., 2005). ITA is also manifested as goal-directed behaviours with goals and directions in mind to guide the adaptation process. For example, Schippers et al. (2007) defined 'adaptation' as 'goal-directed behaviours relevant to achieving the desired changes in team objectives, strategies, processes' (p. 192). In short, teams intentionally adapt to changes through goal-directed behaviours such as identifying deviations from expected behaviours, the utilisation of knowledge and skills and problem solving.

In summary, a common perspective across different disciplines is that ITA is an inherent team capacity. It requires the use of members' cognitive and affective resources to enable joint actions when confronted with changes. ITA is implicit and cannot be directly observed. However, it can be measured based on observable indicators, including members' positive relationships, joint behaviours and goal-directed behaviours at the team level.

Apart from conceptualisation, the form of measurement is also a key issue for developing team-level construct (Han & Williams, 2008). The referent-shift model is commonly adopted to measure ITA. Chen et al. (2005) viewed this model as the most appropriate for measuring constructs that require shared perceptions or are interdependent. The referent-shift model involves switching an original individual tone into the team's tone; it describes team phenomena from the perspective of individuals' feelings, thinking and actions (Paulin & Griffin, 2015). A further problem involves deciding how to aggregate from individuals to a team level. Two most common models of aggregation are compilation and compositional. The the former uses direct team-level measurements, and the latter adopts the sum or average of individual-level measurements.

For the compilation model, representative measurements include Resick et al.'s (2010) measurement and Rosen et al.'s (2011) work. Resick et al. (2010) measured team adaptation as time spent on decision-switching after changes; this method is similar to that of other scholars, who measured it as an outcome variable (e.g. Uitdewilligen et al., 2013; Waller, 1999). Rosen et al. (2011) did not present a final scale but suggested six principles for developing measurement. Regarding the composition model, the most applicable work is from Han and Williams (2008), who proposed that 'the relationship between individual adaptive performance and team adaptive performance can be defined by a composition model' (p. 662). They measured team adaptive performance via a 14-item scale with three factors: network selection, network invention and coordination maintenance. Another measurement that also employs the compositional model is Schippers and her colleagues' (2007) work, which includes five items that measure 'the extent to which [the] team members carry out planned actions and make adaptations that were agreed upon' (p. 195).

However, both existing models for measuring team adaptation are problematic. First, none of the existing measurements is validated across different samples or developed through rigorous procedures that fulfil requirements for latent construct development. Second, no measurement was found that directly studies ITA or intentional team adaptation. Third, measurements that adopted the compilation model use team outcomes to represent team adaptation, which does not capture the idea of abilities being positioned as input (Maynard et al., 2015). Compared to the compilation measurement model, measurements based on the compositional model are more likely to capture the nature of team adaptation, though existing measurements still had problems with construct validity.

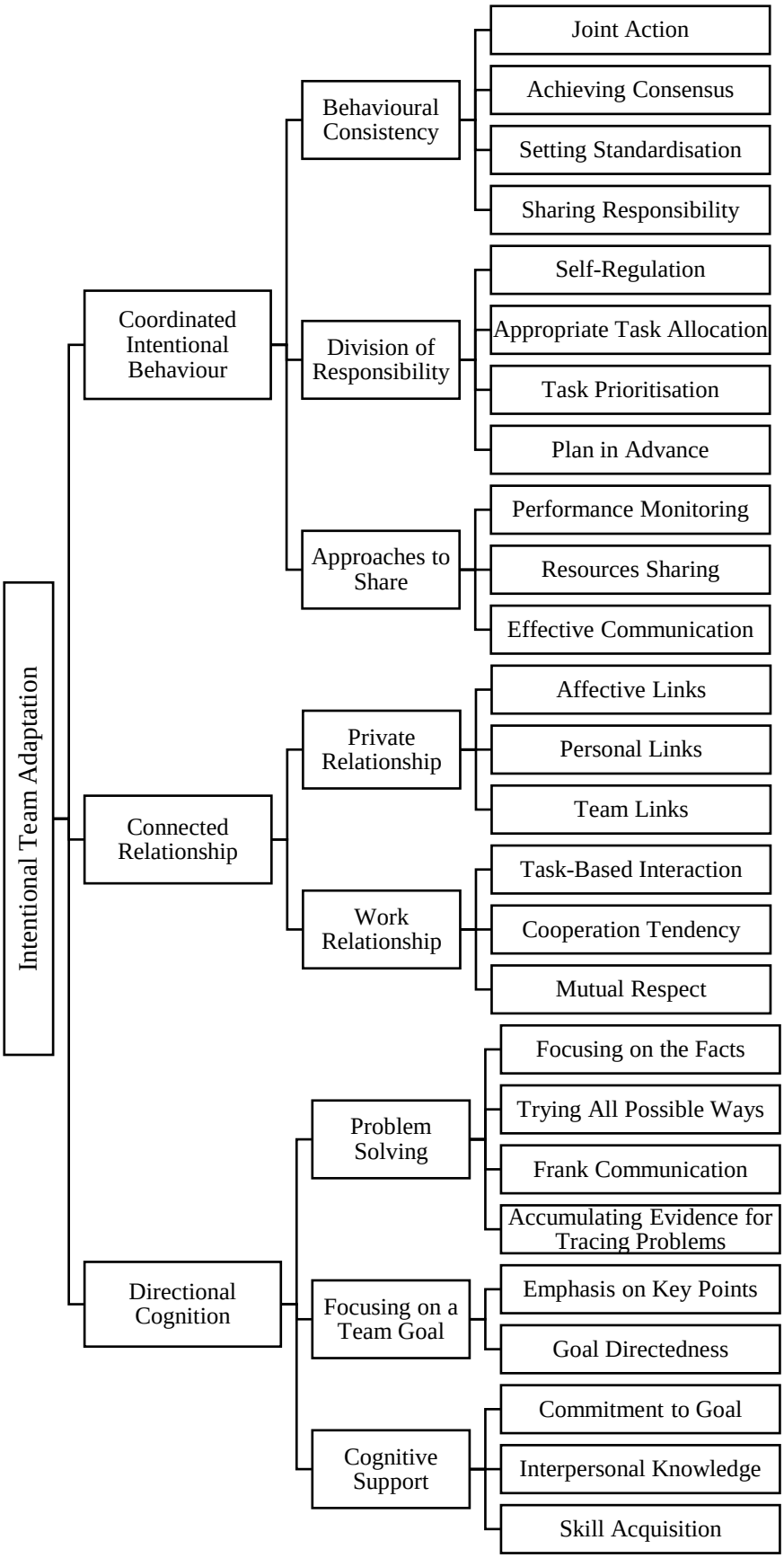
The current work supports the use of the compositional model to measure ITA for the following three reasons: First, ITA cannot be observed directly; it can only be measured at the individual level. Second, although the contents of individual adaptability and team adaptability are different, shared content among individuals concerning ITA is similar. Third, when the compositional model is adopted to measure team adaptation and to aggregate individual data into teams after checking the within-group agreement, teams that have high scores in identifying with team goals, giving backup to each other and taking action to deal with changes are more adaptive. Therefore, the compositional measurement model was adopted in this research to measure ITA.

After reviewing existing literature on both conceptualisation and measurement, it can be concluded that ITA refers to the inherent abilities of teams that cannot be reduced to the individual level but can be manifested through individuals' interactions and is partly determined by members' cognitive resources. Potential indicators for ITA include individual members' compensatory behaviours and motivation, the allocation of resources, close relationships with each other, the identification of environmental cues and problem-solving efforts. The measurement of ITA can be built on referent-shift and compositional models. In other words, individual members' cognitive, affection and behavioural responses can be aggregated into the team-level to represent ITA by using the averaged value.

5.3 Item Generation and Judgement

Items are generated based on the literature analysis and findings from the grounded study. The construct structure is depicted according to findings from the grounded study illustrated in Figure 5.1.

Figure 5.1 Construct Structure of Intentional Team Adaptation(ITA)



Initial items were collected to cover all the main subcategories and codes revealed in Table 4.2. Three academic experts and two field practitioners were invited to review the scale (written in Chinese) to ensure content and face validities. They proposed several wording changes. Finally, 26 items were used for measuring intentional team adaptation, which is presented in Table 5.1.

Apart from content and face validities, one more issue in this step concerned deciding on a proper format of measurement. This study used the general 5-point Likert format to measure items. It is argued that the Likert format scale is appropriate for measuring psychological constructs, including both behaviour and attitudes (Boyle, Saklofske, & Matthews, 2015). Item numbering is also a consideration; the inclusion of more than three items to measure each dimension of a construct is recommended. Too many items may tire respondents; therefore, fewer than 10 is preferred for each dimension.

Table 5.1 Initial Scale Items

Indicator	Statement
Joint action	QB.1 In our team, we have to take joint action to achieve the common goal.
Achieving consensus	QB.2 In our team, we formulate similar ideas through discussion to complete the task.
Setting standards	QB.3 In our team, we established the procedures, steps and standards to complete the task.
Sharing responsibility	QB.4 In our team, we share the responsibility.
Self-regulation	QB.5 In our team, all of us can do our own job according to the requirement.
Appropriate task allocation	QB.6 In our team, the labour division is clear, including time and task content.
Task prioritisation	QB.7 In our team, we will arrange the subtasks according to their importance after dividing the team task into pieces.
Plan in advance	QB.8 In our team, we make plans before completing the task.
Performance monitoring	QB.9 In our team, we all have the approach to knowing what others are doing.

Table 5.1 Initial Scale Items (Continued)

Indicator	Statement
Resources sharing	QB.10 In our team, we share diversified resources.
Effective communication	QB.11 In our team, we put effort into understanding each other.
Focusing on the facts	QC.1 We focus on the task when problems occur.
Try all possible ways	QC.2 We try every possible way and use all the available resources to solve the problem.
Frank communication	QC.3 We share opinions openly and sincerely to solve problems and avoid covering up the truth for any reason.
Accumulating evidence for tracing problems	QC.4 We have enough materials to trace the origin of problems.
Emphasis on key points	QC.5 We always focus on the most important thing at the moment.
Goal-directedness	QC.6 Everything we did aimed to achieve the target.
Commitment to goal	QC.7 We all know and identify with the team's task and target.
Interpersonal knowledge	QC.8 We are familiar with each other's personality, skills and work styles.
Skill acquisition	QC.9 All of our team members have the ability and skills to complete team tasks.
Affective links	QA.1 We encourage and support each other when encountering any troubles or problems.
Personal links	QA.2 We have good personal relationships with each other.
Team links	QA.3 We are proud to be part of the team.
Task-based interaction	QA.4 We exchange views with each other during work.
Cooperation tendency	QA.5 We are willing to sacrifice personal benefits in order to solve the team's problems.
Mutual respect	QA.6 We have mutual respect and mutual trust for each other.

5.4 Scale Development and Verification

After generating the initial scale, the researcher used factor analysis and item analysis methods to revise the scale. Indicators employed during the analysis included eigenvalues, scree tests, total variance explained, communalities, Cronbach's α and item-to-total correlations. Consistent with previous studies, a questionnaire-based survey was first conducted to begin the development and revision work. This section reports the scale development and verification results, including sample characteristics and the scale analysis.

5.4.1 Sample and measurement

The target sample in this study included who worked in teams and completed team tasks through collaboration. A questionnaire was distributed via email and through an online site (https://www.wjx.cn/). A total of 205 valid questionnaires were received with data on the initial scale of ITA and team performance. Team performance was measured using a 5-item scale adopted from Tjosvold, Law and Sun (2006). Background data included gender, industry, age, team size and work experiences. The questionnaire was designed to be anonymous in order to attract respondents. The questionnaire in full is presented in Appendix III.

The background information of the sample was as follows: A total of 56.6% of the respondents were male, and the remaining 43.4% were female. Their average age was 32.82, and their average work experience was 9.17 years. Most of them came from the manufacturing industry (39.5%); others were from the education field (20.5%), followed by the service industry (20%), the IT industry (13.7%) and other fields (6.3%).

5.4.2 Item analysis and results

This study was mainly designed to develop an ITA scale with initial items generated from both theoretical work and the grounded study. KMO and Bartlett's tests indicated the data were appropriate for exploratory factor analysis (KMO=0.955, sig=.000 for χ^2). The case to item ratio was 7.88/1, indicating the adequacy of the sample size (Hinkin, 1998). A factor analysis was conducted using the principal component extraction method with maximum likelihood techniques. Oblique rotation instead of varimax rotation was adopted in this analysis since the three potential factors identified were interrelated, as theories suggested.

Item correlation analysis was conducted prior to an explorative factor analysis

(EFA). The results showed that the average inter-item correlations were larger than .30 for each item, and all the items were significantly correlated with each other. The EFA of the 26 items resulted in three factors extracted with selection criteria and eigenvalues larger than 1. However, the scree plot (Figure 5.2) revealed that only a single factor had a large eigenvalue (larger than 12.5), and those remaining were all lower than 2.5. This result indicated that the factor structure was not stable. These extracted factors accounted for 60.079% of the total variance. Each item and its factor loading are presented in Table 5.2. Factor loadings that were smaller than .30 are not shown in the table. Data in Table 5.2 reconfirm that the factor structure was not appropriate, and the loadings were different from the theoretical prediction.

Figure 5.2 Scree Plot of ITA

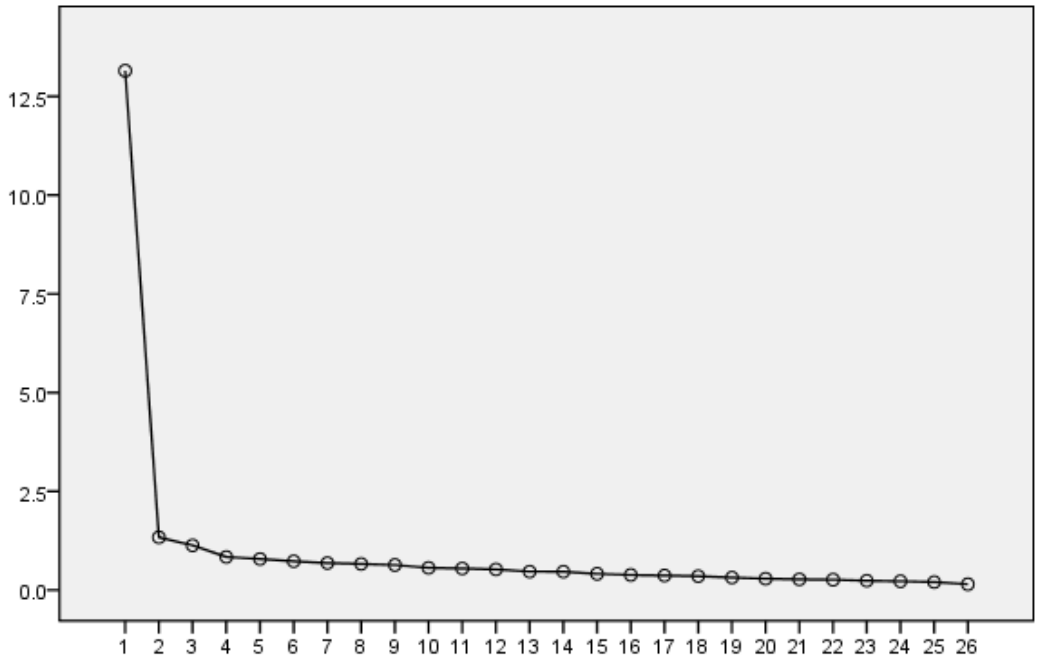


Table 5.2 Initial Scale and Factor Loadings

Item content	Factor 1	Factor 2	Factor 3
QB.1	.869	-.061	.173
QC.7	.852	-.092	-.088
QC.1	.818	-.136	.320
QC.6	.772	.032	-.027
QA.1	.771	.071	.237
QB.8	.750	.077	.086
QC.2	.729	.078	-.079
QB.3	.724	-.010	-.320
QB.11	.718	-.066	-.212
QB.5	.689	.063	.211
QA.6	.649	.250	.110
QA.4	.644	.053	-.242
QB.6	.639	.101	.025
QB.2	.624	.167	-.169
QA.3	.599	.163	-.287
QB.7	.597	.128	-.129
QC.3	.590	.112	-.461
QC.9	.575	.225	-.256
QC.5	.568	.217	.231
QC.4	-.156	.896	.105
QB.9	.057	.704	-.118
QB.10	.088	.626	-.285
QC.8	.290	.516	.177
QA.5	.287	.497	-.190
QB.4	.338	.493	.199
QA.2	.354	.461	.163

Extraction method: Principal components

Rotation Method: Direct Oblimin

The initial results indicated the need for scale revision, which was conducted according to Netmeyer et al.'s (2003) suggestions. First, items with low communalities (lower than 0.55) were deleted iteratively (QB.6, QB.7, QA.2, QB.11 and QC.5). Then, those items with multiple loadings were removed (i.e. difference between factor loadings was less than 0.20). Deleting item QC.4 in this step resulted in decreasing one factor. The same procedure was conducted repeatedly, and four remaining items were deleted iteratively (i.e. QC.8, QB.4, QB.9 and QA.4). Furthermore, QB.10 was deleted due to multiple loadings, resulting in a single factor. The same procedures were repeated, which resulted in the deletion of QA.5, QC.1 and QB.5. Finally, multicollinearity was checked with each item, resulting in no item with a variance inflation factor greater than 6—i.e. they varied from 1.9 to 2.9. Accordingly, the final EFA was a single-factor solution, accounting for 61.60% of the total variance. This factor included 12 items in total, with four items measuring behavioural manifestations, five items measuring

cognitive manifestations and three items measuring affective manifestations. as theories suggested. The final scale items and factor loadings are presented in Table 5.3.

Table 5.3 The Final Scale Items and Factor Loadings

No. and Indicator	Item Content	Factor Loadings
QA.6 Mutual Respect	We have mutual respect and mutual trust for each other.	.811
QC.2 Try All Possible Ways	We try every possible way and use all the available resource to solve the problem.	.798
QB.1 Joint Action	In our team, we have to take joint action to achieve the common goal.	.796
QC.6 Goal Directedness	We all aim to achieve the target.	.793
QC.7 Commitment to the Goal	We all know and identify with the team's task and target.	.793
QB.8 Plan in Advance	In our team, we will make plans before completing the task.	.793
QA.1 Affective Links	We encourage and support each other when encountering any troubles or problems.	.785
QB.2 Achieving Consensus	In our team, we formulate similar ideas through discussion to complete the task.	.780
QB.3 Setting Standards	In our team, we establish procedures, steps and standards to complete the task.	.779
QA.3 Team Links	We are proud to be part of the team.	.775
QC.9 Skill Acquisition	All of our team members have the ability and skills to complete team tasks.	.773
QC.3 Frank Communication	We share opinions openly and sincerely to solve problems and avoid covering up the truth for any reason.	.761

The results of CFA (confirmative factor analysis) for the one-factor structure of ITA was acceptable: χ^2/df=2.999, RMR=.028, CFI=.934, IFI=.935. Item loadings were all significant, with values greater than .80. Two different measurement models were compared: one single factor model and a three-factor model with items loading on three

types of manifestations (behavioural, affective and cognitive). As the results in Table 5.4 show, the one single factor model fit better than the three-factor one with a significant chi-square difference (△χ2/df=9.735). This provided clear evidence for the one-factor construct structure. The Cronbach's α reliability for the remaining scale was 0.941, thus exceeding the 0.70 cut-off value Numally (1978) recommended.

Table 5.4 Comparison Results of the Measurement Model

Models	χ2/df	RMR	CFI	IFI
Single-factor model	2.999	.028	.934	.935
Three-factor model	12.734	.298	.614	.617

The results of the path analysis of ITA and team performance supported the nomological validity of ITA. The structural equation model was a good fit for the data (χ2/df=2.390, RMR=.027, CFI=.937, IFI=.938). The correlation between ITA and team performance was .76 at the 0.01 significance level.

The above results provided initial evidence of validity and credibility for ITA.

5.5 Examination of Construct Validity and Scale Validation

The final step in the scale development was to confirm the validity and reliability of the measurement. Apart from internal consistency, test-retest reliability, criterion-related validity, convergent validity and discriminant validity should be examined and discussed. *Test-retest reliability* refers to the stability of measurement across time; a higher value is preferred. *Convergent validity* is 'the degree to which two measures designed to measure the same construct are related' while the *Discriminant validity* refers to 'the degree to which two measures designed to measure similar, but conceptually different, constructs are related' (Netemeyer et al., 2003, p. 13). Both can be examined via confirmative factor analysis. *Criterion-related validity* typically refers to the extent to which a measure corresponds to the measure of interest. In this study, the measurement of ITA was used to predict team performance and team adaptation to confirm criterion-related validity. Accordingly, data were collected from students' project teams and the relationship between ITA and team performance was examined.

To assess construct validity, several related constructs and measurements were included in this study, i.e. team performance, a published scale of team adaptation and individual adaptability. Team performance was measured to test the nomological validity. Since ITA is argued to be a capacity of maintaining effectiveness in both

routine and novel situations (Marks et al., 2000), there should be a positive relationship between ITA and team performance. The published scale of team adaptation derives from Schippers et al. (2007); it measures 'the extent to which the team members carry out planned actions and make adaptations that were agreed upon' (p. 195). There should be a positive relationship between the scores derived from Schippers et al. (2007) and the scores from the newly developed scale in this study. Moreover, ITA was compared with average members' adaptability to obtain discriminant validity data. *Individual adaptability* was defined as the ability to 'handling emergencies or crisis situations, handling work stress, solving problems creatively, dealing with uncertain and unpredictable work situations, learning work tasks, technologies and procedures, demonstrating interpersonal adaptability, demonstrating cultural adaptability and demonstrating physically oriented adaptability' (Pulakos et al., 2000, p. 616). An eight-item scale measuring the above eight dimensions of individual adaptability was formed based on the Job Adaptability Inventory (JAI) (Pulakos et al., 2000). Each of the team members filled in the scales of ITA and the shortened version of JAI. The data of ITA were aggregated into the team-level after aggregation tests while the data of JAI were averaged to the team-level without aggregation tests. A confirmative factor analysis was conducted for the team-level data, and it examined the nomological model based on the relationship between ITA and team performance. Full detailed items are presented in Appendix IV, including the measurement of ITA, team adaptation and individual adaptability.

5.5.1 Sample and procedures

Thirty-six teams (180 students) from a normal university (i.e. an institution that previously aimed to train schoolteachers in the early 20th century) in China participated in this study. They were required to submit a piece of software at the end of the term. They had to conquer any changes during the process to complete their team projects. Two professional teachers evaluated team performance based on the quality of the teams' software. Each team consisted of five students; midway through the project, all of them were asked to fill in a questionnaire about ITA and background information. At the end of the term, they were asked to fill in questionnaires on individual adaptability and the well-established scale of team adaptation from Schippers et al. (2007). A total of 37.8% of the students were male, and the remaining 62.2% were female. They were all second-year undergraduate students.

5.5.2 Measurement

All constructs were measured on a Likert-type scale ranging from 1 to 5 (1=strongly disagree; 5=strongly agree). ITA consisted of 12 items developed in a previous study. The Cronbach's α was .955. Items that measure individual adaptability were taken from Pulakos et al.'s (2000) Job Adaptability Inventory (JAI) with eight items, and a Cronbach's α equal to .86. The team adaptation scale, developed by Schippers et al. (2007), consisted of five items with a Cronbach's α of .85. Professors' final scores were used to measure teams' projects and presentations and were regarded as team performance.

5.5.3 Aggregation analysis

Indicators for evaluating aggregation adequacy are r_{wg} and ICC, as suggested in previous works (James, 1982; James, Demaree, & Wolf, 1984). R_{wg} is used to measure the degree to which individual ratings within a team are interchangeable; the acceptable value is larger than .70 among members' responses. ICC is the indicator to assess the relative consistency of responses among team members. ICC (1) is the degree of reliability concerned with a single assessment of the group means, and ICC (2) is the estimation of the reliability of the group means (James, 1982). An acceptable value for ICC (1) is larger than .12; for ICC (2), an acceptable value is larger than .60. Team size can influence ICC (2), with a larger size leading to a larger value.

The average r_{wg} value was 0.98 for ITA and 0.96 for team adaptation. The ICC (1) values for ITA and the team adaptation scale were 0.79 and 0.95; the ICC(2) value for ITA and the team adaptation scale were 0.91 and 0.97, respectively, thus indicating acceptable results for aggregation. Therefore, the means of team members' responses were used to represent ITA and team adaptation scale.

5.5.4 Confirmatory factor analysis of the intentional team adaptation (ITA) scale

To evaluate the single-factor structure of ITA, a confirmative factor analysis was used with the maximum likelihood procedure in AMOS (Hinkin, 1998). Three models were compared: a single-factor model; a two-factor model with all the behavioural related items indicating a latent factor and the remaining cognitive and affective-related items indicating another factor; and a three-factor model with behavioural, cognitive or affective-related items indicating a latent factor, respectively. The results of the

comparison of the three models are shown in Table 5.5. In support of the explorative factor analysis, the confirmative factor analysis revealed a single factor structure that provided the most appropriate fit for the data, with χ^2/df=1.446, RMR=.008, CFI=.970, IFI=.970 and RMSEA=.10. The results of the two-factor model (χ^2/df=3.412, RMR=.273, CFI=.838, IFI=.840, and RMSEA=.26) and three-factor model (χ^2/df=5.247, RMR=.320, CFI=.714, IFI=.718, and RMSEA=.35) were not comparable with the one-factor model when the factor number increased. Correlations, variances and standardised discrepancies were further examined, and all results suggested that a one-factor solution was the most appropriate. The Cronbach's alpha for the team level's data was .98, indicating a high internal consistency.

Table 5.5 Comparison Results of the Measurement Model

Models	χ2/df	RMR	CFI	IFI	RMSEA
Single-factor model	1.446	.008	.970	.970	.10
Two-factor model	3.412	.273	.838	.840	.26
Three-factor model	5.247	.320	.714	.718	.35

5.5.5 Scale analysis and construct validity

To assess the construct validity of the ITA scale, correlations and a confirmative factor analysis were calculated at the team level. Convergent validity was tested by comparing the new scale with the established one, as suggested by Campbell and Fiske (1959). The established scale was adopted from Schippers et al. (2007). The result of the correlation test showed that the coefficient between the current scale and team adaptation scale was r=.506, p<0.01, suggesting good convergent validity.

Average individual adaptability was compared with ITA by comparing different CFA models to examine discriminant validity (DeVellis, 1991). Items of individual adaptability that were assigned to the measurement model were calculated as averages of members' scores. Two models were compared: the first model included two different latent variables (i.e. ITA and average individual adaptability), and the second model included only one latent variable (i.e. assigned items of average individual adaptability to ITA). The results of the CFAs showed that the average individual adaptability items were indeed distinctive from those items measuring ITA: The fit results for the first model were χ^2=240.407, χ^2/df=1.414, SRMR=.019 CFI=.922 and IFI=.924; the fit results for the second model were χ^2=296.187, χ^2/df=1.742 SRMR=.014, CFI=.860 and IFI=.863. In addition, the coefficient between ITA and a team level's individual adaptability was r=-.174, n.s., thus providing direct evidence for differentiating ITA

from aggregated individual adaptability.

Nomological validity is supported when confirming the theoretically hypothesised relationships (Hair et al., 2006). In this study, the relationship between ITA and team performance was examined. It was assumed that teams with high adaptability could achieve better performance despite environmental changes and process difficulties (Burke et al., 2006; Klein & Pierce, 2001). Therefore, a structural equation model was used to assess the correlation between ITA and team performance for these student project teams. The path coefficient was positive and significant ($r=.551$, $p<.001$), which provided support for the nomological validity of ITA.

The above analysis suggested a validated construct. Along with the results reported in the previous section, this study developed an internally consistent scale that was used to measure ITA. An additional study was conducted to apply the measurement in organisational settings; it will be discussed in Chapter 7.

5.6 Summary

This chapter reported on the scale development processes and results and empirically examined the scale's validity and credibility based on two different samples. According to Netmeyer et al.'s (2003) suggestions, EFA and CFA were conducted separately to revise the scale as well as confirm the construct structure. The final scale of ITA has 12 items measuring behavioural consistency (joint action, achieving consensus, setting standards), plan in advance, problem-solving (try all possible ways, frank communication), focusing on the team goal (goal-directedness, commitment to goals) and cognitive support (skill acquisition). Apart from scale development, the results also revealed the positive role of ITA for team performance. Mechanisms of intentional team adaptation were further examined through two additional empirical studies separately conducted in a laboratory and in the field. The results are reported in the following chapters.

CHAPTER 6 STUDY III: EXPERIMENTAL STUDY ON THE SHARED COGNITIVE MECHANISM FOR INTENTIONAL TEAM ADAPTATION UNDER DIFFERENT GOAL INTERDEPENDENCE

This chapter reports on the results of Study III, which examined the role of the shared team cognition mechanism in intentional team adaptation. Specifically, the dynamic relationship between the shared mental model and team performance was analysed with different goal interdependence for changed tasks. This study was designed to provide support for the internal validity of the intentional team adaptation theory and to respond to the research problems regarding 'how to achieve intentional team adaptation' and 'the boundary condition of intentional team adaptation'. Therefore, an experimental study was designed to fulfil the above objectives. This chapter includes three main sections: hypotheses development; the research design and description of the participants; and the results of the experimental study.

6.1 Hypotheses Development

In order to clarify the shared cognitive mechanism of intentional team adaptation, three types of relationships were discussed and examined in this study: the relationship between the shared mental model and team performance; the relationship between shared mental model updating and team adaptation strategies; and the moderation effect of goal interdependence.

6.1.1 Shared mental model and team performance

Shared mental models are the organised mental representations of key elements in a team environment that are shared across team members (Klimoski & Mohammed, 1994). Two characteristics of shared mental models are usually evaluated: similarity and accuracy (Mohammed et al., 2010). *Similarity* refers to the degree to which members' mental models overlap, and *accuracy* refers to the degree of adequacy in representing the specific content of the mental model. When team members have similar mental models, it is easier for them to form similar judgements, to reduce

conflicts and to develop consensus towards knowledge sharing, thus leading to a high level of team performance (Xiang, Yang, & Zhang, 2016; Xie, Zhu, & Wang, 2009). These outcomes are all related to teamwork effectiveness (McIntyre & Foti, 2013). Apart from being on the same page, members should also be on the right page. An accurate shared mental model contributes to the team's forming of an accurate judgement, overseeing of the completion of the team task and appropriate adopting of knowledge to solve problems, which also leads to a high level of team performance (Edwards, Day, Arthur, & Bell, 2006; McIntyre & Foti, 2013).

The following hypotheses were developed based on the above arguments:

H1a: Shared mental model similarity is positively related to team performance.

H1b: Shared mental model accuracy is positively related to team performance.

6.1.2 Shared mental model updating and team adaption

However, the above relationship holds for single tasks in relatively stable environments. It is unlikely that this relationship between shared mental models and team effectiveness still holds for uncertainty. The shared mental model may hinder performance in a novel situation due to mismatches (Uitdewilligen et al., 2013). When a task changes, its initial mental model loses its efficiency in explaining and predicting, thus leading to the degradation of a team's performance (Parker et al., 2018). The only ways to maintain team effectiveness are to update the shared mental model in the required direction and to ensure that all members' mental models change in the same way so that they can maintain their similarities after the changes (Gorman & Cooke, 2011). This type of change is termed 'shared mental model updating' which refers not to absolute change but to modifications aligned with task-related changes.

Shared mental model updating is, by nature, a process of team members changing the underlying knowledge structure and matching it with targeted tasks. In this process, they develop an adaptive strategy for a change problem in two ways: Team members' reflection on their actions, such as whether the actions are helpful or unhelpful, and they make decisions about what actions to continue or change (Abrantes et al., 2018). Specifically, shared mental model updating begins with members' awareness of change and their judgement of the appropriateness of a current problem-solving strategy, which leads to a revision of the initial mental model and results in an adapted mental model for the new problem (Santos et al., 2016). When a shared mental model changes, the strategy for solving a problem changes accordingly (Randall et al., 2011). Therefore,

shared mental model updating facilitates the development of strategies to solve new problems. Accordingly, the following hypothesis was developed:

H2: Shared mental model updating is positively related to the development of a team's adaptive strategy.

6.1.3 The moderation effect of goal interdependence

Shared mental model updating includes two processes: members' awareness of change and the alignment of their mental models to fit new situations (Burke et al., 2006; Uitdewilligen et al., 2013). The latter is a proximal antecedent of team adaptation. To form and conduct adaptive strategies, members need to react based on the shared updated mental model. Interaction among team members is a key mechanism that combines individuals' mental models to form a team mental model, which contributes to adaptive strategies and post-change team performance (Cooke, 2015). According to social interdependence theory (Deutsh, 1949), individual members' beliefs about how their goals are related determine the ways they interact as well as how they perform. Members in a cooperative situation perceive their goals as positively related to each other; in turn, they put forth more effort and have more positive relationships in this cooperative environment compared to when they are involved in competitive and individualistic situations (Johnson & Johnson, 2005). In this study, the researcher focused on goal interdependence because it had been established as an important indicator of knowledge sharing (Ghobadi et al., 2017) and positive interpersonal relationships (Johnson & Johnson, 2005), which are essential for the functioning of shared mental model updating.

Cooperative and competitive goal interdependences are two typical types of goal interdependence that teams adopt. Team goal interdependence has a substantial impact on individual members' perception of goals and their surroundings, and it subsequently influences the effort they put forth to achieve individual and team goals. According to Deutsch (1949), with cooperative goal interdependence, which is characterised by positive interdependence, individuals tend to have higher-level reasoning and metacognitive thoughts. These aspects contribute to their awareness of environmental change (Johnson & Johnson, 2005). Moreover, due to the limitations of individual attention, important cues can be ignored even if team members have put in considerable effort. Thus, information sharing is necessary in order to obtain an accurate mental model that represents the problems. As previous research had demonstrated,

cooperative goal interdependence is effective for promoting effective communication (Johnson & Johnson, 2005) and information sharing (Ghobadi et al., 2017). In addition, cooperative goal interdependence is beneficial in facilitating the process of individual members' mental model alignment. Individuals in cooperative situations tend to be more supportive and more willing to contribute their expertise, and they transfer information more frequently and widely (Ghobadi et al., 2017). On the other hand, individuals in competitive situations tend to be more self-interested, keep valuable resources for themselves even though they may not use the resources appropriately, and hide their expertise to inhibit the success of others (Johnson & Johnson, 2005). Empirical evidence has shown that teams with cooperative goal interdependence are better adapted than teams with competitive goal interdependence (Beersma et al., 2009; Johnson et al., 2006). Cooperation, coordination and information sharing are the underlying reasons for such adaptability (Ghobadi et al., 2017). In consideration of the argument expressed in previous paragraphs, cooperative goal interdependence can be inferred as a facilitator for the functioning of shared mental models' updating and enabling of adaptation for new tasks, which leads to the following hypothesis:

H3: Goal interdependence moderates the relationship between shared mental updating and team adaptive strategies. Specifically, cooperative goal interdependence facilitates the process of shared mental model updating and, accordingly, contributes to the formation of team adaptive strategies. On the other hand, competitive goal interdependence inhibits the process of shared mental model updating, leading to the failure of team adaptive strategies' formation.

6.2 Methods

6.2.1 Experimental platform introduction and task analysis

The experiment was a two (between teams) by two (within teams) design. Three-person teams engaged in a card game that required all team members' different role expertise and cooperation to complete the task. Because no experimental task in prior literature met all the requirements to manipulate goal interdependence and stimulate the necessity of team adaptation, this study developed a new task for this purpose, which was adapted from tasks used in previous studies. Cohen and Bacdayan (1994) developed the original form of this card game, which was a two-person game. In the original experimental task, team members had different roles and were limited by the rules of their roles. This game was a rational problem-solving task and could have a

clear solution. Later on, Wang and Zhang (2008) further developed the game by changing it to a three-person game, which was more complex but could be used to capture the interactive processes of cooperation and coordination. The solution for the game was very clear, and this provided reliability for the measurement in this study.

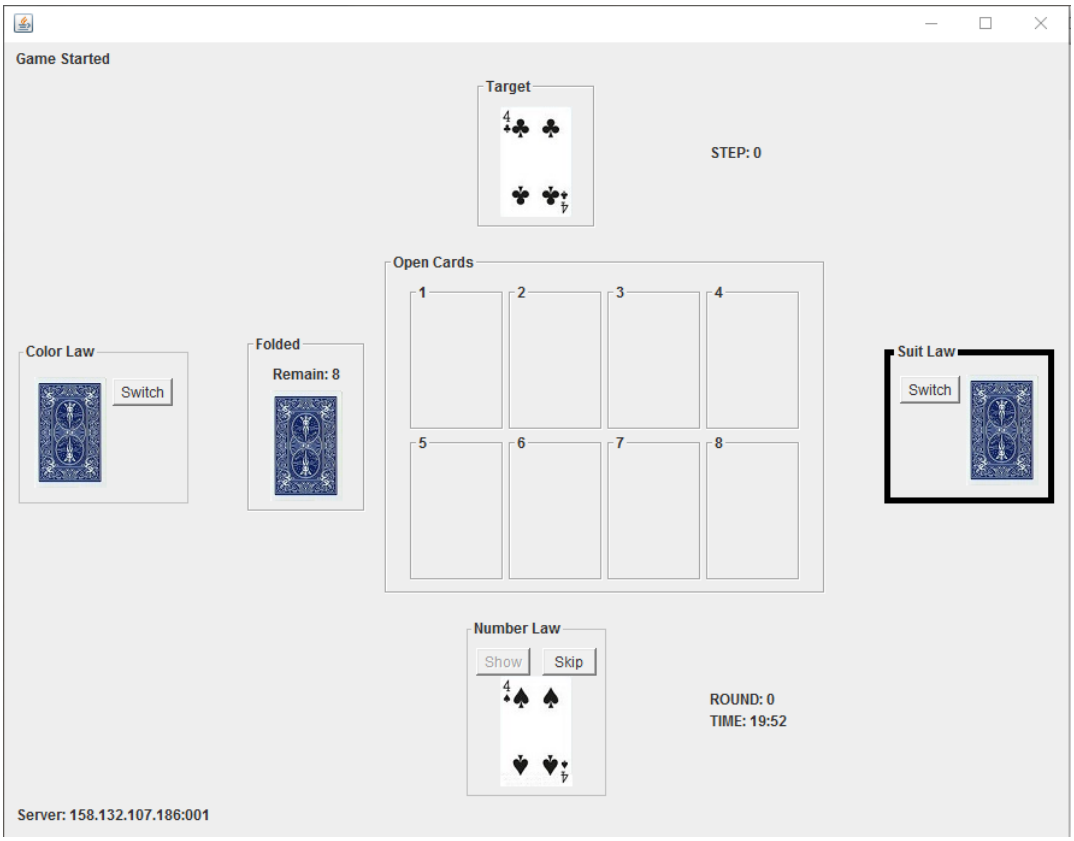
The basic aim of the card game was to move a certain card (i.e. the heart 2) to a certain place (i.e. the target place for club 4). Three team members needed to follow certain rules, including the same suit rule, the same colour rule and the same number rule, respectively. Members who were assigned to follow the same suit rule were only allowed to change their cards with cards of the same suit. Members who were assigned to follow the same colour rule were only allowed to change their cards with cards of the same colour. Members who were assigned to follow the same number rule were only allowed to change their cards with cards of same number.

There were 12 cards in total in this game, including heart 2, 3, 4, club 2, 3, 4, spade 2, 3, 4 and diamonds 2, 3, 4. The interface is shown in Figure 6.1. The contents that appear in the interface include the target place, three members' place, folded card pool, open card pool, total steps, remaining time, switch button, show button and skip button. Every team member was given a card at the beginning of the game, but only two cards could be seen by each of the team members, including club 4 in the target place and one's own card. Apart from the two cards in the hand of the other two members, the remaining eight cards were in the folded card pool. This was consistent with the idea of small random uncertainty influencing team behaviours. When exchanging cards with the folded cards, the rules for the same suit, same colour and same number did not apply, and the card in hand was shown in the open card pool. This was consistent with the idea that information a team received should not be fixed to one expert and should instead be random and re-allocated by team members. The above setting enabled it to be available for re-allocating. This was the function of exchanging cards with other team members. If one was not sure how to allocate, another way to reallocate the resource was to show the card to the public, then the other two team members could decide whether or not to exchange the card.

Accordingly, members had six behavioural choices: 1) to exchange a card with the card in the target place according to the rule assigned to one's role (marked as 'Tar' in the following description); 2) to exchange a card with one in the folded card pool regardless of the exchange rule (marked as 'Inv' in the following description); 3) to exchange a card with one in the open card pool according to the rule assigned to one's

role (marked as ‘Tran’ in the following description); 4) to exchange a card with other members in the team through clicking the ‘switch’ button, after which the one who contacted received a dialogue box showing the information, and he or she accepted (marked as ‘Par’ in the following description) or rejected (marked as ‘Decl’ in the following description) the request; 5) to publicise one’s own card through clicking the ‘show’ button, so that other members could see his or her card (marked as ‘Pub’ in the following description); and 6) to do nothing by clicking the ‘skip’ button (marked as ‘Skip’ in the following description).

Figure 6.1 Interface of Experiment Platform



The criterion for one round’s completion was to move heart 2 to the target place (which was shown as club 4 in the experiment). Teams needed to conduct several rounds of the game within 20 minutes. Steps and time were used to evaluate a team’s performance. In order to better record all the steps, simulative computer software was developed to conduct this game. All the behaviours were counted as one step except for ‘Skip’ and ‘Decl’.

6.2.2 Experimental manipulations

Two main factors needed to be manipulated. One was goal interdependence, which

was a different factor among teams; the other was the change that aimed at triggering the necessity for team adaptation, and this should be a different factor within teams.

Different instructions for reward that were consistent with previous studies (Beersma et al., 2009; Johnson et al., 2006) were used for the manipulation of goal interdependence. The cooperative goal interdependence was manipulated as a team-level reward and was presented as follows: 'The prize will be given to the best team'. The competitive goal interdependence was manipulated as an individual-level reward and was presented as follows: 'The prize will be given to the best player'. A 'best player' was identified based on two requirements: the player's team had won, and the player had contributed the most (i.e. he/she completed the final step). Detailed instructions are presented in Appendix 5-1.

In this experimental study, a change in the performance evaluation criteria triggered team adaptation. Since changes occurred within a team, only two different sets were needed. Task A involved completing as many rounds as possible in 20 minutes, while Task B involved completing at least 10 rounds in the lowest number of steps possible. It was assumed that the change of tasks between A and B could trigger the necessity of team adaptation (Porter et al., 2010; Randall et al., 2011).

Table 6.1 (below) shows the four settings according to the two manipulations. In order to exclude the learning effect, the combinations of Settings 1/2 and 3/4 (i.e. within team change) were randomly assigned, which meant some control teams would experience the shift from Task A to B while others would experience the shift from Task B to A. The same happened in all experimental teams.

Table 6.1 Experimental Settings

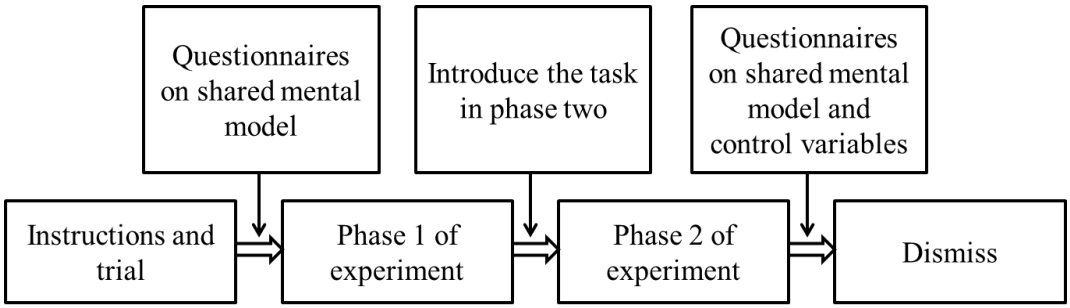
	Task A	**Task B**
Competitive goal interdependence	Setting 1	Setting 2
Cooperative goal interdependence	Setting 3	Setting 4

6.2.3 Procedures

When they arrived at the laboratory, participants were randomly assigned to different teams and were given instructions on how to play the game. In order to exclude the influence of familiarity, those people who come together were assigned into different teams purposely. They were then allowed to play for two minutes in order to become familiar with the task. After the two-minute trial, all participants were given five minutes to complete questionnaires on the shared mental model. The formal phase of the experiment began after their completion of the questionnaires (shown in

Appendix 5-2). After completing the first phase, there was a break to give instructions on the second phase of the experiment. Each round lasted for 20 minutes, and the task setting was one of the four settings described above. After these two rounds, questionnaires of control variables and shared mental model were distributed to the participants for completion. The experimental study process is shown in Figure 6.2.

Figure 6.2 Flowchart of the Experimental Process



6.2.4 Measurement

Team performance. Team performance was measured separately for Task A and Task B since Task A involved completing as many rounds as possible in 20 minutes while Task B involved completing at least 10 rounds in the lowest number of steps. Their performance was evaluated differently. The performance of Task A was the total rounds completed within 20 minutes, and the performance of Task B was the total steps used to complete the initial 10 rounds.

Team adaptation. In this study, the operationalised definition of 'team adaption' was the effective changes in strategy after a task change. It means teams that have high score on team adaptation employ effective strategies for both tasks. According to the task analysis, three types of behaviours were efficient for the final success of Task A (i.e. completing as many rounds as possible): 1) decreasing the behaviour of exchanging cards with the open card pool (-TranA); 2) increasing the behaviour of exchanging cards with the target place (+TarA); and 3) not declining other members' requests for card exchange (-DelA). Four types of behaviours were recognised as effective for the final success of Task B, i.e. to complete at least 10 rounds in as few steps as possible. They were 1) increasing the behaviour of exchanging cards with the target place (+TarB); 2) decreasing the behaviour of exchanging with folded cards; 3) decreasing the behaviour of exchanging cards with the open card pool (-TranB); and 4) increasing the behaviour of skip (+SkipB). Teams that completed more rounds may have used more steps to do so; therefore, the ratio of each behaviour in each round was calculated to represent the

task strategy. Therefore, the adaptive strategy of Task A was calculated as the ratio of the three behaviours, the adaptive strategy of Task B was calculated as the ratio of the four behaviours, and team adaptation was calculated as the sum of these behaviours in the two phases.

Adaptive strategy of task A = (TarA -TranA-DelA)/SumA

Adaptive strategy of task B = (TarB+SkipB-TranB-InvB)/SumB

Team adaptation = (TarA -TraA-DelA)/SumA+ (TarB+SkipB-TranB-InvB)/SumB

The correlation between the adaptive strategy of Task A/B and the performance of Task A/B supported the validity of the task analysis (for Task A, $r=.64$, $p<0.001$; for Task B, $r=-.52$ $p<0.001$). The results showed that teams that employed adaptive strategies completed more rounds within 20 minutes and required fewer steps to complete 10 rounds.

Shared mental model and updating. The shared mental models' similarity and accuracy were calculated along with shared mental model updating. The original data were members' mental models that described the possible route for completing the task. The instruction for Task A was 'please write down as many routes as possible to complete the task', and the instruction for Task B was 'please write down all the potential routes to complete the task as quickly as possible'. Each member's mental model data for completing the related tasks could be obtained by responding to the two prompts. Based on the definition of 'shared mental model similarity' (Mohammed et al., 2010), each member's mental model was compared with the other two. The shared mental model similarity was calculated as the average of the three comparisons. For example, i, j and k were members of a team. First, i's mental model was compared with j and k to obtain similarity between ij and ik. Then, j's mental model was compared with k to obtain similarity between jk. Finally, the average of ij, ik and jk was used to represent shared mental data similarity. The calculation function was as follows:

Shared mental model similarity = (similarity between i & j + similarity between i &k + similarity between j & k)/3

According to the definition of 'shared mental model accuracy' (Mohammed et al., 2010), this study compared each member's mental model with the expert one. The latter was built based on the task analysis. As for Task A, all the possible routes with up to five cards were written down as the expert mental model since participants only had five minutes to write down their mental models. As for Task B, routes with only three cards were written down as the expert mental model. Thereafter, the researchers

calculated comparison data for each member and obtained the average in the team-level to represent shared mental model accuracy. The calculation function was as follows:

Shared mental model accuracy = (member i's mental model accuracy + member j's mental model accuracy + member k's mental model accuracy)/3

Shared mental model updating was the correct change according to different tasks, and it was different from shared mental model differences (Uitdewilligen et al., 2013). The first step involved calculating the differences of each member's mental models between session one and session two. Then a '+1' or '-1' was assigned to the difference value according to the direction of change. For example, a team that conducted Task A in the first session and Task B in the second session should have different mental models based on the task. When a team member changed his mental model so that it was more similar to Task B's expert model, a '+1' was assigned to the difference value of two sessions. When a team member changed his mental model to the opposite direction, a '-1' was assigned to the difference value of the two sessions. Lastly, the average of three values in a team was used to represent shared mental model updating. The calculation functions were as follows:

Member i/j/k's mental model updating = differences between two mental models in the two phases * (-1 or +1)

Shared mental model updating = (member i's mental model updating + member j's mental model updating + member k's mental model updating)/3

Control variables. Control variables included game experience, gender and education background. Game experience was measured using three items ('The degree of similarity between the game I have played/seen/known with this game is', rating from 1-5). Gender was thought to influence the results because males were usually better at solving computational problems than females, so this study included the ratio of males in each team as the control variable. Education background was thought to influence the results due to a similar reason. In other words, those with background of science and engineering were usually better at solving the problems in this study. Therefore, this study included the ratio of those with a science and engineering background in each team as the control variable.

All the measurements are presented in Appendix 5-2.

6.2.5 Sample Description

A total of 210 students from Zhejiang University in China took part in the

experiment. They responded through an open forum of the university. They were randomly arranged into 70 teams, with three members on each team. These 70 teams were assigned to different experimental settings, with 35 experiencing a cooperative goal interdependence situation and 35 experiencing a competitive goal interdependence situation. Each team consisted of three team members with a different assigned 'specialty' (i.e. the same colour rule, the same suite rule and the same number rule). In order to exclude the effect of familiarity, students who came to the laboratory together were assigned to different teams. The three members on the same team were arranged to sit at different rows, so that they could not see each other or talk to each other.

Since participants had to complete at least 10 rounds for Task B (i.e. use the lowest number of steps to complete 10 rounds), three teams failed this task. In addition, due to the problem of an experimental platform and missing answers on questionnaires, five other teams were dropped from the dataset, resulting in 62 teams in total. Information on the sample is presented in Table 6.2.

Table 6.2 Background Information on the Experimental Sample

Indicators	Information	Number	Proportion
Gender in sample	Male	97	52.2%
	Female	89	47.8%
Gender composition in teams	Three male members	5	8.1%
	Two male and one female members	30	48.4%
	Two female and one male members	22	35.5%
	Three female members	5	8.1%
Major in sample	Mathematics-related major	110	59.1%
	Humanity	13	7%
	Social science	20	10.8%
	Agriculture and medical science	43	23.1%
Major composition in teams	Three members with mathematics-related major	14	22.6%
	Two members with mathematics-related major	24	38.7%
	One member with mathematics-related major	20	32.3%
	No one with mathematics-related major	4	6.5%
Total number	62 teams with three members in each	186	100%

As shown in Table 6.2, within the valid dataset, 97 males and 89 females participated in this study, resulting in 62 three-person teams. Of these teams, five were

composed of three male members, 30 were composed of two males and one female member, 22 were composed of one male member and two females, and the remaining five had three female members. No significant effect was found due to the gender composition according to the ANOVA result ($F(3,58)=1.19$, n.s.). In terms of the major composition, more than a half majored in a mathematics-related specialty (59.1%), and the others were humanity (7%), social science (10.8%) and agriculture/medical science (23.1%). The effect of the major composition was also examined through an ANOVA. The results did not show any significant differences among the four categories of major composition ($F(3,58)=1.44$, n.s.).

6.3 Results

6.3.1 Descriptive analysis

Table 6.3 presents the results of the descriptive analysis; it shows the general characteristics of the sample as well as the preliminary results of this study. Information in this table includes correlations among the main variables, means and standard deviations for the whole sample, and teams with a competitive goal interdependence and teams with a cooperative goal interdependence separately. According to the descriptive statistics, the following can be concluded: (1) The performance of Task A and Task B was higher in teams with cooperative goal interdependence; and (2) teams with cooperative goal interdependence demonstrated better team adaptation and shared mental model updating. According to the correlation coefficients, shared mental model updating was positively related to team adaptation ($r=.71$, $p<0.01$). Moreover, the data in Table 6.3 indicate that shared mental model accuracy and similarity were related to task performance for Task A, while only accuracy was related to task performance for Task B. The above results provided preliminary support for the hypotheses.

Table 6.3 Correlation Table

	Mean (S.D.)	1	2	3	4	5	6	7
1.SMMA_accuracy	.30 (.18) **.26 (.11)** *.34 (.23)*							
2.SMMA_similarity	.35 (.17) **.31 (.17)** *.39 (.17)*	.07						
3.SMMB_acccuracy	.29 (.15) **.26 (.16)** *.31 (.13)*	-.40**	.24					
4.SMMB_similarity	.33 (.15) **.34 (.18)** *.31 (.12)*	.06	.10	.20				
5.TaskperA (total rounds)	32.77 (25.19) **18.26 (7.92)** *47.29 (28.14)*	.40**	.29*	-.004	-.17*			
6.TaskperB (Total steps)	104.16 (28.38) **112.13 (29.08)** *96.19 (25.70)*	-.02	.12	-.35*	-.11	-.15		
7.SMMU	.23 (.40) **.00 (.37)** *.45 (.29)*	.14	.15	.08	-.27*	.49*	-.18	
8.Team adaptation	.38 (0.20) **.25 (0.14)** *.51 (0.16)*	.14	.14	.23	-.17	.64**	-.52**	.71**

*p<0.05; **p<0.01

The second row shows the mean and standard deviation of the variables.

The numbers in brackets ( ) are the standard deviation.

The first line of the mean and standard deviation is for the total sample; the second line of the mean and standard deviation is for teams with a competitive goal interdependence and is in **bold**; and the third line of mean and standard deviation is for teams with a cooperative goal interdependence and is in *italics*.

SMMA accuracy = shared mental model accuracy for Task A;

SMMA similarity = shared mental model similarity for Task A;

SMMB_accuracy = shared mental model accuracy for Task B;

SMMB_similarity = shared mental model similarity for Task B;

Taskper A (total rounds) = performance in Task A;

Taskper B (total steps) = performance in Task B;

SMMU = shared mental model updating.

6.3.2 Hypothesis testing

The linear regression model was used to test the simple effect hypothesised in this study. Table 6.4 reports the regression results. The goal interdependence was controlled when analysing the effect of the shared mental model's accuracy and similarity on task performance. The results showed no significant relationship between the shared mental model and task performance except for the relationship between shared mental model accuracy and the performance of Task A. The coefficient of the shared mental model's accuracy for Task B was marginally significant, but the explained variance it added to the performance of Task B was not substantial enough to indicate its impact ($\triangle R^2$=.042, n.s). Accordingly, Hypotheses 1a and 1b were not supported. The second hypothesis indicates a positive relationship between shared mental model updating and team adaptation. Based on the results of M7 in Table 6.4, Hypothesis 2 was supported (r=.501, $p<0.01$).

Table 6.4 Regression Results of the Experimental Study

Predictor	**Team outcomes**							**Shared mental model updating**	
	Task A (total rounds)		Task B (total steps)		Team adaptation				
Models	M1	M2	M3	M4	M5	M6	M7	M8	M9
Game experience	.020	.033	.021	-.009	-.069	-.107	-.075	-.035	-.063
Task sequence	.247	.172	.681	.651	.497**	.055	-.019	.478**	.149
Major composition	.038	.045	.097	.136	.007	-.030	-.058	.083	.056
Gender composition	-.067	-.090	.013	-.002	-.146	-.094	-.115	.003	.042
Goal interdependence (dummy variable)	.397*	.352*	-.773**	-.700**		.628**	.394**		.467**
SMMA_similarity		.143							
SMMA_accuracy		.275*							
SMMB_similarity				.092					
SMMB_accuracy				-.217					
SMMU							.501**		
Total R^2	.371	0.460	0.318	0.360	.265	.456	.623	.231	.337
$\triangle R^2$		0.099		0.042		.191	.167		.106
F	6.60**	6.56**	5.22**	4.34**	5.14**	9.39**	15.12**	4.29**	5.68**

*p<.05; **p<.01

SMMA accuracy = shared mental model accuracy for Task A;

SMMA similarity = shared mental model similarity for Task A;

SMMB_accuracy = shared mental model accuracy for Task B;

SMMB_similarity = shared mental model similarity for Task B;

SMMU = shared mental model updating.

The third hypothesis focused on the moderation effect of goal interdependence. In other words, teams with a cooperative goal interdependence can better adapt to the changed task through facilitating shared mental model updating; teams with a competitive goal interdependence cannot adapt to the changed task since the shared mental model updating process was inhibited. Therefore, the regression model of the shared mental model and team adaptation was compared with two different goal interdependence types. The results are presented in Table 6.5. The data is this table indicate that shared mental model updating was significantly related with team adaptation for cooperative goal interdependence (r=.629, p<0.01); while the relationship between shared mental model updating and team adaptation was not significant for competitive goal interdependence (r=.288, n.s.). This result supported Hypothesis 3.

Table 6.5 Regression Results with Different Goal Interdependence Types

	Team adaptation			
Predictor	Cooperative Goal Interdependence		Competitive Goal Interdependence	
Models	M10	M11	M12	M13
Game experience	-.448*	-.245	.034	.029
Task sequence	.295	.016	-.047	-.009
Major composition	.084	-.087	-.080	-.058
Gender composition	.125	.052	-.555**	-.497**
SMMU		.629**		.288
Total R^2	.242	.525	.329	.406
$\triangle R^2$		.283*		.077
F	2.076	5.524**	3.19*	3.42*

*p<.05; **p<.01

6.4 Summary

The results of this experimental study demonstrated the shared cognitive mechanism for intentional team adaptation as well as the boundary condition of goal interdependence. The insignificant relationship between the shared mental model and

team performance indicated the ineffectiveness of shared cognition in predicting team performance, thus providing indirect evidence for the necessity of team adaptation research. Shared mental model updating was examined as the indicator of team adaptation, which obtained support from the experimental data. Additionally, teams that adopted cooperative goal interdependence were more adaptive than teams that adopted competitive goal interdependence. The internal validity of intentional team adaptation theory was achieved through this experimental study. A field study was conducted to provide support for the external validity of intentional team adaptation theory, which is reported in the next chapter.

CHAPTER 7 STUDY IV: FIELD STUDY OF THE DISTRIBUTED COGNITIVE MECHANISM FOR INTENTIONAL TEAM ADAPTATION UNDER DIFFERENT LEVELS OF TASK INTERDEPENDENCE

This chapter reports the results of Study IV, which examined the distributed cognitive mechanism in intentional team adaptation. Specifically, the relationship between intentional team adaptation (ITA) and team adaptive performance was analysed, along with the mediating effect of the transactive memory system and the moderating effect of task interdependence. This study was designed to provide external validity for the theory of intentional team adaptation as well as to respond to the research problems of 'how to achieve intentional team adaptation' and 'the boundary condition of intentional team adaptation'. Therefore, a questionnaire-based survey study with a sample of production teams that experienced equipment replacement problems was conducted. This chapter is structured as follows: First, it discusses the hypotheses for the problem of 'how to achieve adaptation after equipment replacement' , which were developed based on intentional team adaptation theory and transactive memory system theory (Wegner, 1987; Lewis, 2003). Second, it details the empirical study that was designed to examine the proposed hypotheses. Third, the findings of this study are reported.

7.1 Hypothesis Development

Equipment replacement is generally related to issues of team adaptation. These issues are common in organisations' development lifecycles. In addition, production teams can take measures to prepare for new equipment installation. Therefore, this adaptation situation is quite suitable for examining intentional team adaptation theory. Since it is difficult to find situations where team adaptation is triggered as a result of certain changes and affects a relatively large number of teams, this study was conducted in situations of equipment replacement in the manufacturing industry.

Equipment replacement usually generates a series of people-related problems, such as the rearrangement of a workforce and the need to learn new technology and

develop new modes of cooperation. To take full advantage of the newly installed equipment, it is necessary to develop an efficient pattern of interactions between production teams and their production tools, i.e. new equipment. Such a process is the manifestation of intentional team adaptation. In this section, hypotheses related to adaptation after equipment replacement are proposed.

7.1.1 Intentional team adaptation and team adaptive performance

Team adaptation to equipment replacement can be divided into three phases (Hale et al., 2016). Phase 1 (disruption) is characterised by a 'flux in coordination such that prior states and processes become disordered and performance decrease' (p. 908). Phase 2 (recovery involves performance improvement, reconfiguration, socialise replacement and new knowledge acquisition. Phase 3 focuses on stabilisation and is the end of the adaptation process. This study suggested that the most important contributor in the process is intentional team adaptation (ITA), which guides individual members' skill development and coordinated behaviours.

ITA manifests in three aspects: Behaviourally, team members make an agreement and commitment to be a part of a team and to act jointly. Affectively, team members have positive work relationships and private relationships with each other as well as with their team. Cognitively, team members have sufficient knowledge and skills to solve problems, and the team goal and task requirements direct their behaviours (Zhang & Yue, 2016). In the case of equipment replacement, ITA enables members to act as a single body, which decreases the presence of chaos and lowers the coordination costs in the recovery stage. Joint production motivation theory, which Lindenberg and Foss (2011) proposed, indicates that when members view themselves as part of the collective and knowledge of their functional roles and corresponding responsibilities, this collective shows higher consensus and better performance. Affective links among team members enabled information accessibility and backup behaviours, contributing to knowledge sharing and coordination, which facilitated the development of joint production motivation. Goal-directedness guided the whole process (Trestman, 2012), thus ensuring efforts made in knowledge sharing and information analysis result in better performance after equipment replacement.

On the basis of this argument, ITA can accelerate adaptation to equipment replacement, leading to better performance and a shorter time to adapt. Accordingly, the following was hypothesised:

H1: ITA is positively related to team adaptive performance in the case of equipment replacement. Additionally, an adaptive team experiences less performance loss and time spent in the disruption stage, higher performance growth and less time spent in the recovery stage.

7.1.2 Transactive memory system as a mediation mechanism

The functional outcome of intentional adaptation to equipment replacement relies on the process of proactive learning. Team learning was defined as changes in collective knowledge (Kozlowski & Bell, 2008). Specifically, this study used the transactive memory system as an indicator of team learning. Two main reasons were considered: Firstly, the theory of transactive memory system proposes that knowledge is distributed among team members and that the system is formed through coding, storage and retrieval, which met the basic idea of team learning. Secondly, the transactive memory system has been recognised as an important antecedence for production teams or those teams that carry out assembly tasks (Lewis & Herndon, 2011; Wegner, 1987), which met the idea of testing team learning after equipment replacement in production teams. In this section, the mediating role of transactive memory system was emphasised for intentional team adaptation.

Transactive memory system (TMS) is 'a cooperative division of labour for learning, remembering, and communicating relevant team knowledge' (Lewis, 2003, p. 587). Teams with highly functioning TMS are able to obtain accurate information to complete their tasks in a short amount of time through learning, remembering and communicating relevant knowledge (Peltokorpi & Hood, 2018). It is argued to be more efficient in dynamic environment since members are more likely to consult others for additional information on the changing task environment (Ren & Argote, 2011). For the efficient functioning of TMS, it is important to understand who is in charge of what, thus making it clear for coding, storage and retrieval (Lewis & Herndon, 2011). ITA contributes to the development of an efficient transactive memory system through shared intention, providing access to private resources and guiding the development of the system so that it is fit for problem solving in novel situations.

For production teams after equipment replacement, the first advantage TMS brings is saving the cost of coordination since everyone knows who is in charge of what and where to look for help (Ren & Argote, 2011). Another advantage is the appropriate distribution of the workforce, which can decrease the individual team members' burden

related to learning new knowledge and new skills (Su, 2012; Moreland, 2006). This system also enables quick responses to change through initial arrangements of responsibility and credibility among workers in the same production line (Lewis, 2004). Taking all this evidence together, ITA is necessary for developing a transactive memory system that contributes to the adaptation to equipment replacement. Thus, the following hypothesis was developed:

H2: The transactive memory system mediates the relationship between ITA and team adaptive performance.

7.1.3 The moderation effect of task interdependence

Research on team adaptation is in the preliminary stage of development, and the boundary of the theory has not been established (Maynard et al., 2015; Christian et al., 2017). Among all the potential interventions, characteristics of a task have drawn the most attention, especially for task interdependence. Task interdependence is the task structure in which 'team members work closely with each other, must coordinate their activities frequently and within which the way one member accomplishes her or his task has strong implications on the work process of other team members' (Hertel et al., 2004, p. 6). Previous studies on team adaptation have typically examined relationships within moderate to high levels of task interdependence. However, researchers have suggested generalising the conclusion with lower levels of interdependence (Burke et al., 2006). Moreover, a recent study found that task interdependence may influence the process of team coordination, resulting in structural adaptation and cross-disciplinary knowledge creation (Ben-Menahem et al., 2016). Therefore, this study examined whether the relationship still holds for different tasks with different levels of interdependence.

As was argued in previous sections, ITA contributes to better performance in novel situations. The implicit assumption is that coordination and direction matter for the completion of a team task. However, the requirement of coordination differs based on the level of task interdependence. Accordingly, different relationships between ITA and team adaptive performance may exist for different tasks. For tasks with low interdependence, there is less of a requirement for coordination (Bachrach et al., 2007). Each member's work performance is largely based on his/her own effort, and no other information is needed to complete one's own work. Even when members' work-related tools are replaced or changed, team performance will not suffer greatly if individual

members still have related knowledge and skills. For tasks with high interdependence, team performance is determined based on each team member's work, the ways that others work and their access to related information (Gully et al., 1995). An individual member's work cannot be completed with help from others since his/her work is just a small piece of the whole task. In the situation of equipment replacement, as task interdependence increases, related equipment replacement may be more complex, which indicates a higher requirement for coordination. Therefore, the effect of sharing intention and goal-directedness will be more significant. Based on this argument, the following hypothesis was developed:

H3: Task interdependence moderates the relationship between ITA and adaptive team performance.

Since the mediation effect and the moderation effect coexist, the mixed effect should also be examined. Different levels of task interdependence may moderate the mediation effect of transactive memory system. For teams with high interdependent tasks, the completion of a team task requires members' cooperation and behavioural alignment. In the situation of task changes or other environmental changes, teams need to gather information to identify cues and make plans for novel situations. The processes of coding, storage and retrieval help teams quickly and accurately process information. Therefore, the function of transactive memory system is highly important for interdependent teams' achieving of team adaptation. The transactive memory system influences team adaptation through situation assessment, skill coordination and flexible retrieval. For teams that carry out tasks with low interdependence, the function of the transactive memory system is less important and will not influence their effectiveness. Work completion relies on individual members' independent behaviour, and one can handle all the problems of his/her work with his/her own expertise. The knowledge that is required to perform work is sufficient for dealing with possible challenges in the environment. Moreover, the development of TMS relies on task interdependence. As argued in a recent review of the transactive memory system, the key to TMS effectiveness is the development of an interdependent cognitive division of labour (Peltokorpi & Hood, 2018). Once task interdependence is low, the interdependent cognitive division of labour is not important for team performance. Therefore, only teams involved in highly interdependent tasks related to experienced equipment replacement would rely on the effectiveness of the transactive memory

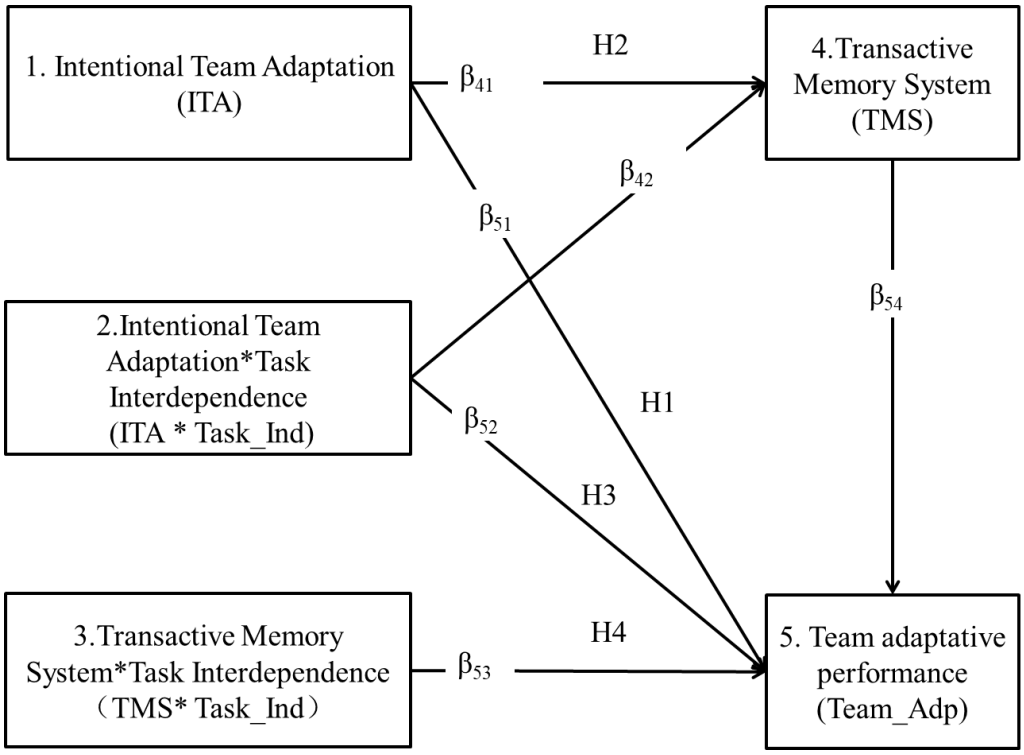
system to achieve adaptation. Thus, the following moderated mediation hypothesis was proposed:

H4: Task interdependence moderates the mediation effect of the transactive memory system. Specifically, as task interdependence increases, the amount of mediation will be larger. The difference in the indirect effect between low task interdependence and high task interdependence is significant.

7.1.4 Hypothesised Model and Equations

According to the theoretical argument, the hypothesised model is depicted in Figure 7.1. This research model included both the moderated mediation effect and the mediated moderation effect; thus, the moderation effect for the relationship between ITA and team adaptive performance was curvilinear rather than linear (Muller, Judd, & Yzerbyt, 2005). The complex effect was examined through several regressions (Holland et al., 2016).

Figure 7.1 Hypothesised Model with Both Mediation and Moderation



Related equations for examining the hypothesised model are listed as follows:

$Team\_Adp=\beta_{51\text{-}1}ITA+d_1$（H1）

$TMS=\beta_{41}ITA+\beta_{42}ITA*Task\_Ind+d_2$

$Team\_Adp=\beta_{51\text{-}2}ITA+\beta_{54\text{-}1}TMS+d_3$ （H2）

$Team\_Adp=\beta_{51\text{-}3}ITA+\beta_{52\text{-}1}ITA*Task\_Ind+d_4$（H3）

$Team\_Adp=\beta_{51}ITA+\beta_{54}TMS+\beta_{52}ITA*Task\_Ind+\beta_{53}TMS * Task\_Ind+d_5$（H4）

In these equations, β are the coefficients, 'Team_Adp' is short for team adaptative performance, TMS is short for transactive memory system, 'ITA' is short for Intentional Team Adaptation, and 'Task_Ind' is short for task interdependence.

Accordingly, in order to confirm Hypothesis 1, $\beta_{51\text{-}1}$should be significantly different from zero.

In order to examine the direct mediation effect (H2), the following conditions should be met: (1) $\beta_{51\text{-}1}$ should be significantly different from zero; (2) β_{41} should be significantly different from zero; and (3) $\beta_{54\text{-}1}$ should be significantly different from zero. If $\beta_{51\text{-}2}$ is also significantly different from zero, TMS is considered to have a partial mediation effect. If $\beta_{51\text{-}2}$ is no longer significantly different from zero, TMS is considered to have a full mediation effect.

In order to examine the mixed model of both the mediation effect and the moderation effect, the interaction of TMS and task interdependence as well as ITA and task interdependence are included in the same equation. The direct moderation effect would be supported if $\beta_{52\text{-}1}$ was significantly different from zero. The moderated mediation effect would be supported if both β_{42} and β_{53} are significantly different from zero.

Examinations of the hypotheses were conducted based on the above equations.

7.2 Methods

7.2.1 Sample

Factories that met the following requirements were invited to join this study: 1) had experienced equipment replacement in the past year; 2) had at least one production line; 3) teams with more than three members completed the production work; and 4) had minimal turnover within the adaptation process after equipment replacement. For each factory selected, the researcher visited its manufacturing plant and explained the study to each worker. Some of them were interested in participating in the study since it would help them improve their performance after equipment replacement. Questionnaires were distributed to those people with the guarantee of anonymous data collection.

Data on performance and task characteristics were collected from leaders, while data about the team state (including ITA and transactive memory systems) were collected from team members to avoid common method biases (Podsakoff et al., 2003). In total, 276 workers and their team leaders participated in this study. Based on this sample, 276 questionnaires were collected, 60 from team leaders and 216 from team members. A total of 60 teams with an average of 3.6 members participated. They were distributed across China under the umbrella of the manufacturing industry. Since most of the investigated factories require heavy work, production teams were mainly composed of young males (80.1%). The average age was 27.8 years (*SD*=5.9), and the average work experience was 73.4 months (*SD*=47.6 months). Due to the labour-intensive work requirement, workers in the manufacturing plants were not usually well educated, with 58.8% having the education experience of junior high school and 31% with a high school education. Only 10.2% had college diplomas.

7.2.2 Measurement

Team adaptativen performance. This study calculated team adaptive performance as a ratio of the time and performance change, i.e. the difference between the final performance level after adaptation and the original performance level before equipment replacement. This study further employed four indicators to explore adaptation performance in detail: 1) performance loss, i.e. the difference between the bottom performance level and the original performance level; 2) time spent in the disruption stage, i.e. recovery time, shortened to 'time1' in the following; 3) performance growth, i.e. the difference between the highest performance level and the original performance level; and 4) time spent in the recovery stage, i.e. stabilisation time, shortened to 'time2' in the following. Both performance loss and performance growth were compared with the original performance level before equipment replacement. Since the performance data were collected across different industries that have different units and standards for performance, the leaders were asked to provide the ratio of their team performance compared with the industry's average level. The time spent on adaptation was calculated in the same way.

Intentional team adaptation. The measurement tool for ITA was a 5-point Likert scale with 12 items, as discussed in Chapter 5. Team members evaluated this scale, and it was then aggregated to the team level. The mean of r_{wg} (short for within-group interrater reliability) was 0.95, and all the teams had r_{wg} above 0.9, which was

considered appropriate for aggregation (James et al., 1984). Furthermore, ICC (1) and ICC (2) were both calculated to provide further evidence for aggregation. The results support the action of aggregation (ICC (1) =0.75; ICC (2) =0.94). ICC (1) is the indicator of reliability of the scores within the group, and ICC (2) is the reliability of the mean group score. Cronbach's alpha for this study was 0.94. Since the scale was newly developed, this study also ran a confirmatory factor analysis, and the results showed a good fit for the one-factor model (χ^2/df= 3.622, CFI=0.052, TLI=0.92, RMR=0.92).

Transactive memory system. A 15-item scale, which Lewis (2003) developed and Zhang et al. (2006) further translated, was used to measure the transactive memory system. Sample items included the following: 'Each team member has specialised knowledge of some aspect of our teamwork'; 'I was comfortable accepting procedural suggestions from other team members'; and 'Our team had very few misunderstandings about what to do'. Respondents rated each item from 1 (strongly disagree) to 5 (strongly agree). The mean of r_{wg} was 0.94, and all the teams had r_{wg} above 0.9, which was considered appropriate for aggregation. Furthermore, ICC (1) for the sample was 0.49, while ICC (2) for the sample was 0.74, providing further support for the aggregation. Therefore, the 13 items were aggregated to obtain the score of the transactive memory system for each team. Cronbach's alpha for this study was 0.85, which was acceptable for a mature scale's credibility.

Task interdependence. This study adopted a 7-item scale from Hertel, Konradt and Orlikoski (2004) and Bachrach et al. (2007), which was designed for team leaders to assess the interdependence of teams' tasks. Leaders were asked to rate the statements from 1 (strongly disagree) to 5 (strongly agree). Sample items included the following: 'Group members work closely with each other in doing their work' and 'To achieve high performance, it is important to rely on each other to get information and advice'. Cronbach's alpha for this scale was 0.897.

Control variables. Since the sample consisted of workers from different factories in the manufacturing industry, this study controlled for several organisation-level and team-level variables, including organisation scale (total number of employees), annual production value, history (years of foundation) and turnover rate of teams. History was measured as the operation years of the investigated plant. By emphasising the investigated plant, this study was able to exclude biases from some large companies that had a variety of businesses. The turnover rate was measured using a 5-point item,

i.e. ‘Please evaluate the level of your team members’ turnover: 1-very low; 2-relatively low; 3-average; 4-relatively high; 5-very high)’.

Detailed scales of task interdependence and team adaptation are presented in Appendix 6-1. Detailed scales of ITA and transactive memory systems are presented in Appendix 6-2. Both were in Chinese but were translated into English for easy reference.

7.3 Hypotheses Testing

7.3.1 Descriptive statistics

Table 7.1 presents the means, standard deviations and zero-order Pearson correlations of all the key variables. Cronbach’s alpha appears along the diagonal in the brackets. In Table 7.1, some preliminary support can be found for the hypotheses. First, ITA was positively correlated with team adaptive performance ($r=.507$, $p<0.01$) and was negatively correlated with time1 ($r=-.544$, $p<0.01$) as well as time2 ($r=-.606$, $p<0.01$). Second, ITA was positively correlated with transactive memory system ($r=.655$, $p<0.01$). Third, the transactive memory system was positively correlated with team adaptive performance ($r=.519$, $p<0.01$) and negatively correlated with time1 ($r=-.582$, $p<0.01$) and time2 ($r=-.528$, $p<0.01$). However, both ITA and the transactive memory system were unrelated to performance loss and performance growth.

Table 7.1 Results of Descriptive Analysis and Correlations

Variables	Mean	S.D.	1	2	3	4	5	6	7
1. ITA	3.59	.77	(.94)						
2. Transactive memory system	3.85	.41	.655**	(.85)					
3. Task interdependence	3.73	.97	-.312*	-.200	(.897)				
4. Team adaptive performance	.31	.52	.507**	.519**	.053				
5. Performance loss	.16	.11	.032	.116	.219	.228			
6. Recovery time	0.99	.45	-.544**	-.582**	.256	-.587**	-.004		
7. Performance growth	.26	.19	.038	.158	.033	.518**	.153	-.248	
8. Stabilisation time	1.20	.73	-.606**	-.528**	.344**	-.521**	.052	.691**	.021

** $p < 0.01$, * $p < 0.05$

Since the correlation between ITA and transactive memory system was relatively high, this study ran an extra analysis to examine the discriminant validity and common method bias (Podsakoff et al., 2003). The results of the CFA showed that a two-factor model better fits the data than a one-factor model (for the two-factor model: $\chi 2/df=3.245$, RMR=.059, CFI=.90, IFI=.90; for the one-factor model: $\chi^2/df=5.145$, RMR=.110, CFI=.612, IFI=.615), indicating the discriminant validity of the two constructs. Furthermore, five factors were produced through EFA with the former two accounting for 30% and 20% of the variance respectively, indicating that common method bias was not serious.

7.3.2 Test of the hypotheses

A linear regression analysis with a stepwise method was employed in this study to test the hypotheses. Table 7.2 presents the model summaries, and Tables 7.3-7.5 present the regression results.

Table 7.2 Summaries of the Regression Models

Test of hypotheses	Models	Names
	M1, M6, MA/B/C/D 1	Regression models of control variables and dependent variables
H1	M1-2	Main effect model of ITA and team adaptive performance
	MA1-2	Main effect model of ITA and performance loss
	MB1-2	Main effect model of ITA and performance growth
	MC1-2	Main effect model of ITA and time1
	MD1-2	Main effect model of ITA and time2
H2	M7	Relationship model of ITA and TMS
	M4	Mediation effect model of TMS on ITA and team adaptive performance
	MC4	Mediation effect model of transactive memory system on ITA and time1
	MD4	Mediation effect model of transactive memory system on ITA and time2
H3	M3	Moderation effect model of task interdependence on ITA and team adaptive performance
	MC3	Moderation effect model of task interdependence on ITA and time1
	MD3	Moderation effect model of task interdependence on ITA and time2
H4	M5 (with M8)	Moderated mediation effect model on ITA and team adaptive performance
	MC5	Moderated mediation effect model of ITA and time1
	MD5	Moderated mediation effect model of ITA and time2

7.3.2.1 Test of hypothesis 1: main effect

Hypothesis 1 proposed that ITA was positively related to team adaptive performance. As shown in Table 7.3, for M1 and M2, the main effect was supported ($\beta=0.482$, $p<0.05$).

Table 7.3 Regression Results of ITA, Transactive Memory System and Team adaptive performance

Dependent Variables	Team adaptive performance					Transactive Memory System		
	M1	M2	M3	M4	M5	M6	M7	M8
Control variables								
Organisation scale	.193	.153	.044	.105	-.052	.212	.152	.132
Annual production value	.050	-.043	-.091	.005	-.012	-.013	-.151	-.170
Organisation history	-.100	.042	.081	-.007	.064	-.058	.155	.180
Team turnover	-.209	-.050	-.101	-.080	-.127	-.141	.095	.079
Independent variables								
ITA		.482*	.479**	.255	.351*		.716**	.657**
Moderator								
Task interdependence			.078		.064			-.122
Mediator								
Transactive memory system				.317*	.068			
Interaction								
ITA* Task interdependence			.386**		.175			.239*
TMS* Task interdependence					-.157			
R^2	.099	.283	.438	.336	.492	.062	.469	.515
ΔR^2		0.184	0.155	0.053	0.156		0.407	0.046
F	1.503	4.260**	5.781**	4.474**	5.387**	.912	9.532**	7.877**

$N = 60$; ** $p < 0.01$, * $p < 0.05$.

This study further examined the effect of ITA for the four indicators that represent the team adaptation process: performance loss, recovery time (time1), performance growth and stabilisation time (time2). As the results in Table 7.4 indicate, ITA was negatively correlated with time1 (MC2, β=-.609, $p<0.01$) and time2 (MD2, β=-.505, $p<0.01$) but did not have significant relationships with performance loss and performance growth. This result further supported Hypothesis 1, which indicated that when ITA was high, teams would spend less time in both the disruption stage and the stabilisation stage. However, the effect of ITA on performance change was not found, which might be due to the measurement of performance change. Since performance change was calculated as the ratio of performance change and the original performance level, and both were a relative percentage of industrial standards, this indicator was not sensitive enough to be statistically significant.

Table 7.4 Regression Results of ITA and Team Adaptation Process Indicators

DV	Performance Loss		Performance Growth		Time1		Time2	
	MA1	MA2	MB1	MB2	MC1	MC2	MD1	MD2
Control variables								
Organisation size	.045	.045	-.080	-.092	-.092	-.042	-.084	-.042
Annual production value	-.028	-.029	.015	-.012	-.004	.113	-.159	-.062
Organisation history	.028	.030	.091	.132	.071	-.110	.242	.093
Team turnover	-.100	-.099	.142	.188	.101	-.099	-.374*	-.207
Independent variable								
ITA		.003		.139		-.609**		-.505**
R^2	.014	.014	.030	.045	.021	.315	.209	.412
ΔR^2		0	.015			.294		.203
F	.195	.154	.421	.510	.292	4.963**	3.636*	7.554**

$N = 60$; ** $p < 0.01$, * $p < 0.05$.

7.3.2.2 Test of Hypothesis 2: mediation effect

Both the mediation effect and the moderation effect are discussed relative to the main effect. Therefore, in the following examinations, this study did not discuss performance change in the adaptation process. Hypothesis 2 proposed the mediation effect of the transactive memory system. The classical four-step method was employed to test the mediation effect (Baron & Kenny, 1986). In support of Hypothesis 2, the results in Table 7.3 indicate that 1) ITA was related to team adaptive performance as was proved in Hypothesis 1; 2) ITA was related to the transactive memory system (M7, β=.716, $p<0.01$); 3) the transactive memory system was related to team adaptive performance after controlling for ITA (M4, β=.317, $p<0.05$); and 4) ITA was no longer significantly related to team adaptive performance after entering the transactive memory system (M4, β=.255, n.s.), thus suggesting a full-mediation effect.

This study ran an additional analysis on recovery and stabilisation time (Time 1 and Time 2). The results are presented in Table 7.5. As shown in MC4 and MD4, when the model included transactive memory system, the transactive memory system was negatively related to time1 (MC4, β=-.382, $p<0.05$) and time2 (MD4, β=-.281, $p<0.05$). Although the regression coefficients of ITA were still significantly different from zero, the significant level decreased (MC4，β=-335, $p<0.05$；MD4，β=-.304, $p<0.05$), which indicated a partial mediation effect of the transactive memory system. These results further support Hypothesis 2. Accordingly, when ITA is higher, teams can more effectively take advantage of the transactive memory system, thus decreasing the recovery time (Time1) and stabilisation time (Time2) after equipment replacement, which in turn leads to better team adaptation.

Table 7.5 Results of the Mediation Effect and the Moderation Effect on Time1 and Time2

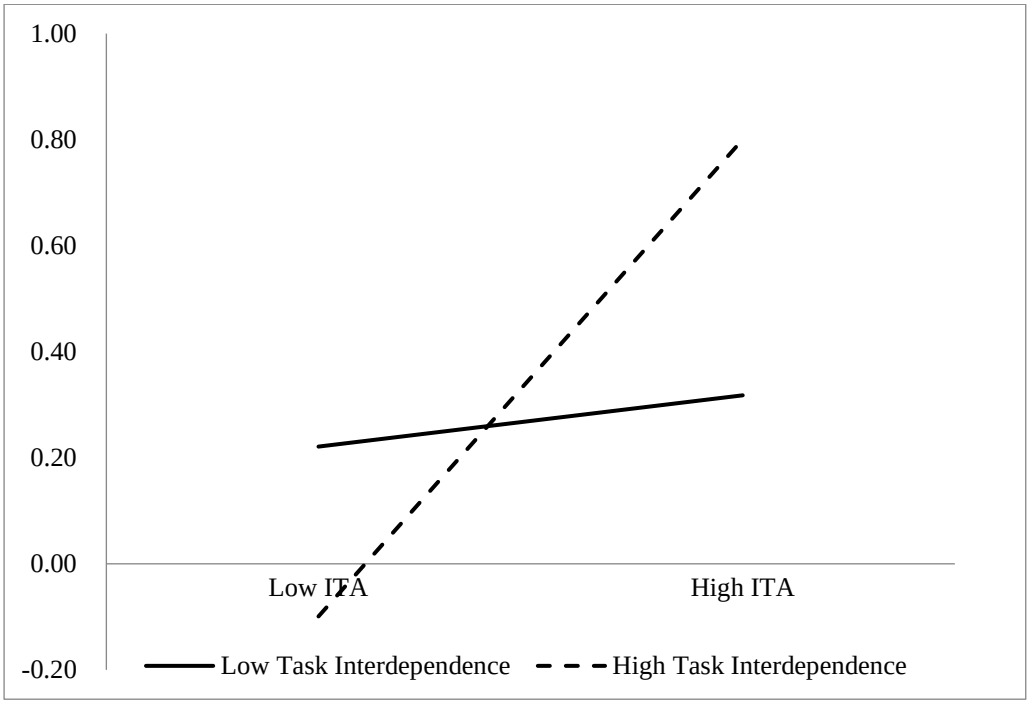
Dependent Variables	**Time1**			**Time2**		
	MC3	MC 4	MC5	MD3	MD4	MD5
Control variables						
Organisation size	-.055	.017	.018	-.057	.001	-.062
Annual production value	.119	.056	.041	-.044	-.104	-.055
Organisation history	-.125	-.051	-.069	.057	.136	.095
Team turnover	-.098	-.063	-.066	.215	.234*	.224
Independent variable						
ITA	-.544**	-.335*	-.313	-.372**	-.304*	-.258
moderator						
task interdependence	.161		.133	.320**		.284
mediator						
Transactive memory system		-.382*	-.303		-.281*	-.225
Interaction						
ITA* Task interdependence	-.138		.011	-.328**		-.352*
TMS*Task interdependence			-.123			.125
R^2	.340	.392	.407	.529	.453	.547
ΔR^2	.319	.077	.386	.320	.041	.338
F	3.821**	5.705**	3.814**	8.327**	7.327**	6.722**

N = 60; ** $p < 0.01$, * $p < 0.05$

7.3.2.3 Test of Hypothesis 3: moderation effect

Hypothesis 3 proposed the moderation effect of task interdependence for ITA and team adaptive performance. In other words, when task interdependence is high, ITA will function as a more effective predictor for team adaptive performance. When task interdependence is low, ITA will be less effective. All interaction variables were centralised, and the regression results are shown in Table 7.3 (M3, β=.386, p<0.01). To depict the relationship more clearly, this study plotted the interaction with one standard deviation above and below the mean of task interdependence. Figure 7.2 shows that the interaction pattern is consistent with our hypothesis: ITA was not related to team adaptive performance when task interdependence was low (β=.274, n.s.), but it was more positively related to team adaptive performance when task interdependence was high (β= .719, p<0.01). Hence, Hypothesis 3 was supported.

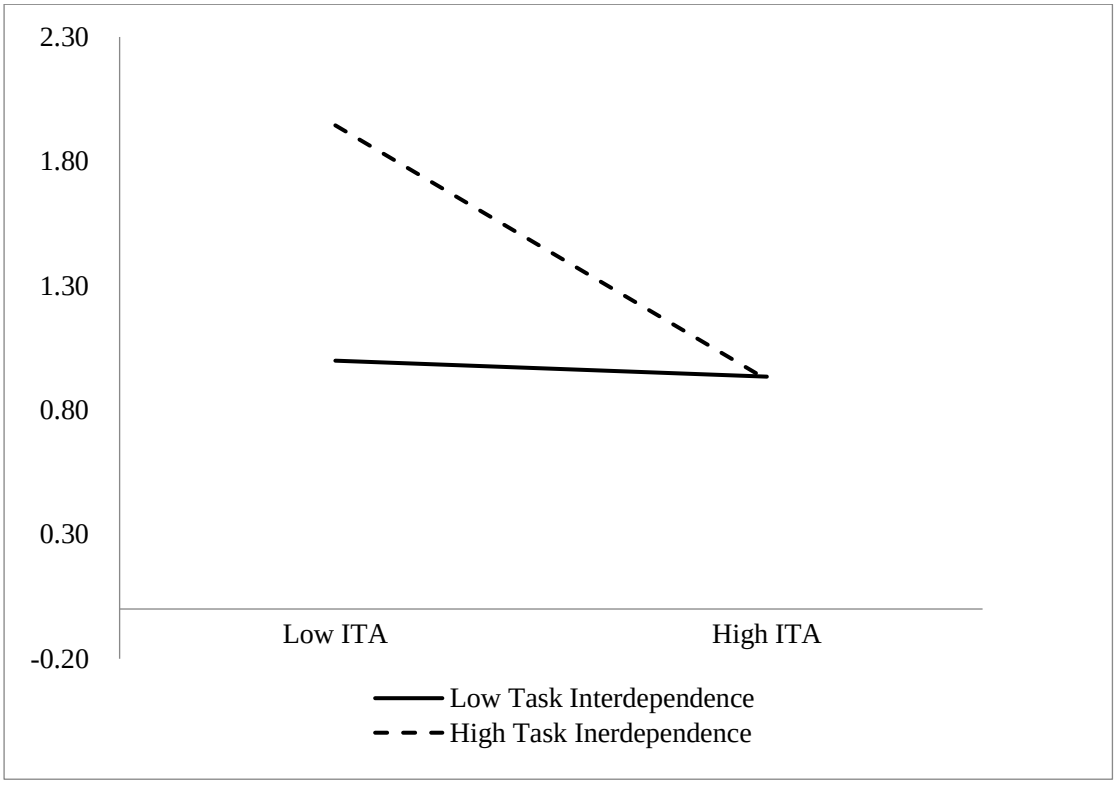
Figure 7.2 The Moderation Effect of Task Interdependence for ITA and Team adaptive performance



This study further explored the moderation effect on recovery time (Time 1) and stabilisation time (Time 2). The results are presented in Table 7.5. As shown in MC3 and MD3, the interaction of ITA and task interdependence was not significantly related to recovery time (MC3, β=-.138, n.s.), but it was significantly related to stabilisation time (MD3, β=-.328, p<0.01), which indicated that task interdependence only

moderated the relationship between ITA and stabilisation time during the adaptation process. This study adopted the same procedure as before to depict the moderation effect. As shown in Figure 7.3, the interaction pattern was consistent with Hypothesis 3: ITA was not related to stabilisation time when task interdependence was low (β=-.240, n.s.), but it was more negatively related to stabilisation time when task interdependence was high (β=-.490, p<0.01). Therefore, only when task interdependence was high would ITA contribute to reducing stabilisation time, thus leading to team adaptation. This result further supported Hypothesis 3.

Figure 7.3 The Moderation Effect of Task Interdependence for ITA and Stabilisation Time

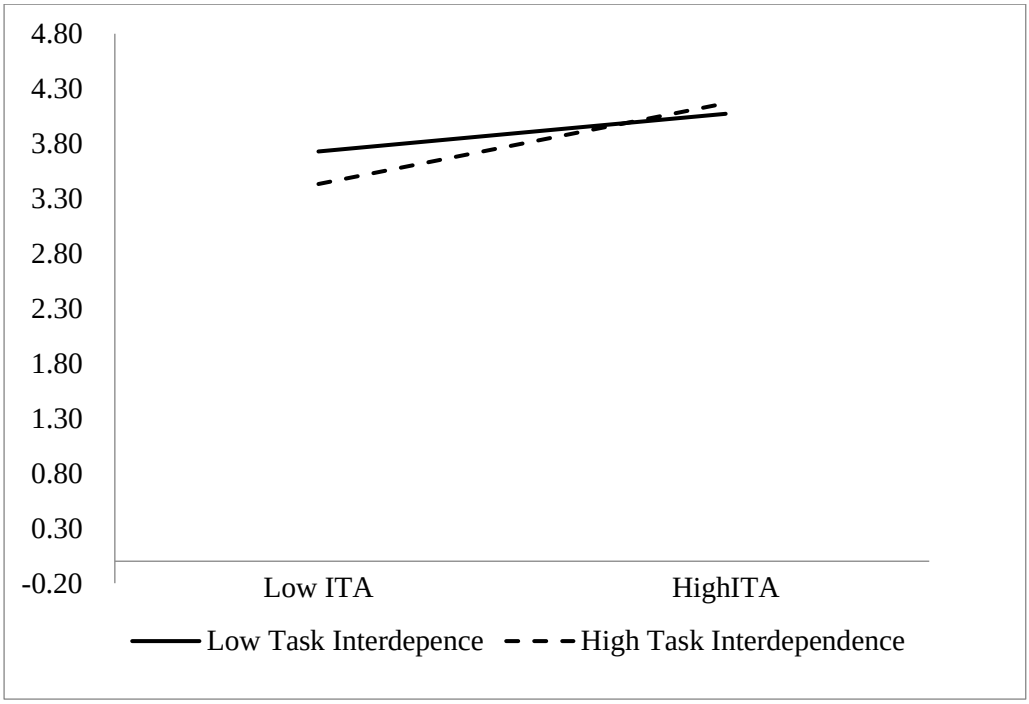


7.3.2.4 Test of Hypothesis 4: moderated mediation

In addition, it can be inferred from M8 in Table 7.3 that the interaction of task interdependence and ITA had a positive relationship with the transactive memory system (M8, β=.239, p<0.05), indicating that task interdependence also moderated the relationship between ITA and transactive memory system. Figure 7.4 depicts the relationship between ITA and the transactive memory system with different levels of task interdependence. The coefficient was larger when task interdependence was high (β=.880 for higher task interdependence and β=. 419 for lower task interdependence). The quality of the transactive memory system was the lowest when task

interdependence was high, while ITA was low. According to these results, this study ran further analyses on the mixed effect of both moderation and meditation, i.e. the moderated mediation effect proposed in Hypothesis 4.

Figure 7.4 The Moderation Effect of Task Interdependence for ITA and the Transactive Memory System



Hypothesis 4 proposed that the indirect effect of the transactive memory system would be larger when task interdependence was higher. Although task interdependence moderated the relationship between ITA and TMS, the coefficient of the interaction of TMS and task interdependence was not significant for team adaptive performance (M5, β=-.157, n.s.). It is argued that regression methods may be biased in examining the moderated mediation effect due to a limited sample. Therefore, this study further adopted the bootstrapping method per Edwards and Lambert's (2007) suggestion. In all, 1,000 samples were produced to compute bias-corrected confidence intervals. The results in Table 7.6 indicate that the difference in the indirect effect between low task interdependence and high task interdependence was significant ($\triangle r^2$=0.218, $p < 0.05$). Furthermore, the indirect effect was not significant for low task interdependence. Hence, Hypothesis 4 was also supported.

Table 7.6 Results of Moderated Mediation Effect

Moderator	ITA (X)→ Transactive memory system (M) → Team adaptive performance (Y)				
	First stage	Second stage	Direct effects	Indirect effects	Total effects
Low task interdependence	0.172**	-0.246	0.071	-0.042	0.029
High task interdependence	0.467**	0.375*	0.228*	0.175*	0.403*
Differences	0.294**	0.622*	0.157	0.218*	0.374*

N = 60; ** $p < 0.01$, * $p < 0.05$.

7.4 Summary

This study fulfils its three aims: First, this study was a trial to apply the scale of ITA to the field and to solve practical management problems. Second, this study examined the distributed cognitive mechanism for intentional team adaptation. Third, this study explored the above relationship with tasks of different interdependence levels. In the context of equipment replacement in the Chinese manufacturing industry, intentional team adaptation was demonstrated as effective. Teams with a high level of ITA proactively take measures to gain new equipment knowledge and skills, coordinate members' behaviours accordingly, and develop new transactive memories to process information. It is especially beneficial for teams conducting highly interdependent tasks to develop ITA.

A thorough conclusion and discussion will be provided in the next chapter, which explains the intentional team adaptation theory in detail based on findings from the four studies.

CHAPTER 8 DISCUSSION

Work teams in current organisations are required to adapt to dynamic environments, tasks and situations (Burke et al., 2006). Therefore, team adaptation, i.e. taking measures to respond to changes and maintain team performance, has become a popular research topic in the past 15 years (Christian et al., 2017; Han et al., 2018). Although much effort has been put into this research field, many problems remain unanswered (Frick et al., 2018). This study is a step forward in developing theory of team adaptation by investigating intentional responses towards changes and mechanisms of optimising and integrating cognitive resources within teams. This chapter presents the unique contribution of this research in compared with previous studies both theoretically and methodologically. Besides, this chapter also discusses the practical implications for business teams. Last but not the least, this chapter notices the limitations of this research and proposes some directions for future studies.

8.1 General Discussion

The current work puts effort into understanding intentional team adaptation through exploring manifestations of ITA, changes in team adaptive strategies and ways of achieving adaptive performance. Team cognition is believed to be an important mechanism of achieving team adaptation within uncertain situations (Burke et al., 2006; Zajac et al., 2014). However, almost all the existing studies only examined the relationship between team cognition and team performance or team effectiveness due to the limitation of the 'Input-Process-Output' paradigm. This work contributes to team research by identifying underlying cognitive mechanisms of intentional adaptation. Specifically, the current effort focused on shared mental models as a shared cognitive mechanism and the transactive memory system as a distributed cognitive mechanism.

In addition, the current work investigated the boundary condition of intentional team adaptation. Since previous studies on team adaptation usually only examined the relationship within moderate or high levels of interdependence, Burke et al. (2006) suggested generalising conclusions with lower levels of interdependence. Recent studies found that interdependence may influence the process of team coordination, resulting in structural adaptation and cross-disciplinary knowledge creation (Ben-Menahem et al., 2016). Therefore, the effects of interdependence, i.e. both goal interdependence and task interdependence, were examined in this research.

There is no doubt that research on intentional team adaptation can contribute to both management practice improvement and theory development. Efforts were made to enrich the whole picture of team adaptation in response to the need to clarify important mechanisms for achieving adaptation. Furthermore, by legitimising teams as social actors, theoretical achievements related understanding organisational behaviour occurred. Moreover, suggestions for helping teams achieve adaptation are provided, and the accumulation of knowledge for better team management is recommended.

8.2 Theoretical Implications

Various scholars have focused on developing adaptive teams to improve organisational effectiveness in the past 15 years (Frick et al., 2018; Gorman et al., 2010; Kozlowski et al., 1999). However, extant research was constrained due to the framework of 'Input-Process-Output', which views a team as a system that reactively responds to external changes to maintain effective outputs. Adaptive teams were argued to have the capabilities of coordinating their activities under novel situations and adjusting strategies through team members' compensatory behaviours and resource reallocation (Cannon-Bowers et al. , 1995; Gorman et al., 2010). Such capabilities were regarded as team adaptability in the literature, which was identified as teams' inherent performance capabilities that drive team effectiveness. However, there is a lack of both theoretical and empirical evidence to construct and understand team adaptability as its inherent ability. This research aimed to construct adaptive teams based on collective intentionality theory. In other words, teams are argued to have intentional states and inherent abilities that are different from members' intentional states and abilities. Based on the theoretical work that justified teams as intentional agents, four empirical studies were conducted to examine the intentional adaptation process. Accordingly, this research resulted in three main contributions: 1) It built the theory of intentional team adaptation, enriching research on team effectiveness, especially on the research problem of team adaptation; 2) it built a research tool for studying and justifying ITA; and 3) it explored the underlying mechanisms and boundary conditions for intentional team adaptation.

8.2.1 The theory of intentional team adaptation

The proposed intentional team adaptation theory contributes to the understanding of team adaptation and organisational behaviour in general.

Firstly, intentional team adaptation depicts the proactive adaptation process. By viewing a team as an actor, one can analyse a team's response towards change as an intentional process, which allows for a better explanation and the prediction of adaptation with forethought. Most of the previous studies presented adaptation as a response to salient and unpredicted changes (LePine, 2003; Burke et al., 2006); however, adaptation is needed in other circumstances. Team adaptation is more commonly seen as the process of predicted change. Sverdrup et al. (2017) described adaptation to predicted change as 'expecting the unexpected' (p. 53). They examined the effectiveness of a team charter for adaptation, and also aimed to understand proactive adaptation. In the case of equipment replacement, the results showed that ITA contributed to adaptation through the development of the transactive memory system.

Secondly, a typology of team adaptation based on the relationship between changes and responses was proposed in this study, which contributes to integrating extant studies that remain dispersed in separate fields. Frick et al. (2018) described the current situation as 'a lack of synthesis', which 'hinders comprehensive theoretical refinement and ready application to practice' (p. 411). Further, Baard et al. (2014) suggested additional conceptual works to flush out mechanisms of the adaptation process and the relationships of these mechanisms. Although some preliminary classification research was conducted, there are no systematic discussions on the typology of team adaptation. For example, Maynard et al. (2015) classified triggers for team adaptation as 'task-based' and 'team-based' (p. 660). Moreover, Uitdewilligen et al. (2013) classified changes as evolutionary or radical, but these classifications served as propositions without further theoretical or empirical evidence. The taxonomy proposed in this research has solid theoretical foundations and integrates the extant research; it also allows new research to be situated with inherent consistency.

Thirdly, justifying teams as intentional social actors contributes to organisational behaviour research in general. Team adaptation, by nature, includes joint actions. The main dispute regarding joint action is whether we can ascribe intentional states to collectives in order to analyse such actions. Tuomela and Miller (1988) proposed the 'we-intention' to justify joint actions as intentional, which supports the opinion that related collective intentionality determines joint actions. Similarly, King, Felin and Whetten (2010) identified intentionality and external attribution as the main assumptions for viewing social entities as social actors. Teams are demonstrated to be social actors with clear external attributions and collective intentionality through a

grounded study, which situates team research into the general picture of organisation research that focuses on a social entity itself rather than on individual behaviours.

8.2.2 Scale development of intentional team adaptation

A measurement tool enables the further exploration of intentional team adaptation. Burke et al. (2006) pointed out that the creation of adequate measures was 'of primary importance to any future empirical investigations of team adaptation' (p. 1203). This research responded to this need by developing a measurement tool of ITA through standardised procedures of scale development (Netemeyer et al., 2003).

The validated scale can also be applied in organisations for evaluating teams' adaptability and identifying what should be emphasised in training. Since ITA contains three aspects, i.e. coordinated intentional behaviour, connected relationship and directional cognition, with 12 items, suggestions can be made in terms of the scores one team achieved on this scale.

8.2.3 Underlying mechanisms of intentional team adaptation

Explorations of the underlying mechanisms of intentional team adaptation are common and ongoing in research. The mechanisms studied include coordination (Entin & Serfaty, 1999), cognition (Gorman et al., 2010) and interactions patterns (Uitdewilligen et al., 2018). This study specifically focused on the shared cognitive mechanism and the distributed cognitive mechanism as well as on boundary conditions of interdependence.

The dynamic relationship between the shared mental model and team performance was examined through an experimental study. In their research, Uitdewilligen et al. (2013) had shown that static cognition may not contribute to team adaptation since it may not be suitable for new situations. Instead, dynamic cognition that changed in alignment with an environment or task requirement was the key to maintain and develop team effectiveness. *Shared mental model updating* describes the accurate changes in mental models to match novel problems or new tasks. The experimental study was designed to capture changes in the shared mental model as well as changes in team behaviours. The findings revealed a non-significant relationship between original shared mental model similarity/accuracy and team adaptation and the positive effect of shared mental model updating, thus supporting the propositions proposed by Burke et al. (2006).

Another important cognitive mechanism is the transactive memory system. The relationship between the transactive memory system and team adaptation was examined in a questionnaire-based field study. The results were consistent with Zajac et al.'s (2014) findings. In other words, three dimensions of TMS, i.e. specialisation, coordination and credibility, contributed to team adaptation through situation assessment, plan formulation, plan execution and team learning. This study further explained that ITA influenced the development of the transactive memory system, thus providing a possible explanation for the inconsistencies between Ellis' (2006) findings, i.e. TMS lost efficiency under stress, and Akgun et al.'s (2006) findings, i.e. TMS was more beneficial for teams in environments with task and knowledge volatilities.

Apart from the intervening effect, moderators were also examined to enrich the research model of intentional team adaptation. Goal interdependence was found to have an effect on the relationship between the shared mental model and team adaptation, which improves our understanding of 'asymmetric adaptation' (Johnson et al., 2006; Beersma et al., 2009; Hollenbeck et al., 2011). Task interdependence was found to have effect on the relationship between the transactive memory system and team adaptation, thus confirming its boundary effect as noted in Burke et al. (2006).

8.3 Methodological Implications

Mixed methods were used in this research to clarify the idea of intentional team adaptation. The research design is consistent with the suggestions of Bryman (2006) and Creswell (2003), i.e. that different approaches should be used for fulfilling different aims. The inclusion of a literature analysis, the grounded theory approach, scale development and experimental and field studies enables deep and wide examinations. Furthermore, these methods were used sequentially instead of randomly to answer the research problem.

Relevant literature was first analysed to clarify the idea of intentional team adaptation through identifying the theoretical gap and connecting the current work with previous research. Problems can be found in management practices, but a research problem is always identified based on literature. This research began with the observation of a turbulent business world that requires the adaptation of organisations, teams and individuals. The first trial that narrowed down the research focus to the team-level is based on the argument related to building meso-theory in recent decades (Levi, 2014). Thereafter, a typology of team adaptation research was built based on the

literature analysis, during which ‘change’ and ‘response’ were identified as two main elements to define team adaptation. Therefore, the focus of this research, i.e. intentional team adaptation, was proposed based on the ‘change-response’ framework.

The grounded theory approach was then used to understand the process of intentional team adaptation. This approach allowed the researchers to keep an open mind and enabled an iterative analysis of the materials. On-going comparisons were employed throughout the study during the initial coding, memo writing, memo comparison, case comparison and theory comparison. The results of the grounded study demonstrated the uniqueness of intentional team adaptation.

The components of intentional team adaptation became clearer after the grounded study. The next step involved developing this idea into a theoretical model. Therefore, a measurement was developed to study the research problem related to intentional team adaptation. Two types of team cognition were studied as the mediation mechanism, and two types of interdependence were studied as the moderation mechanism. An experimental method and a survey method were employed to build the internal validity and the external validity of the research model.

Although mixed methods were employed in this research, it is only an initial step to building the theory of intentional team adaptation. More empirical studies and theoretical studies are needed to enrich this theory and confirm its practical value in the business world.

8.4 Managerial Implications

The reconfiguration of work from individuals to teams began in the last century and is now a noticeable trend for organisations (Marks, Zaccaro, & Mathieu, 2000). A basic reason for a such trend is the increasing demand for diversified expertise and constantly changing work contents (LePine, 2003). Due to the fast pace of modern societies, business organisations are experiencing turbulences, uncertainties and fierce competitions. Teams embedded in business organisations are therefore required to be adaptive to deal with these challenges (Burke, Stagl, Salas, Pierce, & Kendall, 2006). There is a central problem related to enhancing team effectiveness in the 21st century: How can we ensure teams have the abilities needed for adaptation?

Suggested ways to promote team adaptation have included training (Gorman et al., 2010), communication (Entin et al., 2005), coordination (Manser et al., 2008) and leader briefing (Sutton & Edelmann, 2005). However, they are either costly or

ambiguous. This research provided an easier and more understandable way to develop adaptive teams. Managers in organisations should emphasise the idea of 'we' in their delivering tones, including motivation, planning, controlling and briefing. For example, a bonus should be given to the whole group instead of to individuals (i.e. increasing cooperative goal interdependence); tasks should be assigned to groups and make everyone get involved through collective discussions or casual meetings (i.e. increasing task interdependence); and activities should occur that are beneficial for developing personal relationships (i.e. developing connected relationships). The basic ideas in each of these measures are keeping 'we' in individuals' minds, making them believe in 'we' and ensuring they proactively perform their roles as part of the team. They will enjoy taking responsibility for their team and implicitly coordinating each other's behaviour towards shared aims, thus developing team abilities for adaptation.

This research also contributes to developing adaptive teams by providing training advice and selection suggestions based on different tasks. The results of the field study showed that with regard to low-interdependent tasks, the development of the transactive memory system is not necessary for team adaptation. Accordingly, a suggestion for production managers is to make judgement about a team task first. For high-interdependent tasks that require members to work closely and rely on each other's ways to complete their work, managers should emphasise team building and create opportunities for communication and cooperation in daily work. For low-interdependent tasks that can be completed by adding up individual members' work, managers should emphasise workers' skill development rather than cooperation. Similar suggestions can also be made for selection and recruitment. For low-interdependent tasks, skilled workers should be selected as team members, and the one who is in charge of the whole production team should have a basic understanding of each member's skills to arrange the labour distribution. For high-interdependent tasks, workers who have abilities for cooperation should be selected as team members.

Related advice is proposed for training and developing managers. The person in charge of a production team should have the skills of coordination and reconciliation in addition to work-related skills. He or she also needs to have general knowledge of team members' skills and the general skills of all the works included to complete the task.

8.5 Limitations of this research

Since this research is the first comprehensive study on intentional team adaptation,

problems do exist in the research design and analysis.

First limitation is related with the research design of the field study. It is a difficult task to follow the whole process of each team that experienced the same stimuli, i.e. equipment replacement in this research. Therefore, the cross-sectional design was adopted to collect data. In order to depict the team adaptation process, this study employed objective indicators. However, due to the limitation of cross-sectional design, the abundant process data was missed. This study took consideration of such limitation and added some quantitative data to better understand the situation of the sample teams.

Another related problem is the measurement of team adaptation. In this research, two different measurements were employed. The experiment study measured team adaptation as adaptive strategies that were used to complete the tasks; the field study measured team adaptation as changes in performance and time spent on achieving adaptation. Although different measurements were used in the two sub-studies, the two measurements were consistent by nature. Both indicators captured the change rates of team effectiveness according to the definition of team adaptation.

Last but not the least, this research is a very first step into understanding team as an intentional agent. Most of the work were done to prove the legitimacy of the idea that justifying team as an agent, and two cognitive variables and two task characteristics were introduced in the full model. It is not comprehensive to understand the intentional team adaptation theory, more works need to be done.

8.6 Recommendations and Future Studies

Recommendations of methodology and research design are provided for future studies based on the research findings as well as the limitations of this research.

The first is a methodologically recommendation. Since team adaptation is a process related to time, it is better to include the time factor in the research. Further studies should pay more attention to collecting the process data. Changes in performance can perhaps be obtained through archival data or adopt a longitudinal design. Further studies that adopt a longitudinal design should do the following: 1) Find comparable samples that have similar experiences of team adaptation and different results (in order to obtain variance); 2) follow the target sample once change is detected and collect data on a team's original state (e.g. original shared mental model and a team's initial intention); and 3) make decisions on data collection time points, such as before changes, immediately after changes, after changes and when teams are relatively

stable and adapt to changes. By doing so, several waves of data can be obtained, which will allow for an examination of their cyclical relationships.

Additionally, further studies should measure team adaptation more carefully. As Chen and Ployhart (2004) suggested, an individual's performance follows a nonlinear pattern that begins with a decline due to misalignment; it then increases due to realignment. Hale, Ployhart and Shepherd (2016) divided the team adaptation process into two phases: the disruption phase and the recovery phase. The disruption phase is characterised by a 'flux in coordination such that prior states and processes become disordered and performance decrease' (p. 908). The recovery phase is characterised by performance improvement, reconfiguration, socialisation of replacement and new knowledge acquisition. In order to better examine the nature of team adaptation, detailed observations are needed when measuring this phenomenon. Based on a longitudinal design, basic data on time and performance should be obtained separately during different phases. Team adaptation can be further calculated as the sum of the phases' extraordinary performance. The time factor should also be included when calculating team adaptation.

Future research on team adaptation may also investigate intervening variables and conditions of the model. For example, interaction patterns, coordinated behaviours and team situation awareness can be examined as intervening variables according to the review of team adaptation in Chapter 2. Additionally, a previous study had confirmed the important role of communication among team members for improving team adaptation (Stachowski et al., 2009). Future research can conduct empirical studies on clarifying the role of team process and team cognition (or other emergent states) in the relationship between intentional team adaptation and team effectiveness. Task complexity, the magnitude of changes (Uitdewilligen et al., 2013) and types of teams (Burke et al., 2006), for example, can be examined as conditional factors that set up the boundaries of intentional team adaptation. Moreover, individuals' traits are regarded as important 'input', as it is one of the indicators of team composition (Neuman, Wagner, & Christiansen, 1999). When ascribing intentional states to teams, individual traits are contingent and may influence a team's intention. It can be interesting to discuss interactions between consciousness-members and ITA together with their effects on team effectiveness when faced with uncertainties. It can be inferred that teams composed of high-consciousness members may have stronger team adaptation if they developed high level of ITA due to their sensitivity and awareness of external

environments. These empirical studies need to examine whether relationships actually exist.

CHAPTER 9 CONCLUSION

Contemporary organisations must deal with dynamic and complex environments due to the high speed of information development (Unger-Aviram & Erez, 2016). A team-based work design is thus popular for its flexibility and efficiency. Accordingly, teams are required to respond to demands on time, adjust their coping strategies and solve ad hoc complex problems apart from completing work tasks. Therefore, improving a team's adaptability, quickly responding to unexpected changes and maintaining effectiveness in uncertain environments are new missions of team management. This research builds a theory of intentional team adaptation that emphasises teams' proactive responses rather than passive behaviours, arguing for the legitimacy of viewing teams as intentional actors rather than workplaces. With four studies, the manifestations and underlying mechanisms of intentional team adaptation were explained and examined, enriching the whole structure of intentional team adaptation theory. This chapter begins with revisiting the research problem and answered the problem by sequence.

9.1 Research problem revisited

This study addressed the following research question: When and how do teams intentionally achieve an expected performance in a dynamic environment with changes in team-related elements?

Three sub-problems were proposed to answer the above question:

The first sub-problem was to understand team adaptation. This problem was further classified into the following six questions:

1-1 Can teams be considered as agents?

1-2 What are the functions and benefits of viewing teams as agents?

1-3 What are the differences between intentional team adaptation and reactive team adaptation?

1-4 Can teams be considered as intentional agents in daily work?

1-5 What will teams do to achieve adaptation in a short time?

1-6 What are the differences between adaptive teams and maladaptive teams?

The second sub-problem was as follows: How can intentional team adaptation be achieved? This problem was further specified with two cognitive mechanisms: the shared mental model and the transactive memory system. Therefore, this problem was

further classified into the following two questions:

2-1 What is the role of shared mental model for achieving team adaptation intentionally?

2-2 What is the role of transactive memory system for achieving team adaptation intentionally?

The final sub-problem concerns examining the boundary condition of intentional team adaptation. Task interdependence and goal interdependence were specifically selected as the boundary condition of intentional team adaptation in this research. Therefore, the third sub-problem was further classified into the following two questions:

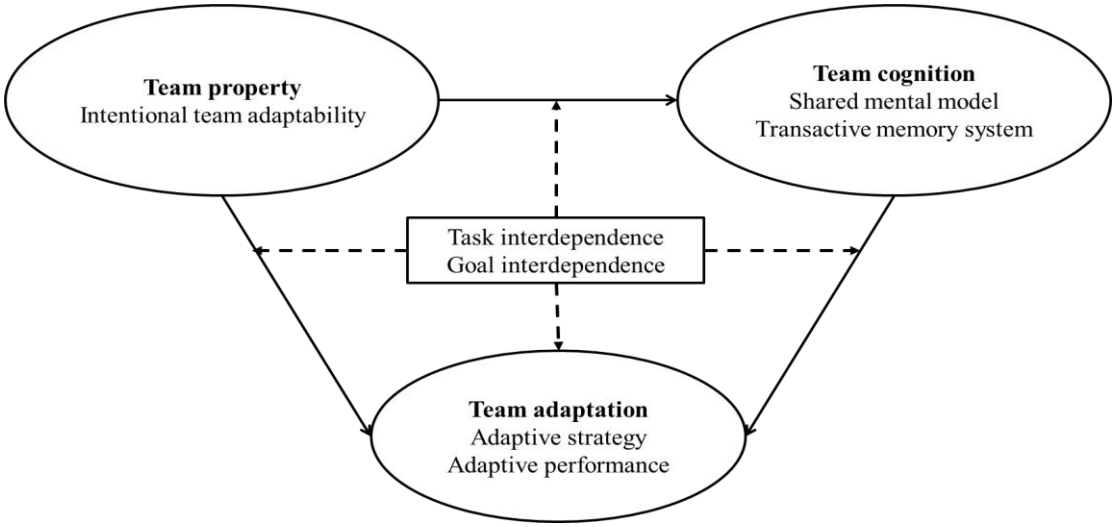
3-1 What is the difference for achieving intentional team adaptation with different levels of task interdependence?

3-2 What is the difference for achieving intentional team adaptation with different levels of goal interdependence?

9.2 Main Conclusion

The idea of intentional team adaptation is proposed based on the classification of extant research on team adaptation with the typology of the 'change-response' framework. By introducing the theory of collective intentionality, this research sought to legitimise teams as an intentional social actor that dominate the process of adaptation. It then explored the manifestations of intentional team adaptation and underlying cognitive mechanisms. Four studies were conducted to understand intentional team adaptation and to provide answers to the main research problem. The conclusions of the four studies are integrated into a simple structure: the relationship among ITA, team cognition and team adaption. Figure 8.1 demonstrates this relationship: Intentional team adaptation contributed to team adaptative results (changes in problem-solving strategies; adaptive performance) through team cognition (shared mental model and transactive memory system) with the conditions of task interdependence and goal interdependence. To specify the conclusion, teams that were characterised as 'coordinated intentional behaviour', 'connected relationship' and 'directional cognition' could utilise shared and distributed cognitive resources to deal with changes. The above intentional team adaptation process only holds for teams with highly interdependent tasks and cooperative goal interdependence.

Figure 9.1 Main Research Model



9.3 Answer to sub-problem 1: developing intentional adaptive teams

Questions 1-1, 1-2, and 1-3 were answered through a theoretical analysis, and questions 1-4, 1-5 and 1-6 were answered through a grounded study (Study I). Answering these questions fulfil sub-aim 1, i.e. clarify the idea of intentional team adaptation, and sub-aim 2, i.e. explore the manifestations of intentional team adaptation.

Question 1-1 Can teams be considered as agents?

According to the theoretical analysis, teams can be considered as agents when fulfilling two requirements: external attribution and collective intentionality. External attribution assumption proposes that other actors should consider a social entity as a capable actor. While intentionality assumption refers to the underlying reasons for actors' behaviours (King, Felin, & Whetten, 2010). Teams' members and leaders naturally consider teams as having action capability and responsibility that give teams the external attribution to be agents. Team also has intentionality that characterises its mental states and directs its behaviours which meet the intentionality assumption. Therefore, teams can be considered as agents.

Question 1-2 What are the functions and benefits of viewing teams as agents?

Viewing teams as intentional agents has at least four advantages. Firstly, viewing teams as agents offers the opportunity to better explain and predict their behaviours. It is commonly accepted that a team is more than a group of people, as there are many compilation and combination phenomena at the team level (Kozlowski & Klein, 2000). This is what makes a team a unique and interesting unit for research. An agentic view contributes to such team uniqueness and makes those team-level phenomena interpretable. Moreover, it is easier to adopt theories of an individual organism's

adaptation to better explain and predict team adaptation. It also legitimises previous team research, which used analogies to analyse teams, such as team motivation (De Dreu et al., 2008), team awareness (Gorman et al., 2006) and team creativity (Hennessey & Amabile, 2009). Furthermore, the agentic view meets the requirements of continuous change within current competitive and dynamic situations. To deal with changes, something needs to be changed accordingly, and others should be clear and constant (Trestman, 2012). Intentional teams guide the adaptation process so that it consistently focuses on their goals and tasks and update their resources, relationships and knowledge in responses to cues. In addition, by viewing team as an agent, researchers can analyse a team's response towards change as an intentional process, which allows for a more effective explanation and prediction of adaptation. The majority of previous studies presented adaptation as a response to salient and unpredicted changes (LePine, 2003; Burke et al., 2006); however, this is not the only situation for which teams need to adapt. Intentional adaptation emphasises coordinated behaviours, interactions among members and direction. Since change can be predicted, team members can enhance their skills and focus on cooperation in order to adapt.

Question 1-3 What are the differences between intentional team adaptation and reactive team adaptation?

Differences between intentional team adaptation and reactive team adaptation originate from changes teams deal with and responses teams make. Changes were classified as two dimensions: type (internal/external) and magnitude (radical/evolutionary). Accordingly, responses were also classified as two dimensions: one-off/continuous and reactive/proactive. Therefore, *intentional team adaptation* refers to proactive responses towards changes related to teams internally, while *reactive team adaptation* usually involves reactive responses to external changes, e.g. environment turbulence and an emergency. The aim of intentional team adaptation also differs from that of reactive team adaptation: Intentional team adaptation aims for learning and development, while reactive team adaptation aims to maintain effectiveness and return a team back to their normal track to complete team tasks.

Question 1-4 Can teams be considered as intentional agents in daily work?

A grounded study provided empirical evidence to support the theoretical argument. Firstly, 'external attribution' for teams was found in daily team members used with references to 'we', 'our team', 'this project' and 'the project team'. Members associated 'team' with teamwork and their roles in completing teamwork. Secondly, the three

categories of intentional team adaptation supported ‘collective intentionality’: 1) Team actors carry out appropriate actions with members’ coordinated behaviours, i.e. coordinated intentional behaviour; 2) members are highly connected so they can act as a body when confronted with changes, i.e. connected relationship; and 3) team behaviour is highly related to the problems at hand and involves cognitive ability to solve problems, i.e. directional cognition.

Question 1-5 What will teams do to achieve adaptation in a short time?

Teams will respond to environmental changes in a proactive way to get adapted. Specifically, teams conduct coordination activities, maintain coordinated interdependence and execute plans according to judgements regarding environmental changes. Behaviours were taken based on information sharing among members, during which members may gather information to assess situations and derive new strategies and plans. Behaviours and cognition were guided by goals and directions so they can identify deviations from expected behaviours, use knowledge and skills to solve problems.

Question 1-6 What are the differences between adaptive teams and maladaptive teams?

Differences between adaptive and maladaptive teams can be described according to the following three aspects: Behaviourally, members of adaptive teams conduct joint action and share their responsibilities so that coordination is easy when confronted with changes. In contrast, members of maladaptive teams work independently and even consider being free riders, thus leading to a waste of resources Thus, these teams cannot appropriately and effectively deal with changes. Affectively, adaptive teams are more positive than maladaptive teams, as manifested in the daily tone, team climate and relationship among team members. For adaptive teams, members’ private and work relationships are usually of good quality; they trust and have mutual respect for one another and support each other. In maladaptive teams, members usually have poor private and work relationships. Moreover, there may be some subgroups or isolation. Members of these teams earn benefits for themselves and are reluctant to share information and resources with others. Cognitively, adaptive teams have better cognitive skills and better usage of stored knowledge; members within adaptive teams discuss problems based on facts and focus on targets and related sub-goals when completing team tasks. Maladaptive team members, on the other hand, may turn their task conflict into a relationship conflict when they discuss problems. Maladaptive teams

are information filters, so changes in the environment will be ignored since not enough information is exchanged within the team to take notice of the changes.

9.4 Answers to sub-problem 2: cognitive mechanisms of intentional team adaptation

This research used shared mental model and transactive memory system to explore the cognitive mechanisms of intentional team adaptation. A *shared mental model* refers to the shared cognitive resources among team members, while a *transactive memory system* refers to the distributed cognitive resources within the team. These two variables are widely used in team cognition research as classical constructs that represent the shared cognition mechanism and distributed cognition mechanism, respectively. Therefore, the mediating effects of shared mental model and transactive memory system were examined in this research.

Question 2-1 What is the role of shared mental model for achieving team adaptation intentionally?

The relationship between the shared mental model and team adaptation was examined through an experimental study. Results of the experimental study showed that it was shared mental model updating rather than the shared mental model that contributed to team adaptation. *Shared mental model updating* refers to the change of a mental model for completing tasks in the right direction. A team's intention guies the process of updating. In other words, a team actor proactively changes its mental model to adapt to new task requirements. This explanation was different from the systematic view that members' mental models update according to the requirements of the external environment to ensure task completion after changes. The systematic view cannot provide an explanation regarding how to change and when to change, nor can it provide an explanation for the direction of change. Viewing a team as an actor, these problems can be naturally solved. The process of adaptation begins with realising changes in environments, which is followed by adjusting the mental model and further executing adjusted plans through members' behaviours.

Question 2-2 What is the role of transactive memory system for achieving team adaptation intentionally?

The role of transactive memory system was examined through a field study(study IV). The results of study IV supported the mediating effect of the transactive memory system for the relationship between ITA and team adaptation. In the setting of

equipment replacement, teams with high ITA could better stimulate the function of the transactive memory system that contributed to decreasing time spent in the disruption stage as well as time spent in the recovery stage. Teams have previously been viewed as transactive memory systems, which refers to situations in which members are knowledgeable about each other and can derive information from specific member(s) when needed. The development of this construct is actually consistent with the systematic view, taking unstructured information as input and producing structured information that can be used to solve problems. However, the underlying premise for the function of this system is not always fulfilled: The flow of information is right, and thus members cooperate with each other to build the system. In this study, the above requirement was fulfilled based on a team's intention. Team actors can direct the flow of information and guide members' cooperation behaviours. Therefore, teams intentionally adapted to equipment replacement through the utilisation of the transactive memory system.

In conclusion, both the shared mental model and the transactive memory system were key cognitive mechanisms that enabled team actors to analyse information and acheive adaptation, and the whole process was dynamic and guided by teams' intentions. By viewing teams as intentional actors, the dynamic process of updating the shared mental model as well as the function of transactive memory system can be better understood.

9.5 Answers to sub-problem 3: boundary conditions of intentional team adaptation

This research further discussed the influence of goal interdependence and task interdependence as boundary conditions for intentional team adaptation. Burke et al. (2006) called for research on 'moderating effect of team type and interdependence level' (p. 1204) to generalise the theory of team adaptation to a lower level of interdependence. Specifically, goal interdependence was established as an important indicator of knowledge sharing (Ghobadi et al., 2017) and positive interpersonal relationships (Johnson & Johnson, 2005), and task interdependence was argued to be the basis for determining the effectiveness of coordination (Manser et al., 2008). Therefore, the moderating effects of goal interdependence and task interdependence were examined in this research.

Question 3-1 What is the difference for achieving intentional team adaptation

with different levels of task interdependence?

The results of Study III revealed the moderating effect of goal interdependence. According to social interdependence theory, individual members have varying behaviours and interaction patterns in different structures of collective goals (Johnson & Johnson, 2005). Cooperative goal interdependence triggers promotive interaction among team members and encourages them to work well with others to achieve success. On the other hand, competitive goal interdependence triggers oppositional interaction among team members, thus preventing them from helping others (Deutsch, 1949). The result showed that in teams with cooperative goal interdependence, both shared mental model updating and team adaptation were higher than in teams with competitive goal interdependence. According to the results, cooperative goal interdependence facilitated the process of individual mental model updating and alignment and contributed to the implementation of adaptive strategies.

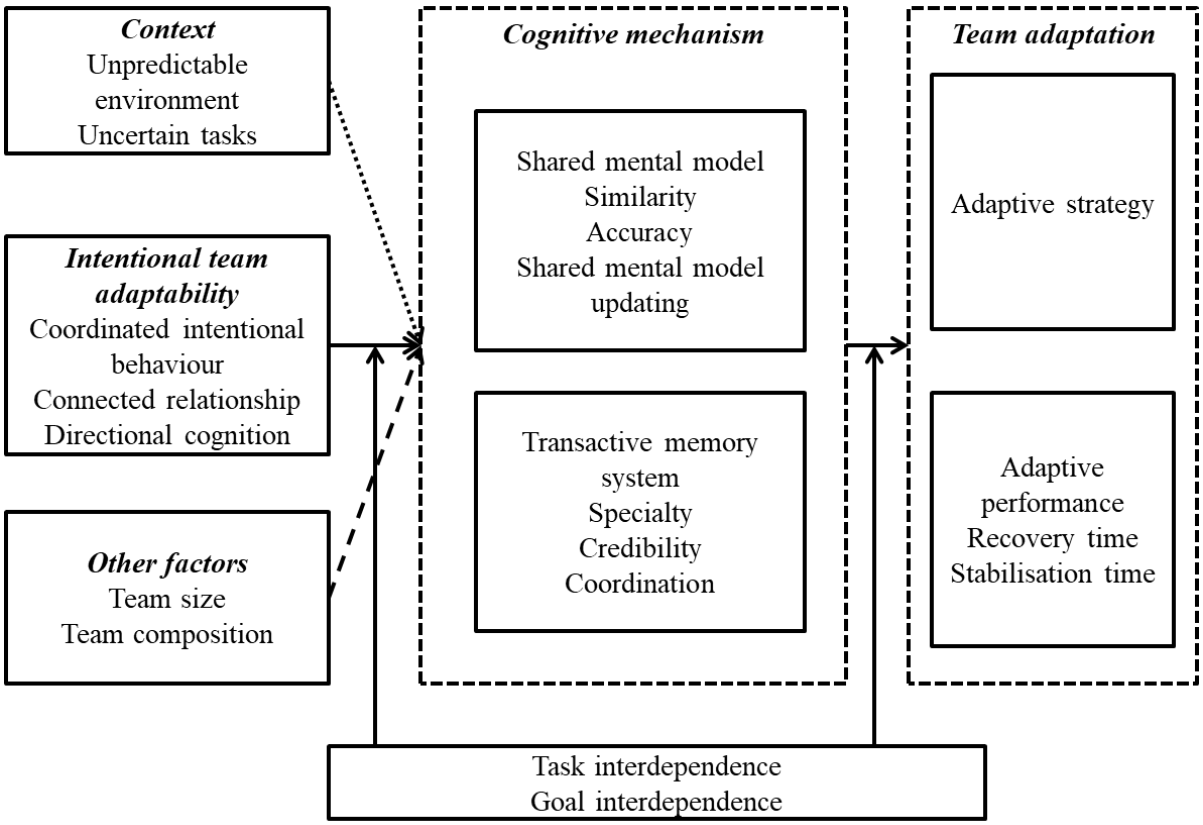
3-2 What is the difference for achieving intentional team adaptation with different levels of goal interdependence?

The results of Study IV supported the moderation hypothesis of task interdependence. The interaction between ITA and task interdependence was significantly related to team adaptative performance, which indicated that teams conducting high interdependent tasks achieve adaptation only when they have high ITA. Mixed-effect of both moderation and mediation were also examined. The results of the moderated mediation examination show that the mediation effect of TMS was higher for highly interdependent tasks than for less interdependent tasks. According to the results of Study IV, the transactive memory system lost its functionality to explain team adaptation for low-interdependent tasks. In other words, the mediation effect was not significant for low-interdependent tasks.

9.6 Summary

Figure 8.2 summarises the main conclusions from this research. The model presents the main intentional team adaptation mechanism studies in this research: ITA that manifested as coordinated intentional behaviour; the connected relationship and directional cognition that influenced teams' adaptive strategy; and an adaptive performance through two main cognitive mechanisms, i.e. the shared mental model and the transactive memory system. The above relationship varies across teams with different levels of goal interdependence and task interdependence.

Figure 9.2 Main Conclusions of This Research



In summary, more studies are needed to validate the theory of intentional adaptation. Future research should promote the validity and credibility of ITA, develop new ways to measure team adaptation and discuss other behavioural results of teams. After all, the idea of intentional adaptation not only refers to quickly and automatically responding to environmental cues but also indicates higher performance, better relationships among team members and higher creativity due to the effective allocation and usage of key resources. Future works can examine the above ideas and nurture more research on teams.

The study of intentional team adaptation is clearly in its infancy. This research contributes to the literature by enriching the conceptual and empirical works of team adaptation as well as by developing a related measurement that provided evidence of construct validity and credibility. This research will hopefully encourage more theoretical and empirical studies of team adaptation, as this is an important topic that affects team performance.

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APPENDICES

Appendix I Interview Outline

(English Edition)

Thanks for joining the survey of team cooperation and team adaptation. Data collected through this survey will be used only for academic research. Besides, we promise the data collected to be anonymous when used for publication. Please feel free to answer the questions.

Q1 Background Information

Q1.1 Team composition (Team members and their responsibilities)

Can you introduce members in your team? Who are they? What are their responsibilities?

Q1.2 Team task and task procedures

Can you introduce your team task briefly? How many procedures are there in the program from demand clarification to software online?

Q2 Understand Team

Q2.1 Reason for adopting team-based work units (and the differences with individual-based work)

In your opinion, why teams are widely used for software development instead of individuals? Is there any difference? What's the advantage and disadvantage of using teams for software development?

Q2.2 Key factors in teamwork

What do you think is the most important factor for teamwork?

What kind of teams do you think is successful/adaptive?

Q2.3 Evaluation of current team

What's the advantages of your team?

Q2.4 Understanding towards team spirit

In your opinion, what is team spirit?

In your team, when do you think you are working along and when do you think you are working with your colleagues?

Q3 Ways to Coordinate Team Members

Q3.1 Importance of keeping alignment among team members

How do you coordinate with your team members? What do you think of your team in coordination? What will be a successful team like in coordination?

(In terms of virtue teams) As a transnational team, do you have any problems with coordination? How does your team coordinate related tasks assigned to people in different countries?

How does your team solve problems of coordination?

Q3.2 Importance of accurate understanding (Problems with misunderstanding)

Did you have any problems caused by misunderstanding in your team? Since developers in the same project work relatively independent, is there any method to avoid misunderstandings?

How does your team solve problems caused by misunderstanding? Do you have any suggestions on avoiding these problems?

Since it is a long journey to develop a software that fulfil the demand, how to decrease losses caused by bias? Can the final software fulfil the demand? Did your team have any problem caused by misunderstanding of client needs?

Q3.3 Understanding "tacit agreement"

How do you define tacit agreement? Is it important in teamwork? Did you have any problems caused by lacking of tacit agreement? How did you solve the problem?

How do you evaluate the tacit agreement between you and your colleagues?

How do you think to build tacit agreement among team members in a short time? What did your team do to build tacit agreement?

Q4 Deal with Uncertainty

Q4.1 Problems caused by changes in task environment

Have you experienced the problem of turnover? What problems can be caused by losing team members? What does your team do to decrease the impact of turnover? Will it cause the problem of misunderstanding?

Did you have problems in the process of development? How did your team solve the problems? What do you think of an adaptive team? Will it have advantages in dealing with this problem? What will adaptive teams do to solve (the problem)?

Q4.2 Measures to deal with emergencies

How do you deal with emergencies? Have you suffered from unexpected changes? How did you deal with it?

Q5 Supplementary Questions

Did you have any other problems in this project? What is the most difficult problem during your teamwork?

(Chinese Edition)

您好！感谢您愿意协助完成关于团队互动合作与团队适应情况的调研。本次调研所涉及到的相关信息仅为学术研究所用，并且在最后公开刊物的发表中采用匿名的方式，所以请尽管放心回答，这些信息概不外泄。

Q1 背景问题

Q1.1 团队构成（团队成员及其各自承担的任务）

你们团队都有哪些成员，怎么确定的？分别负责什么？/有没有对职责边界不确定的事？

Q1.2 任务和流程

你能简要介绍一下任务和完成任务的整个流程吗？/从任务需求到代码开发整个过程要经过哪些环节？/从游戏的 idea 到开发整个过程要经过哪些环节？

Q2 团队是什么

Q2.1 采用团队工作形式的原因（与个体工作形式的区别及利弊分析）

为什么要基于团队而不是个体来工作？ /你觉得为什么需要一个团队来开发这个软件？一个人完不成吗？会有什么区别？/您觉得采用团队有什么样的优势和弊端？

Q2.2 团队工作中最重要的因素（团队工作成功的条件/成功团队的特点），进一步问适应性强、灵活的团队的特点

对于团队而言，什么最重要？

你们觉得一个成功的团队应该具备怎样的能力？

你觉得一个适应性强的团队有什么特点？

Q2.3 对所在团队的评价

你觉得你们团队最大的优势是什么？

Q2.4 对团队精神的理解

您觉得什么是所谓的团队精神、团队意识？

在这个项目组里，你什么时候会觉得只有你一个人在做事，什么时候会觉得你们在一起做事？

Q3 团队如何保持一致

Q3.1 使团队成员之间保持一致的方法和重要性（不一致所产生的问题）

你们通过什么方式来确保工作上的一致和协调呢？/你觉得你们团队在协调一致方面做得好吗？一个做得好的团队应该是怎样的？/（针对虚拟团队）作为一个跨国团队，平时在任务协调方面有没有问题？/相关任务在不同的空间上如何协调？

有遇到因为大家无法达成一致而导致的问题吗？会不会影响工作？/那么多人一起同时编程，会不会存在不一致？是怎么解决的？

Q3.2 使团队成员保持正确的理解的方法和重要性（误解所产生的问题）

在这个项目里，从你的经历来看，有没有因为误解出现的问题？/你们几个开发人员之间要完成同一个项目任务，又是分开独立写代码的，有什么方式保证你们的理解是一样的，不会出现太大偏差吗？/你们在整个项目过程中，有没有遇到过比较大的误解或者冲突？

对项目工作影响大不大？是怎么解决的？/怎么样才能避免这种误解带来的内耗呢？

从需求到开发需要经历很长的过程，怎么减少过程中理解的偏差？/针对业务需求能够完全实现吗？/在一般的软件开发团队中，可能会出现对客户需求理解不当导致编译失败的问题。对于您而言，有没有同样的困扰？

Q3.3 对"默契"的理解和作用

您觉得什么是"默契"，它在团队活动中重要吗？在这个项目里你觉得你们做得好吗？你有遇到过相关的问题吗，是怎么解决的？/你觉得你和你的同事们有默契吗？体现在什么地方？

您觉得应该如何短期内快速提升团队成员的默契程度？/你们公司主要有哪些方式来提升你们团队合作的默契？

Q4 团队如何应对任务环境变化所产生的影响

Q4.1 任务环境变化所产生的影响

比如一个持续性的项目，中间可能会有一些人员离职等导致的流动，会不会使团队任务的理解受到影响？/人员更替会不会影响工作效率？比如有人离职、有新人进来？过渡期间会有哪些措施？/有没有因为人员流动导致的理解上的偏差？

你们在做这款应用的过程中有没有遇到什么困难？是怎么解决的？你们觉得一个适应力比较强的、灵活的团队在遇到这一类的问题时会有什么优势？会采取什么解决方案？

Q4.2 应对紧急状况的措施

在遇到紧急的问题时，您一般如何解决？/你所在的团队有遇到过什么措手不及的变化吗？是如何解决的？

Q5 其他问题的补充

您在这个项目中还遇到过什么比较棘手的问题吗？/你在执行任务的过程中所遇到的最大的问题是什么？/您觉得在目前的状态下，最大的问题是什么？

Appendix II Open Coding and Focus Coding

Examples of Open Coding

Original Materials	Open Coding
(We have) little disagreements. Regularly, divergence is solved through communication. I think the best point in our team is to focus on the work pace and keep alignment. Therefore, we can solve problems in time rather than accumulate the problems as a rolling snowball. We spend a little time every day to keep our work coordinated. It is not required to do the best since life cycle in game industry is quite short. Thus codes we written do not need to be of very high quality. The more important thing is to work together. I mean to work in harmony. When problem occurred, we can identify it and take measures to solve the problem. The advantage of team is to use collective wisdom. However, the most difficult problem is to coordinate different opinions. Various connections exist in teams, including both positive ones and negative ones. If team members are willing to stop their work and ask for others' suggestions as well as value others' suggestions when problem occurred, the problem will be solved more easily. In this situation, the connection is positive. It is also what I mean by saying working in harmony.	A1-1 solve divergence through communication A1-2 focus on the work pace A1-3 keep alignment A1-4 solve problems in time A1-5 work together A1-6 identify problems A1-7 use collective wisdom A1-8 positive/negative connections A1-9 ask for others' suggestions A1-10 value others' suggestions ……

(Chinese Edition, the original materials and coding)

原始资料	开放式编码
基本上没有很大的分歧，一般理解不同都能通过沟通解决。我想我们团队最好的一点是大家都会去关注彼此的工作步调然后尽量保持一致，我们的问题都能及时解决而不会像滚雪球一样越滚越大。平常花一点时间来保持每个人步调一致，不需要让每个人都做到最好，因为游戏行业一个软件生存的时间通常都不会很长，所以我们的代码质量不用很高，更重要的是大家都在一起做这件事，就是说我们要以一种融洽的方式在一起工作。在出现问题的时候，这样的团队都能发现并作出一些事情来解决这个问题。团队的优势在于能集合群众的智慧，但是难点就在于大家经常会有不同的看法，但团队中也充满了各种情感联系，这种情感联系会有积极作用也会有消极作用。如果在出现问题的时候，团队成员愿意停下来听团队其他人怎么讲并且尊重别人的意见，问题就会很容易解决，这时候情感联系就是积极的。这也是我说的融洽的沟通的体现。	A1-1 通过沟通解决理解分歧 A1-2 关注彼此工作步调 A1-3 尽量保持一致 A1-4 及时解决问题 A1-5 一起做事 A1-6 及时发现问题 A1-7 集合群众的智慧 A1-8 积极/消极的感情联系 A1-9 停下来听别人意见 A1-10 尊重别人意见 ……

Examples of Focus Coding

Core categories	Sub-categories	Examples of open coding
Behavioral consistency	Joint action	A1-2 focus on the work pace; A1-5work together; A2-33mutual help……
	Achieving consensus	A1-26 adjust divergence and arrive at consensus; A2-46 achieve consensus on the final product design; A3-21make agreement on understandings……
	Setting standardization	A1-20 have the universally accepted standards in industry (common knowledge); A3-56 set standard for coding format; A4-32 follow standard procedures……
	Share responsibility	A2-34 attach equal importance for team task and individual task; A3-17 do one's own work with the state of disunity (R); A3-53 It is team's responsibility for a bad job……
Work relationship	Task-based interaction	A1-24 Experience of working together; A2-67 Frequent discussion in daily life; A7-4 good work relationship……
	Cooperation tendency	A1-57 cooperation based on agreement; A2-78 close cooperation; A4-68 accept suggestions with open mind……
	Mutual respect	A1-10 respect others' suggestions; A2-28 learning attitude; A3-8 admit shortage and learn from others……
Problem-solving	Caring for the facts	A1-33 consider something as it stands; A2-9 focus on facts; A3-50 avoid personal attack……
	Try all the possible ways	A2-11analysis of potential solution's advantages and disadvantages; A3-62 asking for judgment from the third party; A4-63 detailed discussion of advantages and disadvantaged based on survey……
	Frank communication	A2-10 Encourage members to speak out; A3-23 Open mind and do not be afraid of making mistakes; A4-16 Do not be afraid to expose shortcomings……
	Accumulating evidence for tracing problems	A2-6 have materials for tracing the origin of problem; A4-12 keep documents and examples to ensure the availability of cues; A5-85 feedback in time……
Focusing on team goal	Emphasizing on key points	A2-13 focus on the most important thing; A3-97 agreement with the most important task; A5-125 making effort for the most important tasks……
	Goal-directedness	A1-11 target at team goal; A2-47 have knowledge of what to do; A7-10 have idea of direction……

(Chinese Edition, the original materials and coding)

核心范畴	子范畴	对初始代码的筛选与分类示例
保持一致	联合行动	A1-2 关注彼此工作步调；A1-5 一起做事； A2-33 相互帮助……
	达成共识	A1-26 调整不一致，达成共识；A2-46 对最终产品（的设计）达成共识；A3-21 理解保持一致……
	确立标准	A1-20 行业有公认的标准（公共知识)；A3-56 规范代码风格；A4-32 遵从流程……
	共同负责	A2-34 团队任务和个人任务并重；A3-17 各自为政，一盘散沙（R)；A3-53 没做好是全团队的事……
工作关系	工作互动	A1-24 共事经历；A2-67 平时一起讨论；A7-4 有良好的工作关系……
	合作倾向	A1-57 协商合作；A2-78 亲密无间的合作；A4-68 以开放的心态包容建议……
	态度积极	A1-10 尊重别人的意见；A2-28 学习的态度；A3-8 坦诚自己的不足，学习别人的长处……
问题解决	就事论事	A1-33 就事论事；A2-9 关注点放在事情上；A3-50 杜绝人身攻击……
	想方设法	A2-11 讨论解决方案的利弊；A3-62 请第三方来仲裁；A4-63 经过调研，详细陈述利弊进行方案的筛选……
	开诚布公	A2-10 鼓励大家说出对事情的看法；A3-23 心态要开放，不惧错误；A4-16 不怕暴露自己的缺点……
	问题追踪	A2-6 出了问题后有迹可循；A4-12 保留大量文档和用例，保证线索可获得性；A5-85 及时反馈……
聚焦目标	关注重点	A2-13 抓大放小，关注最重要的事；A3-97 对当下该做的主要的事情有相同的看法；A5-125 把时间精力放在重要的事上……
	目标导向	A1-11 做的事情朝着目标去；A2-47 知道要做成什么样子；A7-10 知道往什么方向去做……

Appendix III Initial Scale of Intentional Team Adaptation

(English Edition)

Dear participant:

This scale is developed for evaluating the quality of teamwork and adaptability. We are now in the stage of scale development and you are highly appreciated to take part in this program. It is required to be filled by those who had teamwork experiences and answer the questions based on the facts in his/her team. Data collected is promised to be anonymous. Thank you for your cooperation and contribution. If you have any suggestions, please contact: Molly_Luan@_____

Part 1: Background Information

1. Gender
○ Male ○ Female
2. Industry:
○ Manufactory ○ Service ○ Education/Training/Consulting ○ IT/E-commercial
○ Others_____
3. Age: _____
4. Team size: _____
5. Work experience: _____(years)

Part 2: Intentional Team Adaptation

Instructions: Please circle the most appropriate score based on your judgment of each statement. Among them, score 1 is for strongly disagree; score 2 is for a little disagree; score 3 is for uncertain; score 4 is for a little agree; and score 5 is for strongly agree.

No.	Statement	Strongly disagree → Strongly agree				
1	In our team, we have to take joint action to achieve the common goal.	1	2	3	4	5
2	In our team, we formulate similar ideas through discussion to complete the task.	1	2	3	4	5
3	In our team, we established the procedures, steps and standard to complete the task.	1	2	3	4	5
4	In our team, we will share responsibility together.	1	2	3	4	5
5	In our team, all of us can do our own job according to the requirement.	1	2	3	4	5
6	In our team, the labor division is clear, including time and task content.	1	2	3	4	5
7	In our team, we will arrange the subtasks according to their importance after dividing team task into pieces.	1	2	3	4	5
8	In our team, we will make plans before completing the task.	1	2	3	4	5
9	In our team, we all have the approach to know what others are doing.	1	2	3	4	5

(Continued)

No.	Statement	Strongly disagree → Strongly agree				
10	In our team, we will share diversified resources.	1	2	3	4	5
11	In our team, we will put effort in understanding each other	1	2	3	4	5
12	We focus on the task when problems occur.	1	2	3	4	5
13	We try every possible way and use all the available resource to solve the problem.	1	2	3	4	5
14	We share opinions frankly and sincerely to solve problems, avoiding cover up the truth for any reason	1	2	3	4	5
15	We have enough materials to trace the origin of problems.	1	2	3	4	5
16	We always focus on the most important thing in the moment.	1	2	3	4	5
17	Things we done all aim at achieving the target.	1	2	3	4	5
18	We all know and identify with team's task and target.	1	2	3	4	5
19	We know well about each other's personality, skills and working styles.	1	2	3	4	5
20	All of our team members have the ability and skills to complete team tasks.	1	2	3	4	5
21	We will encourage and support each other when encountering any troubles and problems.	1	2	3	4	5
22	We have good personal relationships with each other.	1	2	3	4	5
23	We are proud of being part of the team.	1	2	3	4	5
24	We exchange views with each other during work.	1	2	3	4	5
25	We are willing to sacrifice personal benefits for solving team's problems.	1	2	3	4	5
26	We have mutual respect and mutual trust for each other.	1	2	3	4	5

Part 3: Team Performance

Instructions: Please circle the most appropriate score based on your judgment of each statement. Among them, score 1 is for strongly disagree; score 2 is for a little disagree; score 3 is for uncertain; score 4 is for a little agree; and score 5 is for strongly agree.

No.	Statement	Strongly disagree → Strongly agree				
1	Generally speaking, we are very satisfied with their work.	1	2	3	4	5
2	We feel a strong commitment to their work.	1	2	3	4	5
3	We feel highly committed to the goals of their work.	1	2	3	4	5
4	The way we manage our work inspires us to better job performance.	1	2	3	4	5
5	All things considered, the team is highly pleased with the way it manages its work.	1	2	3	4	5

(Chinese Edition, used for collecting data in this study)

您好！本问卷是测评团队合作状况及适应能力的量表，现处于问卷开发测试阶段。诚邀您的参与！本问卷要求填答人有团队合作经历并根据其所在团队情况如实填答，问卷发布人申明所有问卷数据将会匿名处理，十分感谢您的配合和对科研的贡献！有任何建议和意见，请联系：Molly_Luan@_____

一、基本信息

1. 您的性别：[单选题] [必答题]

   ○ 男　○ 女

2. 您目前从事的行业：[单选题] [必答题]

   ○ 制造业　○ 服务业　○ 教育、培训、咨询行业

   ○ IT、电子商务业　○ 其他 _____

3. 您的年龄是：[填空题] [必答题] _____

4. 您所在团队的总人数 [填空题] [必答题]_____

5. 您有几年的工作经验？[填空题] [必答题]_____

二、团队适应力

说明：请您根据您对您所在团队的评价，对以下表述进行判断，圈出您认为合适的评分。其中：1 分表示完全不同意，2 分表示有点不同意，3 分表示不确定，4 分表示有点同意，5 分表示完全同意题项中的描述。

题项	描述	完全不同意	有点不同意	不确定	有点同意	完全同意
1	我们团队会一起努力来完成共同的目标。	1	2	3	4	5
2	我们团队通过协商形成相似的想法来完成任务。	1	2	3	4	5
3	我们团队确立了完成任务的程序、步骤和实现的标准。	1	2	3	4	5
4	我们会共同承担团队行动的结果和责任。	1	2	3	4	5
5	我们团队的成员会按照要求做好自己份内的事情。	1	2	3	4	5
6	我们团队分工很明确，包括截止时间、任务内容等。	1	2	3	4	5
7	我们团队会在细分任务后依据重要性排列任务完成的优先序。	1	2	3	4	5
8	我们会在任务开展之前先做好计划。	1	2	3	4	5
9	我们团队中所有人都有渠道去了解其他人在做的事情以及任务完成的程度。	1	2	3	4	5
10	我们团队会共享彼此之间的差异化资源。	1	2	3	4	5
11	我们团队的成员会通过各种方式沟通来理解彼此的想法。	1	2	3	4	5

题项	描述	完全不同意	有点不同意	不确定	有点同意	完全同意
12	遇到任何困难，我们都会相互鼓励，彼此扶持。	1	2	3	4	5
13	我们团队成员之间有良好的私人关系。	1	2	3	4	5
14	我们会因为是这个团队的一分子而感到自豪。	1	2	3	4	5
15	我们在工作中会经常交流意见。	1	2	3	4	5
16	我们会愿意为了解决团队问题而在自己的利益方面有所妥协。	1	2	3	4	5
17	我们团队成员之间相互尊重、相互信任。	1	2	3	4	5
18	出现问题的时候，我们只针对任务本身进行讨论。	1	2	3	4	5
19	出现问题的时候，我们会想方设法调动一切资源来进行解决。	1	2	3	4	5
20	出现问题的时候，我们会开诚布公地进行讨论，不会因为任何原因而遮遮掩掩。	1	2	3	4	5
21	出现问题的时候，我们有足够的材料来追踪问题发生的根源。	1	2	3	4	5
22	我们总是会聚焦于当下最重要的事情。	1	2	3	4	5
23	我们所做的所有事情都是为了完成目标。	1	2	3	4	5
24	我们都知道并认同团队的任务和目标。	1	2	3	4	5
25	我们对彼此的情况（技术专长、个性、工作风格等）都十分了解。	1	2	3	4	5
26	我们团队的成员都具有完成任务所需要的能力和技术。	1	2	3	4	5

三、团队绩效

说明：请您根据您对您所在团队的评价，对以下表述进行判断，圈出您认为合适的评分。其中：1 分表示完全不同意，2 分表示有点不同意，3 分表示不确定，4 分表示有点同意，5 分表示完全同意题项中的描述。

题项	描述	完全不同意	有点不同意	不确定	有点同意	完全同意
1	总体而言，团队成员对自己的工作很满意。	1	2	3	4	5
2	团队成员的工作责任心很强。	1	2	3	4	5
3	团队成员对自己的工作目标十分投入。	1	2	3	4	5
4	我们现行的工作方式能够启发我们继续改善工作绩效。	1	2	3	4	5
5	总而言之，我们团队对其运作方式高度满意。	1	2	3	4	5

Appendix IV Revised Intentional Team Adaptation Scale for Student Project Teams

(English Edition)

Dear participant:
Thank you very much for participating in this survey on team cooperation and team intentional adaptability. Data collected is promised to be anonymous and will be used only for academic use. Please feel free to fill in the questionnaire.
Please answer the questions based on your experience in the project of this class. Thank you very much! Circle the most appropriate score based on your judgment of each statement for your team.

Part 1: Intentional Team Adaptation

1. We will encourage and support each other when encountering any troubles and problems.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

2. We are proud of being part of the team.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

3. We have mutual respect and mutual trust for each other.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

4. In our team, we have to take joint action to achieve the common goal.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

5. In our team, we formulate similar ideas through discussion to complete the task.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

6. In our team, we established the procedures, steps and standard to complete the task.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

7. In our team, we will make plans before completing the task.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

8. We try every possible way and use all the available resource to solve the problem.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

9. We share opinions frankly and sincerely to solve problems, avoiding cover up the truth for any reason.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

10. What we do all aim at achieving the target.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

11. We all know and identify with team's task and target.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

12. All of our team members have the ability and skills to complete team tasks.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

Part 2: Team Adaptive Manifestation

1. After agreements have been made in this team, everyone does things a little differently.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

2. In this team people keep to agreements.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

3. In this team people have their own personal interpretation of agreements even when they are written down.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

4. What we discuss corresponds with what we do subsequently.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

5. After matters have been agreed, it turns out that different interpretations of the agreements exist among team members.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

Part 3: Individual Adaptability

1. I'm able to quickly analyze options for dealing with crisis.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree
2. I'm working well with difficult circumstance or highly demanding workload.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree
3. It's not difficult for me to generate innovative ideas to solve problems.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree
4. When confronted with changes, I can develop a new plan to meet the requirement in a short period.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree
5. I'm willing to learn new skills to complete my work.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree
6. I'm willing to adjust my own behaviors to better fit my partners in the team.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree
7. I have friends from all over the world.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree
8. I don't like to do exercises to increase my endurance for the future demands of work activities.
○Strongly disagree ○A little disagree ○I'm not sure ○A little agree ○Strongly agree

Part 4: Other Information

1. Gender
○ Male ○ Female
2. Team number/name: _____

(Chinese Edition, used for collecting data in this study)

亲爱的同学:

您好！十分感谢您参加这次基于团队合作任务的适应力调研，本次问卷中所获得的所有数据都将进行匿名处理，并且承诺只用于学术研究，请放心填答！

以下题目请根据您本身在这一课堂项目中的经历来回答，十分感谢！请您根据您对您所在小组/团队的评价，对以下表述进行判断，圈出您认为合适的评分。

一、团队意向

1. 遇到任何困难，我们都会相互鼓励，彼此扶持。
○完全不符合　○不符合　○不确定　○符合　○完全符合
2. 我们会因为是这个团队的一分子而感到自豪。
○完全不符合　○不符合　○不确定　○符合　○完全符合
3. 我们团队成员之间相互尊重、相互信任。
○完全不符合　○不符合　○不确定　○符合　○完全符合
4. 我们团队会一起努力来完成共同的目标。
○完全不符合　○不符合　○不确定　○符合　○完全符合
5. 我们团队通过协商形成相似的想法来完成任务。
○完全不符合　○不符合　○不确定　○符合　○完全符合
6. 我们团队确立了完成任务的程序、步骤和实现的标准。
○完全不符合　○不符合　○不确定　○符合　○完全符合
7. 我们会在任务开展之前先做好计划。
○完全不符合　○不符合　○不确定　○符合　○完全符合
8. 出现问题的时候，我们会想方设法调动一切资源来进行解决。
○完全不符合　○不符合　○不确定　○符合　○完全符合
9. 出现问题的时候，我们会开诚布公地进行讨论，不会因为任何原因而遮遮掩掩。
○完全不符合　○不符合　○不确定　○符合　○完全符合
10. 我们所做的所有事情都是为了完成目标。
○完全不符合　○不符合　○不确定　○符合　○完全符合
11. 我们都知道并认同团队的任务和目标。
○完全不符合　○不符合　○不确定　○符合　○完全符合
12. 我们团队的成员都具有完成任务所需要的能力和技术。
○完全不符合　○不符合　○不确定　○符合　○完全符合

二、团队适应

1. 在团队中已经达成一致后，依然有人做的跟商定的不同。
○完全不符合　○不符合　○不确定　○符合　○完全符合
2. 在这个团队中的每个人都按约定的做。
○完全不符合　○不符合　○不确定　○符合　○完全符合
3. 即便是我们把约定写下来，也依然有人会有自己的一套解释。
○完全不符合　○不符合　○不确定　○符合　○完全符合
4. 我们根据所讨论的情况做事。
○完全不符合　○不符合　○不确定　○符合　○完全符合
5. 在事情商定后，依然有人对达成一致的事情有自己的一套解释。
○完全不符合　○不符合　○不确定　○符合　○完全符合

三、个体适应力

1. 我能够很快地分析出用于解决危机的方案。
○完全不符合　○不符合　○不确定　○符合　○完全符合
2. 我能够很好地处理困难的问题或高强度的工作。

○完全不符合　　○不符合　　○不确定　　○符合　○完全符合
3. 对于我而言，产生创新的想法来解决问题不是一件难事。
○完全不符合　　○不符合　　○不确定　　○符合　○完全符合
4. 当遇到变化时，我能够在很短的时间内想出新的符合要求的方案。
○完全不符合　　○不符合　　○不确定　　○符合　○完全符合
5. 我愿意学习新的技能来完成我的工作。
○完全不符合　　○不符合　　○不确定　　○符合　○完全符合
6. 我愿意调整我的行为来更好地配合我的团队搭档。
○完全不符合　　○不符合　　○不确定　　○符合　○完全符合
7. 我的朋友遍布全世界。
○完全不符合　　○不符合　　○不确定　　○符合　○完全符合
8. 我不喜欢做运动来增加我的耐力来符合未来工作的需要。
○完全不符合　　○不符合　　○不确定　　○符合　○完全符合

四、其他信息

1. 您的性别:
○男　　○女
2. 您的团队编号/代号_____

Appendix V Experimental Materials

Appendix 5-1 Experimental instructions

(English Edition)

1. Instruction for setting 1 (Task A×Cooperative goal interdependence)

- Basic Materials:

12 cards in total: one is in the target place; each player get one in hand; the remaining eight are in the folded card pool.

- Target:

Three players cooperate to move heart 2 to the target place. **Complete as many rounds as possible in 20 minutes, the team who complete the most rounds win the reward 150 RMB.**

- Game Rules:

Same suit rule: only allowed to change cards with cards of the same suit

Same color rule: only allowed to change cards with the same color one

Same number rule: only allowed to change cards with the cards of same number

- Behavioral choices:

Exchange card with the target place: Click the target place, if the rule applies, the card will change accordingly; it is counted as one step.

Exchange card with open card pool: Click the open card pool, if the rule applies, the card will change accordingly, it is counted as one step.

Exchange card with folded card pool: Click the folded card pool to get a new card regardless of the exchange rule; the card in hand will be presented in the open card pool accordingly; it is counted as one step.

Exchange card with other members: Click the “switch” button, the one who is asked for will receive a dialogue box showing the information, he or she can accept the request or reject; if accepted then cards are exchanged successfully and it will be counted as one step; if rejected then cards will not be exchanged, the player can conduct other behaviors.

Publicize one’s own card: Click the “show” button, so that the other members can see your card; it is counted as one step.

Skip: Click the skip button; it is not counted as steps.

2. Instruction for setting 2 (Task B×Cooperative goal interdependence)

(Other parts are same with instruction for setting 1 except for target)

- Target:

Three players cooperate to move heart 2 to the target place. **Complete at least 10 rounds within 20 minutes, the team who use least steps to complete 10 rounds win the reward 150 RMB.**

3. Instruction for setting 3 (Task A×Competitive goal interdependence)

(Other parts are same with instruction for setting 1 except for target)

- Target:

Three players cooperate to move heart 2 to the target place. **Complete as many rounds as possible in 20 minutes, the member contribute most in the winner team who complete the most rounds win the reward 150RMB. The one who exchange heart 2 to the target place is regarded as the contributor.**

4. Instruction for setting 3 (Task B×Competitive goal interdependence)

(Other parts are same with instruction for setting 1 except for target)

- Target:

Three players cooperate to move heart 2 to the target place. **Complete at least 10 rounds within 20 minutes, the member use least steps in the winner team who use least steps to complete 10 rounds win the reward 150RMB.**

(Chinese Edition, used in the experimental study)

1. 场景 1（任务 A×高团队意向性）的说明文本

- 任务设定:

共 12 张牌，其中目标位上一张牌，三个玩家手中各有一张牌，其余八张牌在暗牌牌池和明牌牌池中流动。

- 任务目标:

三个玩家合作把红心 2 换到目标位上。**20 分钟内完成的次数最多的团队胜利，拿到奖金 150 元。**

- 游戏规则:

同花规则：同样花色可以换牌
同色规则：同样颜色可以换牌
同数规则：同样数字可以换牌

- 游戏操作的解释:

与目标位换牌：点击目标位上的牌面，符合规则即成功交换；计入步数
与明牌牌池换牌：点击明牌牌池中的牌面，符合规则即成功交换；计入步数
与暗牌牌池换牌：点击暗牌牌池，得到一张新的牌，手中的牌进入到明牌牌池；计入步数
与其他成员换牌：点击你想换的那个规则位对应的“换牌”按钮，等待对方同意，如果对方不同意则换牌不成功，可以进行其他操作；对方同意则换牌成功，按顺序进入到下一个玩家操作，换牌成功计入步数
公开：让其他人看到手中的牌，计入步数
跳过：不进行任何操作，不计入步数

2. 场景 2（任务 B×高团队意向性）的说明文本

（其他部分相同）

- 任务目标

三个玩家合作把红心 2 换到目标位上。**20 分钟内完成至少 10 局，10 局所用总步数最少的团队胜利，拿到奖金 150 元。**

3. 场景 3（任务 A×低团队意向性）的说明文本

（其他部分相同）

- 任务目标

三个玩家合作把红心 2 换到目标位上。**20 分钟内胜出局数最多的玩家获得奖金 150 元。**（最后一步把红心 2 换到目标位上的玩家则为该局胜出者）。

4. 场景 4（任务 B×低团队意向性）的说明文本

（其他部分相同）

- 任务目标

三个玩家合作把红心 2 换到目标位上。**20 分钟内完成至少 10 局，完成 10 局所用总步数最少的玩家获得奖金 150 元。**

Appendix 5-2 Measurement tools used in the experimental study

(English Edition)

A. Please write down as many potential routes as possible to exchange heart 2 to club 4 in the target place (all rules are available). For example: heart 2→heart3 → diamond 3 → club 3 → club 4.

B. Please write down as many potential routes as possible that are most effective ones to exchange heart 2 to club 4 in the target place (all rules are available). For example: heart 2→ diamond 4→club 4

C. Background Information

1. Major: ☐ mathematic-related ☐humanity ☐social science ☐agriculture and medical science
2. Gender: ☐Male ☐Female
3. Similarity with games I have played:
☐Not at all ☐A little ☐Half and half ☐To a large degree☐Exactly the same
4. Similarity with games I have seen:
☐Not at all ☐A little ☐Half and half ☐To a large degree☐Exactly the same
5. Similarity with games I know:
☐Not at all ☐A little ☐Half and half ☐To a large degree☐Exactly the same

Those players who participate in the setting1→setting 2 or setting 3→setting 4, complete Part A first (before the experiment) and then Part BC (after the experiment)
Those players who participate in the setting2→setting 1 or setting 4→setting 3, complete Part B first (before the experiment) and then Part AC (after the experiment)

(Chinese Edition, used in the experimental study)

A. 根据您对游戏的了解，请尽可能多地写下将红心 2 置换到目标位上（梅花 4）的路径（三个规则均可用）。例：红心 2→红心 3→方块 3→梅花 3→梅花 4

B. 根据您完成任务的情况，请尽可能多地写下您认为将红心 2 置换到目标位上最有效的路径。例：红心 2→方块 4→梅花 4

C．背景信息
1. 我的专业是:
□理工类□文科类□社科类□农医类
2. 我的性别是:
□男□女
3.我**玩过的**游戏中与这个游戏的相似程度:
□没有类似的□有一点点相似□一半相似□很大程度上相似□完全一样
4. 我**看到过的**游戏中，与这款游戏的相似度
□没有类似的□有一点点相似□一半相似□很大程度上相似□完全一样
5. 我**知道的**游戏中，与这款游戏的相似度
□没有类似的□有一点点相似□一半相似□很大程度上相似□完全一样

参与场景 1→场景 2 或场景 3→场景 4 任务变化的玩家先后填答 A 部分（在正式实验开始前），BC 部分（在正式实验结束后）
参加场景 2→场景 1 或场景 4→场景 3 任务变化的玩家先后填答 B 部分（在正式实验开始前），AC 部分（在正式实验结束后）

Appendix VI Questionnaires for the Field Study

Appendix 6-1 Questionnaires of intentional team adaptation and transactive memory system (filled by team members)

(English Edition)

Survey for team adaptation after equipment replacement Number: ____

Dear participant:

We are research team from Zhejiang University and we are working on a series research of team adaptation. One of the studies is to investigate production team adaptation after equipment replacement in manufactory industry, hoping to provide suggestions for factories to solve this kind of problems. Data collected is promised to be anonymous and will be used only for academic use. Please feel free to fill in the questionnaire. Thank you for your cooperation and support!

Part 1: Intentional Team Adaptation

Instructions: Please circle the most appropriate score based on your judgment of each statement. Among them, score 1 is for strongly disagree; score 2 is for a little disagree; score 3 is for uncertain; score 4 is for a little agree; and score 5 is for strongly agree.

No.	Statement	Strongly disagree → Strongly agree				
1	We will encourage and support each other when encountering any troubles and problems.	1	2	3	4	5
2	We are proud of being part of the team.	1	2	3	4	5
3	We have mutual respect and mutual trust for each other.	1	2	3	4	5
4	In our team, we have to take joint action to achieve the common goal.	1	2	3	4	5
5	In our team, we formulate similar ideas through discussion to complete the task.	1	2	3	4	5
6	In our team, we established the procedures, steps and standard to complete the task.	1	2	3	4	5
7	In our team, we will make plans before completing the task.	1	2	3	4	5
8	We try every possible way and use all the available resource to solve the problem.	1	2	3	4	5
9	We share opinions frankly and sincerely to solve problems, avoiding cover up the truth for any reason.	1	2	3	4	5
10	What we do all aim at achieving the target.	1	2	3	4	5
11	We all know and identify with team's task and target.	1	2	3	4	5
12	All of our team members have the ability and skills to complete team tasks.	1	2	3	4	5

(Turn to the opposite and fill the other side of the questionnaire)

Part 2: Transactive Memory System

Instructions: Please circle the most appropriate score based on your judgment of each statement. Among them, score 1 is for strongly disagree; score 2 is for a little disagree; score 3 is for uncertain; score 4 is for a little agree; and score 5 is for strongly agree.

No.	Statement	Strongly disagree → Strongly agree				
1	Each team member has specialized knowledge of some aspect of our project.	1	2	3	4	5
2	I have knowledge about an aspect of the project that no other team member has.	1	2	3	4	5
3	Different team members are responsible for expertise in different areas.	1	2	3	4	5
4	The specialized knowledge of several different team members was needed to complete the project deliverables.	1	2	3	4	5
5	I know which team members have expertise in specific areas.	1	2	3	4	5
6	I was comfortable accepting procedural suggestions from other team members.	1	2	3	4	5
7	I trusted that other members' knowledge about the project was credible.	1	2	3	4	5
8	I was confident relying on the information that other team members brought to the discussion.	1	2	3	4	5
9	When other members gave information, I wanted to double-check it for myself.	1	2	3	4	5
10	I did not have much faith in other members' "expertise."	1	2	3	4	5
11	Our team worked together in a well-coordinated fashion.	1	2	3	4	5
12	Our team had very few misunderstandings about what to do.	1	2	3	4	5
13	Our team needed to backtrack and start over a lot.	1	2	3	4	5
14	We accomplished the task smoothly and efficiently.	1	2	3	4	5
15	There was much confusion about how we would accomplish the task.	1	2	3	4	5

Part 3: Background Information

1. Gender: A. Male B. Female
2. Age: ____
3. Education: A. Junior high school and below B. High school C. Junior college D. Bachelor and above
4. Team size: ____
5. Work experiences: _____years_____months
6. Working time in this team: _____years_____months
7. How many times have you experienced for equipment replacement? _____
8. How many factories have you worked for? _____
9. To what degree are you satisfied with your current work:

A. very unsatisfied; B. a little unsatisfied; C. just so-so; D. a little satisfied; E. very satisfied

10. To what degree are you satisfied with your current payment:

A. very unsatisfied; B. a little unsatisfied; C. just so-so; D. a little satisfied; E. very satisfied

11. To what degree are you satisfied with your current colleagues :

A. very unsatisfied; B. a little unsatisfied; C. just so-so; D. a little satisfied; E. very satisfied

(Chinese Edition, used in the field study)

关于设备更换后的团队适应调查

问卷编号：_____

您好!

我们是来自浙江大学国家创新管理基地的研究团队，目前正在开展以团队适应为主题的一系列研究，其中之一的子课题是调查制造业企业中设备更换后生产团队作业的适应性问题，希望能通过本次研究给企业解决这一类问题提供切实有效的建议。我们保证将匿名处理所有数据，并且承诺这些数据只用于科学研究，请您放心填答！十分感谢您的配合和支持!

第一部分：团队意向

说明：请您根据您对您所在团队的评价，对以下表述进行判断，圈出您认为合适的评分。其中：1 分表示完全不同意，2 分表示有点不同意，3 分表示不确定，4 分表示有点同意，5 分表示完全同意题项中的描述。

题项	描述	完全不同意	有点不同意	不确定	有点同意	完全同意
1	遇到任何困难，我们都会相互鼓励，彼此扶持。	1	2	3	4	5
2	我们会因为是这个团队的一分子而感到自豪。	1	2	3	4	5
3	我们团队成员之间相互尊重、相互信任。	1	2	3	4	5
4	我们团队会一起努力来完成共同的目标。	1	2	3	4	5
5	我们团队通过协商形成相似的想法来完成任务。	1	2	3	4	5
6	我们团队确立了完成任务的程序、步骤和实现的标准。	1	2	3	4	5
7	我们会在任务开展之前先做好计划。	1	2	3	4	5
8	出现问题的时候，我们会想方设法调动一切资源来进行解决。	1	2	3	4	5
9	出现问题的时候，我们会开诚布公地进行讨论，不会因为任何原因而遮遮掩掩。	1	2	3	4	5
10	我们所做的所有事情都是为了完成目标。	1	2	3	4	5
11	我们都知道并认同团队的任务和目标。	1	2	3	4	5
12	我们团队的成员都具有完成任务所需要的能力和技术。	1	2	3	4	5

（请翻到反面继续作答）

第二部分：团队交互记忆

说明：请您根据您对您所在团队的评价，对以下表述进行判断，圈出您认为合适的评分。其中：1 分表示完全不同意，2 分表示有点不同意，3 分表示不确定，4 分表示有点同意，5 分表示完全同意题项中的描述。

题项	描述	完全不同意	有点不同意	不确定	有点同意	完全同意
1	我们团队中的每个人都具有与工作有关的某方面的技术	1	2	3	4	5
2	我具有其他人没掌握的和工作有关的技术	1	2	3	4	5
3	我们每个人各自有不同方面的专长	1	2	3	4	5
4	我们团队中不同的人所具有的专门知识都是完成工作所需要的	1	2	3	4	5
5	我了解别人各自在具体方面的专长	1	2	3	4	5
6	我能够舒服地接受其他人的建议	1	2	3	4	5
7	我相信团队中其他人掌握的有关我们工作的技术是可以信赖的	1	2	3	4	5
8	我相信其他人在讨论中提出的信息是可靠的	1	2	3	4	5
9	当其他人提供了信息，我总想自己再检查一遍	1	2	3	4	5
10	我不太相信其他人的技术	1	2	3	4	5
11	一起工作时我们协调得很好	1	2	3	4	5
12	我们对于该做什么很少产生误解	1	2	3	4	5
13	我们团队经常需要回头对已经做过的工作重新再做一次	1	2	3	4	5
14	我们顺利而且有效率地完成工作	1	2	3	4	5
15	我们对于如何完成工作感到很混乱	1	2	3	4	5

第三部分：背景信息

1. 您的性别：A. 男　　B. 女
2. 您的年龄：____岁
3. 您的学历：A. 初中及以下　B. 高中　C. 专科　D. 本科及以上
4. 您所在团队的人数：____人
5. 您有多长时间的工作经验：_____年_____月
6. 您在这个生产团队中的时间：_____年_____月
7. 您经历过几次设备更换？_____
8. 您在几个工厂/企业做过事情？_____
9. 您对目前工作的满意程度：A. 很不满意 B. 较不满意 C. 一般 D. 较满意 E. 很满意
10. 您对目前工资的满意程度：A. 很不满意 B. 较不满意 C. 一般 D. 较满意 E. 很满意
11. 您对目前同事的满意程度：A. 很不满意 B. 较不满意 C. 一般 D. 较满意 E. 很满意

Appendix 6-2 Questionnaires of task interdependence and team adaptation (filled by team leaders)

(English Edition)

Survey for team adaptation after equipment replacement

Number: _____

Dear participant:

We are research team from Zhejiang University and we are working on a series research of team adaptation. One of the studies is to investigate production team adaptation after equipment replacement in manufactory industry, hoping to provide suggestions for factories to solve this kind of problems. Data collected is promised to be anonymous and will be used only for academic use. Please feel free to fill in the questionnaire. Thank you for your cooperation and support!

Part 1: Task Interdependence

Instructions: Please circle the most appropriate score based on your judgment of each statement about your team task. Among them, score 1 is for strongly disagree; score 2 is for a little disagree; score 3 is for uncertain; score 4 is for a little agree; and score 5 is for strongly agree.

No.	Statement	Strongly disagree → Strongly agree				
1	Group members work closely with each other in doing their work.	1	2	3	4	5
2	Group members must frequently coordinate their efforts with each other.	1	2	3	4	5
3	The way individual members perform their jobs has a significant impact upon others in the group.	1	2	3	4	5
4	Group members work interdependently with each other.	1	2	3	4	5
5	Group members need information and advice from one another to perform their jobs well.	1	2	3	4	5
6	Group members need to collaborate with colleagues to perform their jobs well.	1	2	3	4	5
7	Group members regularly have to communicate with colleagues about work-related issues.	1	2	3	4	5

Part 2: Team Performance

Please evaluate your team performance before and after equipment replacement based on your knowledge about average production level in the industry. Please report the percentage number as the indicator for your team performance. This number is the ratio of your team performance in compared with the average industry performance. For example, 150% refers to the fact that your team performance is 1.5 times of average industry performance; and 50% refers to the fact that your team performance is only half of average industry performance.

1. Before equipment replacement, I think our team performance has_____ times of average industry performance.

2. After equipment replacement, I think our team performance has decreased to _____ times of average industry performance.

3. After adaption to the new equipment, I think our team performance has reached to _____ times of average industry performance.

Please evaluate the time your team spend on recovery from the event of equipment replacement based on your knowledge about average time spend in your industry. Please report the percentage number as the indicator for time spent. This number is the ratio of your team's time in compared with the average time spent in the industry. For example, 150% refers to the fact that time spend in your team is 1.5 times of average industry level; and 50% refers to the fact that your team only spend half time to recovery from equipment replacement in compared with the industry level.

1. I think the duration of recovery to the original production level has_____ times of average industry time.

2. I think the duration of getting stable has _____ times of average industry time.

Part 3: Background Information

1. Industry: _____

2. Total number of employees in the factory: _____; Annual Output Value: _____

3. Operation time: _____ years

4. Turnover rate of the team: A. very low; B. low; C. average; D. high; E. very high

(Chinese Edition, used in the field study)

关于设备更换后的团队适应调查

问卷编号：_____

敬爱的管理者：您好!

我们是来自浙江大学国家创新管理基地的研究团队，目前正在开展以团队适应为主题的一系列研究，其中之一的子课题是调查制造业企业中设备更换后生产团队作业的适应性问题，希望能通过本次研究给企业解决这一类问题提供切实有效的建议。我们保证将匿名处理所有数据，并且承诺这些数据只用于科学研究，请您放心填答！十分感谢您的配合和支持!

第一部分：任务特征

说明：请您根据您的团队所从事的工作的评价，对以下表述进行判断，圈出您认为合适的评分。其中：1 分表示完全不同意，2 分表示有点不同意，3 分表示不确定，4 分表示有点同意，5 分表示完全同意题项中的描述。

题项	描述	完全不同意	有点不同意	不确定	有点同意	完全同意
1	团队成员需要紧密合作来完成他们的工作。	1	2	3	4	5
2	团队成员需要频繁协调来完成他们的工作。	1	2	3	4	5
3	团队成员做事的方式会在很大程度上影响到团队里其他人的工作。	1	2	3	4	5
4	团队成员的工作相互依赖。	1	2	3	4	5
5	为了获得高绩效，团队成员需要依赖于彼此来获得信息和建议。	1	2	3	4	5
6	团队成员彼此间需要相互合作才能完成任务。	1	2	3	4	5
7	团队成员需要经常讨论与工作相关的话题。	1	2	3	4	5

第二部分：团队生产绩效

请根据您对行业生产水平的了解来评估自己所在的生产团队在设备更换前后的绩效水平。以下请用百分比作答，百分比=您所认为的团队绩效水平/您所认为的行业绩效水平。如，150%意味着您的团队绩效水平是行业平均水平的 1.5 倍；50%意味着您的团队绩效水平是行业平均水平的一半。

1. 在设备更换以前，和同行相比，我认为我们的生产量达到了以下水平_____（请填写百分比）
2. 在设备刚更换完，和同行相比，我认为我们的生产量达到了以下水平_____
3. 在设备更换完成、实现正常生产后，和同行相比，我认为我们的生产量达到了以下水平_____

请根据您对行业生产水平的了解来评估自己所在的生产团队在设备更换后恢复和稳定所用的时间。以下请用百分比作答，百分比=您所认为的团队绩效恢复或稳定所用的时间/您所认为的行业平均水平。如，150%意味着您的团队恢复或稳定所用的时间是行业平均水平的 1.5 倍；50%意味着您的团队恢复或稳定所用的时间是行业平均水平的一半。

1. 您的团队的生产量达到更换设备以前的水平花的时间是同行业的_____
2. 您的团队的生产量达到更换设备后的稳定水平花的时间是同行业的_____

第三部分：背景信息

1. 您所在的行业：_____
2. 您所在企业的规模（总员工人数）：_____；平均年产值_____
3. 您所在企业的成立年限_____
4. 您所在团队人员流动率: A. 很低；B. 较低；C. 平均水平；D. 较高；E. 很高