Plan and Situated Action as a Function of Activity Category

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Plans do not serve the particular circumstances of a given situation, but rather serve as abstract descriptions of some future activities. The relationship between plans, which are abstract, and actions, which are concrete, is referred to as the relationship between plans and situated actions. This relationship can be formulated in the following questions: 1) How do individuals conceive of future activities? 2) How does an individual who is acting upon a plan adjust when facing contingencies? The relationship between plans and situated actions has remained a source of intense academic discussions (e.g., Bardram, 1997; Bardram & Hensen, 2010; Leudar & Costall, 1996; Ng, 2002; Schmidt, 1997; Suchman, 1987). Despite the ample research on the relationship between plans and situated actions, a review of the literature indicates that the problem has not been adequately addressed (Randall et al., 2007; Suchman 2003), which has compelled this researcher to create a theoretical model that integrates the disparate nature of plans and line of actions.

Drawing on research on cognition and categorization theory, this thesis proposes a theoretical framework that conceptualizes the relationship between plans and situated actions in terms of activity categories. Specifically, the theoretical framework draws on the prototype and basic-level category theories of categorization, both of which were developed primarily by Rosch (1978), as well as the field theory developed by Lewin (1936). Categorization theories are used to address plans' abstractness as they capture typifications of human experience. Field theory is used to address the concreteness of action as it captures dynamic properties of the situation in the here and now. The basic premise of the theoretical framework is that individuals conceive (have a knowledge) of plans and their attributes as future activity categories with a range of possibilities. These possibilities are structurally graded, ranging from highly typical to atypical. Plans are believed to be formed based on what is typical for the activity. The theoretical framework argues that an association exists between an individual's knowledge of typical adjustment relevant to the activity and actual adjustment the individual makes while performing the activity. With this in mind, the theoretical framework considers the actor's perspective to be central to the investigation. Based on the theoretical framework, several hypotheses are formularized and tested.

An in-depth case study conducted in a ready-mix concrete company was used to examine aspects of the theoretical framework empirically. The results of the case study provide a wide range of independent evidence supporting the framework. In addition, an experimental methodology was developed for quantitative testing in the laboratory aspects of the theoretical framework not attainable in the case study. Theoretical and practical implications of the proposed framework and empirical findings are examined. Future research directions are discussed.

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Dedication

To my parents, wife and son

Khalid, it's time to play ball!

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Chapter 1
Introduction

Plans, like any models of reality, cannot be as exact as the reality itself (Ashby, 1970). Although they serve as abstract descriptions of some future activities, plans do not in fact reflect the particular circumstances of a given situation. The disparate nature between plans, which are abstract, and lines of action, which are concrete, poses a challenge in how they are related. In the literature, this problem—a fundamental problem in information systems—is referred to as the relationship between plans and situated actions (Suchman, 2007).

Ample research exists on the plan–action relationship[1] (e.g., Bardram, 1997; Bardram & Hensen, 2010; Leudar & Costall, 1996; Ng, 2002; Schmidt, 1997; Suchman, 2007). The literature review herein concludes that six paramount issues exist in the plan–action relationship: 1) whether goals precede or follow actions; 2) whether actions are produced partly by goals or completely by local contingencies; 3) whether actions are planned or are fundamentally improvised and ad hoc; 4) whether plans adequately describe actions; 5) whether plans control actions; and 6) whether hierarchical levels or a single level exists in which the plan–action relationship works. However, methodologically, a number of disagreements have arisen in the literature, including 1) the appropriate unit of analysis (mechanisms and constraints of human cognition versus individuals acting in a setting); 2) the appropriate method for studying human action (laboratory experiments versus observations in natural settings); and 3) the role of human perception (is it fundamental to studying behaviors and experiences or a superfluous psychological apparatus?). Given that such themes are the foundation of the plan–action relationship debate, it is essential to discuss these themes in detail, which the current study will do in the literature review.

Despite the ample research on the plan–action relationship, there is a lack of a theoretical framework on how plans and actions are related (Suchman, 2003). The lack of a theoretical framework serves as the

[1] In this thesis the choice of writing "plan–action" with an en-dash, rather than "plans and situated actions," stems from the fact that plans and situated actions are not contrast categories, although any act of planning would have to be situated as well.

impetus for the current inquiry. In particular, the aims of this research are to investigate 1) how individuals conceive (have knowledge and awareness) of plans and 2) how an individual who is acting upon a plan adjusts when facing contingencies. The resulting theoretical framework must combine the abstractness of the plan with the concreteness of the action.

To this end, the current study encompasses two primary objectives. First, it presents a theoretical framework that combines plans as an abstract concept and the line of actions as a concrete concept. The theoretical framework draws on the prototype and basic-level category theories of categorization, both of which were developed primarily by Rosch (1978), as well as the field theory developed by Lewin (1936). Categorization theories are used to address plans' abstractness, as they capture typifications of human experience. Field theory is used to address the concreteness of an action as it captures dynamic properties of the situation in the here and now. Second, the proposed theoretical framework is examined quantitatively and qualitatively through two studies: a case study and a laboratory experiment. The case study was conducted at a ready-mix concrete plant and was followed by a laboratory experiment based on the French card game *La Belote*. The laboratory experiment addressed the aspects of the plan–action relationship that were not testable through the case study.

This work will, therefore, contribute to the information systems literature by addressing in detail the key themes of the plan–action relationship. In addition, through its theoretical framework, this work will provide a better understanding of how plans are related to the actions to which they refer. This work will also consider some of the implications for human categorization processes and information systems literature.

This dissertation consists of two major areas of work: theoretical and empirical. The theoretical element includes the literature review and theoretical framework. Specifically, Chapter 2 reviews and assesses the literature related to the plan–action relationship to examine the underlying assumptions of prior research; the chapter further reviews and contrasts the major theoretical approaches, the psychological theory of planning, and the situated action perspective of plans. Chapter 3 draws from the literature review to present a theoretical framework that combines plans and actions utilizing field theory (Lewin, 1936) and categorization theories (Rosch, 1978). The model, which draws on both Lewin's theory (1936) and Rosch's theories (1978), is then formalized and the hypotheses presented.

The empirical element of the dissertation, which includes case study and laboratory experiments, is structured as follows: Chapter 4 reviews the case study background, method, and the reliability and validity of the case study. Chapter 5 then presents the results and analysis of the case study. Also, the chapter offers a discussion of the case study limitations. Chapter 6 discusses the laboratory experiment, reviewing experimental tasks used to investigate plans; it further presents the results and the analysis of the conducted laboratory experiment. The chapter concludes with a discussion of the laboratory experiment limitations. The final chapter offers concluding remarks and suggestions for future research.

Part I

Theoretical Part: Literature Review and Theoretical Framework

One might ask where these theorists [Hobbes, Rousseau, Adam Smith and Marx] found governing conceptions about mankind in the absence of a science of psychology. The answer is that they found them in their own observations and studies and in the power of their reason-sources not to be despised. (Asch, 1952, p. 5)

Chapter 2
Literature Review

Planning is a fundamental ability for humans and an essential part of everyday life (Dreher & Oerter, 1987). For example, people plan their diet to lose weight or stay healthy, couples plan their wedding party, and families plan where and how to spend a long-deserved vacation. Organizations also plan as companies announce plans to reduce costs and introduce new products. Governments release plans to reduce taxes and provide better services to citizens. Even on a worldwide scale, nations are collectively planning how to overcome the global recession. Given the pervasiveness of planning in contemporary society, what do the sciences have to say about plans? Scientists in fields such as organizational theory, operations research, information systems and psychology, to name a few, have positioned planning as central to their various enquiries (Das, Kar, & Parrila, 1996; Friedman, Scholnick, & Cocking, 1987; Thompson, 1967; Wezel, Meystel, & Jorna, 2006). One of the fundamental issues in planning—and an active area of debate—is how plans (which are abstract) and lines of action (which are concrete) are related (Bardram, 1997; Leudar & Costall, 1996; Ng, 2002; Schmidt, 1997; Suchman, 1987).

In the context of planning, two extreme positions have emerged: the psychological theory of planning (i.e., the "classical view"), which argues that plans are central to understanding human behavior (Miller, Galanter, & Pribram, 1960), and the situated action perspective of plans, which claims that improvisations rather than plans are the central phenomena for understanding human behavior (Suchman, 1987).[2] The psychological theory of planning posits that actions are goal directed, consequential, and connected to knowledge about the goal. Once the hierarchical structure of plans is formed and executed, desired goals can be reached. In this process, feedback loops play an essential role in responding to environmental disturbances. According to this view, the process of attaining goals by forming and executing the hierarchical structure of plans with the aid of feedback loops demonstrates the control property of plans.

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[2] I do not describe situated actions as a theory, but as perspective, as some proponents of situated actions (e.g., Suchman, 2007) take a position against theoretical abstractions, preferring instead detailed descriptions of situations as a method of conducting research (Kushmerick, 1996; Loren, Dietrich, Morrison, & Beskin, 1998).

In their discussion of plans, Miller et al. (1960) suggested that plans for individuals are analogous to computer programs for machines.

Meanwhile, the situated action perspective presumes that actions are not goal-directed; rather, goals are constructed within the activity and through after-the-fact rationalizations about actions (Lave, 1988). According to this view, plans cannot describe, predict, or specify actions on a moment-by-moment level, indicating that plans do not control actions with certainty. Indeed, plans are a weak resource that orients individuals toward their actions. They provide contexts for reasoning about actions prior to or (less often) during the activity. Rationalizing and interpreting actions primarily occur after the fact.

As previously indicated, these two views—classical planning and situated action—are the extremes; other models and theories can be classified in connection to either of these or can take a more moderate position. Researchers in various fields have adopted such views to examine planning. For example, one approach to planning that is closer to the classical view comes from operations research, which is based on mathematical models built on previously known objectives or goals designed to achieve optimal solutions by satisfying a set of constraints (i.e., forces that define the problem space or the set of options; Ackoff, 1970; Starr, 1966). Yet operations research has been criticized as being more concerned with the mathematics than with investigating real-world problems and the actualities of production management (Ackoff, 1979; Crawford & Wiers, 2001; McKay, 2001; McKay, Safayeni, & Buzacott, 1988; McKay, Safayeni, & Buzacott, 1995; McKay & Wiers, 2006). For example, McKay et al. (1995) identified formal scheduling processes that contrast how schedulers actually accomplish their activities. When McKay et al. (1995) investigated different input information, heuristics, and skills in relation to scheduling practices, they discovered that different sorts of plans exist, such as "political plans" for formal communication and "private plans" that reflect what is actually happening.

Another approach to planning that is closer to situated action perspective has been put forward by several organizational theorists, who suggested that a plan's role is to refer to what happened in the past, not what is expected to happen in the future (March, 1974; Weick, 1969). Weick (1969) asserted that “[p]lans seem to exist in a context of justification more than in a context of anticipation. They refer more to what has been accomplished than to what is yet to be accomplished” (p. 102).

Meanwhile, a more moderate position is evident in the cultural and historical school of psychology. Bardram (1997) presented a model based on activity theory that presumes that activities are goal or motive directed, with goals differentiating one activity from another. Plans can be purely intangible (e.g., residing in the head) or material artifacts (e.g., a checklist or flight schedule) that are culturally and historically developed. In addition, plans are not always completely developed before actions occur, but continue to develop within the ongoing activity in which plans are implemented via the hierarchical structure of the activity and feedback mechanisms. Plans also control human activities, transforming a motive or goal into outcomes (Bardram, 1997).

In the context of strategic planning, Mintzberg and Waters (1985) posed a more moderate position by differentiating two types of plans. Deliberate plans are based on established goals that control subsequent actions whereas emergent plans are based on realizing goals after the fact (hence, the control property is relaxed). The authors suggested that the process of “strategy formation walks on two feet, one deliberate, and the other emergent” (p. 271). They further asserted that individuals acting in organizations have their own intentions and goals. Thus, in emergent plans or strategies, acting in accordance with plans indicates that the plan has provided a vision for the actors, which might change through frequent feedback from the surrounding environment. Indeed, if this is the case, earlier vision does not control actors’ actions.

In the organizational context, Ackoff (1970) used the word “adaptivizing” to suggest that planning aims to control the future. Specifically he proposed that plans motivate individuals to behave in a way that is consistent with their goals. He classified the future into three categories: 1) highly predictable (e.g., time required to ship a product); 2) uncertain, but with high probabilities (e.g., alternative fuel, cleaner car engines); and 3) unknown, with unpredictable probabilities or even possibilities (e.g., technological breakthroughs).

These various planning approaches demonstrate how the key themes of the plan–action relationship are addressed, highlighting key similarities and differences. Previous analyses of the literature and researchers' recommendations (e.g., Kushmerick, 1996; Wilson & Myers, 2000) reveal that the two extreme views of planning—namely, the classical psychological theory and the situated action view—comprehensively address the dominant properties of the planning phenomenon and elucidate the underlying assumptions of different theoretical approaches and models. Therefore, the remainder of this literature review will describe the psychological planning and situated action view of plans to specify and explicate the underlying assumptions of the plan–action relationship. Each description is followed by a critical assessment.

2.1 Psychological Theory of Planning

The psychological theory of planning was primarily and most comprehensively articulated by Miller et al. (1960) in their book *Plans and the Structure of Behavior*. The aim of the psychological theory of planning is to describe the relationship between cognition and actions by introducing the concept of plans.

2.1.1 The View of Action and Plan

According to Miller et al. (1960), actions are not only goal-directed, but also preceded by plans. The argument that all actions are planned suggests that, in order to conduct everyday life activities, individuals create and deploy plans. Miller et al. (1960) defined plans as "*any hierarchical process in the organism that can control the order in which a sequence of operations is to be performed*" (p. 16; emphasis in original).

2.1.2 Propositions of the Plan–action Relationship

Based on Miller et al.'s (1960) definition of planning, the plan–action relationship includes two propositions: a hierarchical structure and a control mechanism. Miller et al. (1960) argued that plans are composed of sub-plans, with both plans and sub-plans having a hierarchical structure. They further proposed using a feedback loop in their model, which they called the Test-Operate-Test-Exit (TOTE) unit. The authors asserted that plans are composed of multiple sub-plans, each of which has associated TOTE units. When a plan or sub-plan is executed, the TOTE unit first tests the result of execution (i.e., its current state) by comparing it with the goal (i.e., its desired state). If no incongruity exists between the current state and the desired state when an individual performs the TOTE unit, he or she exits the feedback loop; otherwise, he or she continues to operate, which means that another action is carried out according to the plan, followed by another test. These steps are repeated until no incongruity exists between the current state and the desired state. In the process of attaining goals by moving between different hierarchical structure levels, feedback loops play an essential role in responding to environmental disturbances.[3] Miller et al. (1960) referred to the example of hammering a nail: An individual operates by striking the nail. The individual tests the present state with the desired state through a feedback loop. When incongruity exists, the feedback loop (i.e., TOTE units) continues to work after each operation (i.e., hammer strike) until the nail is flush with the wood, at which point the individual exits the TOTE unit.

The second proposition of the plan–action relationship is the control property. Miller et al. (1960) defined a plan as a controlling mechanism, using the following example:

> [I]magine that you wanted to look at a particular topic in a certain book in order to see what the author had to say about it. You would open the book to the index and find the topic. Following the entry is a string of numbers. As you look up each page reference in turn, your behavior can be described as under the control of that list of numbers, and control is transferred from one number to the next as you proceed through the list (p. 28).

According to Miller et al. (1960), a plan for an individual is similar to a software program for a machine: "[A] plan is, for an organism, essentially the same as a program for a computer" (p. 16). However, it is naïve to claim that an exact correspondence exists between a machine and the human brain. Thus, further research is necessary to investigate under what conditions machine instructions are similar to or differ from individuals' plans.

Schank and Abelson (1977) developed an extension of Miller et al.'s (1960) original work by introducing the notion of script, which they defined as "a structure that describes appropriate sequences of events in a particular context" (p. 41). A script is a predictable pattern that both determines and controls

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[3] Due to the limitations of humans' information-processing capacity, the possibility of having an infinite number of nested loops within the plans and sub-plans should not be considered.

actions in familiar situations. For example, an individual entering a fast-food restaurant is expected to find a seat by him- or herself; however, in more formal restaurants, patrons are expected to be seated by a host or hostess. The concept of scripts addresses situations in which an individual follows well-developed, typical, and familiar sequences of actions. Recent studies have implemented scripts to investigate everyday or routine activities, such as coffee making, using different simulation models. In such a model, the task of coffee making is divided into subtasks, such as adding milk to the coffee and putting sugar in the coffee (Botvinick, 2008).

2.1.3 Unit of Analysis

Defining the unit of analysis is important for differentiating between the psychological theory of planning and the situated action perspective of plans. In the psychological theory of planning, an individual's mind is considered to be the unit of analysis, with the focus being on the mechanisms and constraints of human cognition (e.g., long-term and short-term memory) (Anderson, Reder, & Simon, 1997; Greeno, 1997; Leudar & Costall, 1996). Psychological studies of planning tend to be conducted in laboratories under controlled conditions (Das et al., 1996; Friedman & Scholnick, 1997). However, Miller et al. (1960) suggested that external support (e.g., a timetable) plays an important role during planning because the human capacity to process information is limited. Thus, at least theoretically, the psychological theory of planning suggests a connection between the role of the external support and the role of the individual's mind.

2.1.4 Assessment

Many researchers have criticized Miller et al.'s (1960) assertion that all actions are planned—whether fully planned before actions occur or planned at the moment immediately prior to an action (Agre & Chapman, 1989; Das et al., 1996; Hendriks-Jansen, 1996; Suchman, 1988). Several researchers have argued that Miller et al.'s (1960) theory does not take into account the fact that individuals often take advantage of opportunities encountered when executing plans (Hayes-Roth & Hayes-Roth, 1979). In addition, Das et al. (1996) raised questions about whether infants (i.e., babies) have plans—sequences of operations—as Miller et al.'s (1960) theory implies.

Another critique addressed how Miller et al. (1960) equated plans for individuals with programs for machines, implying that an individual acts according to a plan in the same manner in which a machine operates based on an algorithm, which suggests that plans specify every level of detail (Agre, 1991; Chapman, 1989a; Leudar & Costall, 1996; Suchman, 2003). Critics have concluded that Miller et al. (1960) equated plans with human knowledge, meaning plans can be followed literally (Leudar & Costall, 1996; Suchman, 1988). However, Leudar and Costall (1996) disagreed, concluding that Miller et al. (1960) did not equate plans with human knowledge—a claim supported by Miller et al.'s (1960) aircraft example: Memorizing a description of the actions necessary to land an aircraft does not mean an individual will be able to actually land an aircraft. Similarly, Miller et al. (1960) pointed out that instruction manuals do not specify every minute detail (e.g., muscle movements) of a task to be performed.

In the context of the current research, Miller et al.'s (1960) theory does not appear to be applicable as it does not adequately distinguish between plans and algorithmic program. In addition, the theory assumes that all actions are preceded by a plan, which is not the case.

2.2 Situated Action Perspective of Plans

During the last two decades, journals such as *Cognitive Science*, *Cognitive Systems Research, Ecological Psychology*, *Educational Researcher,* and *Learning Sciences* have published special issues and hosted intense discussions on situated action-related issues. Coupled with numerous related conferences, the journal issues provide a dedicated forum in which to discuss theoretical arguments relating to the situated action perspective of planning, which suggests that these arguments are important to scientific communities (Halverson, 2002). Despite such debates, no unified position or clear definition of situated action has emerged (Anderson et al., 1997; Ciborra, 2006; Kushmerick, 1996; Lave, 1991; Patel, Kaufman, & Arocha, 1995; Suchman, 1993; Vera & Simon, 1993b; Wilson & Myers, 2000; Ziemke & Sun, 2002).

The situated action perspective of plans can be traced to Suchman's (1987) study, which reported empirical data based on an uncontrolled experiment that investigated how completely novice participants used sophisticated photocopy machines. Participants in Suchman's study were tasked with making double-sided copies; no detailed instructions were provided. To accomplish the task, participants used an expert system built into the photocopy machine to answer a series of questions about their task. The expert system subsequently invoked step-like instructions, which Suchman (1987) referred to as a plan, suggesting that Suchman equated instructions with plans. The expert system had to recognize participants' actions in order to invoke the next step. The machine was built based on the assumption that, if instructions were followed in a step-by-step manner, the task would be accomplished.

Participants in Suchman's (1987) experiment worked in pairs and were told to read the instructions aloud as the machine presented them. The resulting discussion was recorded on videotape and provided a major source of data for analysis. Methodologically, Suchman and Jordan (1997) argued that videotaping activity provides a "microscopic" view of a situation, capturing participants' detailed behavior in moment-to-moment interactions, largely independent of the analysts' intervention (Suchman, 1987; Suchman, 1990). However, Suchman (1995) subsequently concluded that the objectivity afforded by videotapes does not offer independence from interference as the analysts must still decide where to place the camera, what to record, what to present, and so on.

During the analysis, Suchman (1987) created a table to indicate participants' actions that might be captured by the machine (e.g., pressing a button) and actions of the machine that might be recognized by participants (e.g., delivering paper). The data from the videotapes and transcripts demonstrated that many problems arose when participants had to make sense of the photocopier's malfunctions (e.g., when pressing a button did not have the anticipated result) (Suchman, 1987). The central conclusion of the study was that actions are situated since participants needed to interpret every single instruction on a moment-to-moment basis (Agre, 1990; Ciborra, 2006; Suchman, 1990).

2.2.1 The View of Action and Plan

A situated action refers to an activity that takes place in a particular place, at a particular time, and in relation to particular social and material local circumstances (Agre, 1997; Clancey, 1997; Greeno & Moore, 1993; Lave, 1991; Suchman & Trigg, 1991). Situated action researchers (e.g., Lave, 1988; Suchman 1987) have identified three characteristics governing actions within the situated action perspective—namely, 1) actions are not goal-directed but goals are constructed as after-the-fact rationalizations, 2) improvisations rather than plans are the central phenomenon for understanding human behavior, and 3) actions are entirely a product of moment-to-moment interaction.

Situated action researchers assert that the first characteristic of actions is that "action is not 'goal directed,' nor are goals a condition for action" (Lave, 1988, p. 183)—an understanding that contrasts Miller et al.'s (1960) conclusions. To support the claim that actions are not goal directed, Lave (1988) referred to an episode of how a shopper decides to buy a certain number of apples. The shopper's narrative is as follows:

> [T]here are only about three or four [apples] at home, and I have four kids, so you figure at least two apiece in the next three days. These are the kind of things I have to resupply. I only have a certain amount of storage space in the refrigerator, so I can't load it up totally…Now that I'm home in the summertime, this is a good snack food. And I like an apple sometimes at lunchtime when I come home (Murtaugh, 1985, p. 188, cited in Lave, 1988, p. 2).

According to Lave (1988), this episode demonstrates that no specific goal exists (e.g., purchasing an exact number of apples); as a result, actions are not directed toward specific goals. Lave's assertion raises an important question: What is the role of goals if not to direct and motivate actions? Situated action researchers have concluded that goals are constructed during actions (e.g., buying apples) and serve as after-the-fact descriptions of what actually happened (Lave, 1988; Nardi, 1996; Rönkkö, Dittrich, & Randall, 2005).

The second characteristic of plans, according to situated action researchers, is that plans are not central phenomena in relation to actions; instead, improvisations are central (Agre, 1997; Chapman & Agre, 1987; Suchman, 2007). Unlike Miller et al. (1960), the situated action perspective deems that all actions are at some level improvisations[4]—what to do here and now—rather than planned actions (Agre & Horswill, 1992; Clancey, 1997; Suchman, 2002). Based on this understanding, Deutsch (1968) and Ross and Nisbett (1991) underscored the role of actors' subjective perceptions of their situations when studying human behavior as such perceptions emphasize the actors' experience of their situation that can only define and describe whether a situation is improvised or planned. The role of perception in human actions will be thoroughly discussed in the assessment subsection (see section 2.2.4).

The third characteristic of actions in the situated action perspective is that actions are essentially and exclusively a product of the "moment-to-moment" interaction (Agre, 1997; Clancey, 1997; Dourish, 2001; Suchman, 1987; Suchman, 2002; Suchman & Wynn, 1984), which has led some researchers (e.g., Suchman, 2007) to conclude that every situation is unique. Based on this conclusion, these researchers have adopted an anti-theory position (Kaptelinin & Nardi, 2006; Rogers, 2004) that describes theory building as an erroneous activity (Suchman, 2007). Dourish (2006), Goodwin, (1997), and Nardi (2002) argued that theoretical progression beyond the particular circumstances of a given situation is an essential activity. Thus, Goodwin (1997) concluded that "[t]he issue, therefore, is not particularism but rather access to a range of basic cognitive processes that require for their analysis detailed study of actual work in endogenous settings" (p. 135).

Situated action researchers (e.g., Suchman, 1994) define plans as imaginative acts that project some future actions manifested in artifacts. In this context, the term artifact refers to tool and technology (Ehn, 1989; Randall, Harper, & Rouncefield, 2007; Trigg, Blomberg, & Suchman, 1999).

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[4] Other expressions have been used in the literature to refer to improvisations, such as ad hoc (Agre, 1997; Chapman, 1991; Suchman, 2007) and problem solving (Suchman & Wynn, 1984).

2.2.2 Propositions of the Plan–action Relationship

Situated action researchers have offered several propositions that relate to plans and their relationship to the actions to which they refer—namely, 1) plans do not describe actions adequately; 2) plans do not control actions; 3) plans are best characterized as a resource among other resources; and 4) plans consist of reasoning about actions. The first and second propositions stem from situated action researchers' (e.g., Suchman, 1987) criticisms of Miller et al.'s (1960) theory of psychological planning. These researchers argued that, if Miller et al.'s (1960) theory of planning were correct, plans ought to describe and predict action at every level of detail. Yet they challenged this view by arguing that plans are not adequate for describing actions and do not control actions; thus, the plan–action relationship is problematic (Suchman, 2003). As a result, the third and fourth propositions were put forth as alternative explanations of the plan–action relationship. This section discusses these four propositions in greater detail.

In the first proposition, situated action researchers argue that plans are incomplete, inadequate descriptions of actions (Chapman, 1989a; Suchman, 1982; Suchman & Trigg, 1991; Suchman, 2007). For example, Suchman (1987) claimed that "the production and use of instructions have concentrated on the irremediable incompleteness of instructions" (p. 101). Similarly, Fikes and Henderson (1980) stated that "a procedure which implements a task is necessarily an inadequate description of all the actions which must be done to achieve the task's goals in all the various situations that can (and inevitably *will*) occur" (p. 203; emphasis in original). Different expressions have been used in the situated actions literature to refer to the argument that plans are inadequate for describing the actions to which they refer, such as plans are not generative mechanisms for actions (Button & Dourish, 1996; Crabtree, 2003) and plans are neither necessary nor sufficient conditions for actions (Sharrock & Button, 2003; Streibel, 1995).

Empirically, studies of situated actions have focused on the particular circumstances of a given situation to demonstrate how plans fail to specify or predict these circumstances. For example, Garfinkel (1996) studied a group of individuals who were asked to use instructions to code clinical files. The researcher concluded that, at some level, coders had to use their own judgment to employ the instructions in actual situations. In another study, Suchman (1983) examined two accountants who recorded payments for purchased supplies. According to the procedures, all items had to be received and paid for in order to file payments; otherwise, the information was to be kept in a temporary file. The study reported a case in which a purchase order was lost, although official documents showed that all items had been received. Interestingly, the company's record indicated that only two out of eight items had been paid for, while the supplier claimed that six items had been paid for and two outstanding items remained. As the solution of the case was not in the official procedures and required informal arrangements, Suchman concluded that procedures cannot specify or predict all possible situations. Similar patterns of focusing on the particulars of situations when procedures do not go according to plan have been reported in many other studies (e.g., Beck, 1995; Wynn, 1979).

The second proposition, which is the crux of situated action researchers' argument, is that plans do not determine or control the progress and sequence of actions (Agre, 1988; Chapman & Agre, 1987; Clancey, 1997; Dourish & Button, 1998; Suchman, 1987). For example, Suchman (1988) asserted that "in no case—and this is the crucial point—do such plans control action in any strict sense of the word 'control'" (p. 314). She used the analogy of how maps do not control travelers' actions to illustrate how plans do not control actions: "Just as it would seem absurd to claim that a map in some strong sense controlled the traveler's movements through the world, it is wrong to imagine plans as controlling actions" (p. 189). However, the analogy seems to be problematic because a plan is an intentional act (i.e., to have a plan is to have the intent to act upon the plan), whereas simply possessing a map does not require intent.

Some researchers have argued that these first two propositions, which—as previously stated—serve as criticisms of Miller et al.'s (1960) theory, apply only to the fields of cognitive science and artificial intelligence, as these fields adopt Miller et al.'s (1906) argument that plans precede actions and are defined as a sequence of operations to be carried out to control actions (Button, 2008; Randall et al., 2007; Rouncefield, 2002; Sharrock & Button, 2003; Slezak, 1999). These researchers further argued that the critics of the situated action perspective of plans (e.g., Schmidt, 1997; Vera & Simon, 1993a) fail to understand this point. Yet Suchman (2003), as well as other researchers (e.g., Bardram, 1997; Koschmann, 2003; Leudar & Costall, 1996; Schmidt & Simone, 1996; Woolgar, 1989), asserted that the situated action perspective of plans can and should be extended beyond cognitive science and artificial intelligence to include plans in everyday life.

In order to explain the plan–action relationship, situated action researchers presented an alternative view to Miller et al.'s (1960) theory—namely, the third proposition. This proposition asserts that a plan is a resource used among other resources (e.g., equipment and papers) to determine what to do here and now, during the course of actions (Agre & Chapman, 1989; Suchman, 1987). Although the idea of plans as resources for situated actions is a fundamental principle in human-computer interaction, computer-supported cooperative work, and other fields (Schmidt & Simone, 1996), it seems that this principle is frequently used without a clear definition. The current researcher traced the use of this term throughout the literature in an effort to establish a definition. Table 2.1 lists the term *resource* as it is used across various studies, which suggest that *resource* refers to tangible items such as project files as well as intangible items such as experience. According to Spagnolli, Varotto, and Mantovani (2003), *resource* appears to be a broad category equivalent to the category of "thing." Several other studies have argued that plans are strong resources for coordinating human activities (Bardram, 1997; Chapman, 1989b; Leudar & Costall, 1996; Rosebery, 2005; Schmidt, 1997), without providing criteria by which a plan can be judged to be a weak, strong, or neutral resource.

Table 2.1: Sample List of Appearances of the Term Resource in the Situated Action Perspective Literature

Resources	Reference
Plans	Agre & Chapman (1989); Suchman (1987)
Project files	Suchman, Blomberg, Orr, & Trigg (1999); Suchman, Trigg, & Blomberg (2002); Trigg et al. (1999)
Whiteboards	Trigg, Suchman, & Halasz (1986)
Experience, embodied skill, material evidence, communicative competence, and members' knowledge	Suchman (1988)
Attorneys and attorneys' form files	Blomberg, Suchman, & Trigg (1996)
Systems designed to track plans	Suchman (1995)
Chalkboard	Stefik, Foster, Bobrow, Kahn, Lanning, & Suchman (1987)

The fourth proposition of the plan–action relationship according to the situated action perspective is that a plan is a way of reasoning about actions (Suchman, 1987). More specifically, plans serve as a way to think and talk about actions both before (i.e., prospective) and after (i.e., retrospection) they occur (Agre, 1997; Chapman, 1991; Suchman, 1987; Suchman, 1988). Suchman (2007) extended the claim that plans involve reasoning about action to include the reasoning about action within an activity. Reasoning about action beforehand is performed to orient individuals to accomplish their activities (Suchman, 1987). For example, according to Suchman (1987), "[t]he function of abstract representation is…to orient or position us in a way that will allow us, through local interactions, to exploit some contingencies of our environment and to avoid others" (p. 188). The notion of an after-the-fact reference to plans emerges in the context of justification (Leudar & Costall, 1996; Mantovani, 1996; Suchman, 1987). Suchman (1987) explicitly stated that "it is only when we are pressed to account for the rationality of our actions, given the biases of European culture, that we invoke the guidance of a plan" (p. ix). Nonetheless, both theoretically and empirically, the result is an inadequate description of how this reasoning works.

2.2.3 Unit of Analysis

The unit of analysis in the situated action perspective is social interactions—namely, two or more individuals acting in a setting (Button, 2008; Cole, 1991; Pea, 1993; Vera & Simon, 1993a). Unlike psychological theorists, situated action researchers argue that actions are social phenomena in which the individual interprets others' actions in an interactional context. As a result, individual cognition is both theoretically and empirically irrelevant to situated action studies (Salomon, 1993).

With respect to the level of analysis, situated action researchers have conflicting views (Agre, 1997; Greiffenhagen & Sharrock, 2008; Suchman, 1987; Wilson & Myers, 2000; Ziemke & Sun, 2002). Suchman (1987) argued that the level of analysis occurs at the moment-to-moment level; other situated action researchers (e.g., Lave, 1988, 1991) have asserted that various levels of analysis exist for studying human behavior. For example, Lave (1988) suggested microscopic, intermediate, and organizational interaction levels.

Methodologically, situated action researchers observe individuals in their natural settings. These researchers do not consider other methodologies, such as laboratory experiments, to be valid for studying human behavior (Lave, Murtaugh, & de la Rocha, 1984; Suchman, 1987).

2.2.4 Assessment

This section assesses Suchman's (1987) photocopy machine study, which so significantly influenced subsequent studies that embraced a similar methodological approach and provided a basis for various theoretical propositions put forward by situated action researchers. It then evaluates different theoretical issues of the plan–action relationship, elaborating upon propositions suggesting that plans are inadequate descriptions of actions and do not control actions as well as the role of actors' direct perception in situated action studies.

To Suchman's (1987) credit, the photocopy machine study is one of the earliest studies that carefully examined how technology is used in a natural environment (Carroll, 2003; Hert, 1997; Wells, 2003). According to Ciborra (2006), the strength of Suchman's study is that its theoretical analysis goes hand in hand with its empirical analysis. Theoretically, one of the study's important insights is the assertion that actions that include creating and executing plans are situated in a particular time and place in relation to the social and material world (Leudar & Costall, 1996; Räsänen & Nyce, 2006). Empirically, Suchman (1987) introduced conversational analysis and videotape recording technology to study the situated property of actions in technological settings (Carroll, 2003; Pea, 1993; Wells, 2003).

In her study, Suchman (1987) aimed to investigate the plan–action relationship; however, compared to the actions side, which was well demonstrated (Räsänen & Nyce, 2006), the plan side of the study was not adequately addressed—if at all (Vera, 2003). Indeed, several concerns have emerged about the plan side of the study. First, the study equates the step-like instructions, provided to users by the machine's expert system, with the actor's plans (Suchman, 1987), which raises the question of whether plans and instructions are similar enough to use interchangeably in the study. Second, in the study, the notion of plans is restricted to the machine's instructions as programmed by the machine designer. However, participants may have had their own plans that did not necessarily correspond to the designer's plans. Carroll (2003) explained that "[f]requently, people are not even trying to follow instructions in such episodes, rather they are trying to achieve their own task-oriented goals" (p. 275). Suchman (1987) failed to consider the possibility that participants may not have been following instructions, but rather maintaining their own plans.

Third, participants had to follow a predefined, fixed sequence of actions to act in accordance with the plans. In other words, unlike plans in everyday life, highly structured tasks (e.g., making a double-sided photocopy) do not allow for flexibility (Agre & Chapman, 1989). Clancey (2006) argued that, because the plan in Suchman's (1987) study was a fixed, predefined task, it resembled a puzzle rather than a real-world plan. In fact, assuming that acting in accordance with the plan means following a specific path may have limited the generalizability of the study as it focused on a very specific type of plan—namely, a predefined, fixed sequence of actions.

Finally, the photocopy machine study used only novice participants who had never used the machine before, thereby amplifying the results by producing more heterogeneous actions than if participants had been a mixture of novice and expert users or if similar participants had been observed over a period of time (Wells, 2003). Ultimately, the photocopy machine study did not empirically demonstrate the alternative view of situated actions toward the plan–action relationship—namely, that a plan could involve reasoning about actions and post-hoc rationalization.

2.2.4.1 The Role of Plans in Describing and Controlling Action

One of the central arguments in the situated action literature is that plans do not control actions (Suchman, 1987). According to Randall et al. (2007), much of the confusion surrounding the notion of control can be attributed to the assumption that the meaning of control in planning is exactly analogous to a computer program that controls machines. If plans are like computer programs, they must be implemented literally and run by themselves, implying that plans predict all possible situations.

Organizational theorists such as Thompson (1967), Blau and Scott (1963), and others have asserted that plans do not describe concrete actions in full detail. For example, Selznick (1948) stressed that:

> The formal administrative design can never adequately or fully reflect the concrete organization to which it refers, for the obvious reason that no abstract plan or pattern can—or may, if it is to be useful—exhaustively describe an empirical totality. At the same time, that which is not included in the abstract design…is vitally relevant to the maintenance and development of the formal system itself (p. 215).

If plans ought not to describe concrete actions and at the same time control actions to which they refer, then the question becomes what does 'control' mean?

It seems that control is not binary and that a degree of control may exist, as implicitly indicated by several situated action researchers (e.g., Agre, 1997; Suchman, 1987; Suchman, 1988) who associated the idea that plans do not control actions with qualifiers such as "in any strict sense," "in any strong sense," and "mechanically determined actions." Some researchers further argued that the source of the degree of control is the structure of the task (Mintzberg, 1983; Schmidt & Simone, 1996; Schmidt, 1997). Schmidt and Simone (1996) empirically demonstrated that, in highly structured situations, such as a Kanban system (a system for moving parts in the production line from one station to another using cards and boxes), workers are not expected to search for and negotiate why they do what they are doing; rather, they act according to the system's set of available acceptable choices.

Another possible explanation of control is evident when the distribution of the outcomes correlates with the plans. A thought experiment may help illustrate this point. If a class has been instructed to write their first names, control exists if the students follow the instructions. Otherwise, we might find date of birth, shopping lists, or anything else—or even nothing at all—written down. However, the instruction "write your first name" does not specify whether or not the name should be capitalized; thus, the control remains at the level of the instructions specified.

2.2.4.2 The Role of Perception in Understanding Individuals' Action

The role of human perception of situations also seems problematic in situated action studies. Situated action researchers treat individuals' accounts of their actions (e.g., what they say about themselves) as always unreliable because individuals' accounts of their actions are post-hoc (i.e., after-the-fact) rationalizations (Nardi, 1996). The key issue here stems from how the experience of actions should be described (Clancey, 1997; Schön, 1983).

Suchman's (1996) study, entitled "Constituting Shared Workspaces," examined what the researcher called a "trouble situation"; the study illustrated how the situated action perspective treats individuals' accounts of their actions as unreliable. The trouble situation started when a flight having arrived at the airport, but the ladder used to unload passengers from the airplane did not work. Suchman described the situation on a moment-to-moment basis:

> The *unremarkable status of the incident* was indicated to us, for example, by the observation that a coworker coming in from the ramp shortly after the trouble's resolution, who inquired of one of the operations room workers present to the event, "What's happening," received the reply, "Oh, nothing much" (p. 59, note 14; emphasis added).

Although Suchman labeled this situation as trouble, the individual who experienced the situation claimed that it was not trouble but was, in fact, "nothing much." Both Suchman (1996) and the actor are correct in their description of the situation. On the one hand, Suchman (1996) refers to trouble in relation to some sort of objective measurement, which involves moment-to-moment interactions as recorded on videotapes. On the other hand, the actor refers to his or her subjective experience from a direct perception. Suchman (1996) successfully distinguished between the two kinds of experience, but she did not analyze the difference. In fact, she labeled the event as a trouble situation, favoring the researcher's judgment rather than the actor's description of his/her situation.

Although social desirability may occur in which actors' descriptions may be tailored to what they think makes them look good (Babbie, 1992), favoring an analyst's account of the actions and disregarding individuals' accounts of their actions may not be a justifiable approach because the analyst is at risk of making arbitrary choices. It seems that other situated action perspective arguments, such as the notion that all actions are improvisations, problem solving, or ad hoc, are made by favoring the analyst's account of the situation. Indeed, stating that all actions are improvisations—regardless of the actor's experience—relates to some sort of objective measurement that, according to Clancey (1997), is made "at some level."

Thus, when analyzing human behavior, a distinction may exist between the analyst's descriptions of any situation and the actor's perception of the situation. Indeed, many researchers (e.g., Deutsch, 1968; Ross & Nisbett, 1991) stress the importance of studying how individuals experience situations based on their perceptions—an idea central to this study framework.

2.3 Summary

As evident from the literature review thus far, the plan–action relationship is an active area of debate. The lack of agreed-upon definitions of fundamental constructs (i.e., actions and plans) creates major challenges; however, some attempts have been made to address the plan–action relationship (e.g., Miller et al., 1960; Suchman, 1987). Although the psychological theory of planning does not adequately address the plan–action relationship (Agre & Chapman, 1989; Suchman, 1987), the situated action perspective also fails to provide a satisfactory explanation of the plan–action relationship (Vera, 2003). Such a lack of an adequate explanation provides support for the significance of the current study.

Additional major findings from the literature review can be summarized as follows:

1. Situated action researchers have argued that Miller et al.'s (1960) psychological theory of planning implies that plans ought to describe and specify actions; however, neither Miller and his colleagues nor situated action proponents claim that plans ought to describe and specify actions at every level of detail.
2. Many situated action researchers have proposed that only one level of analysis exists when analyzing actions—namely, the moment-to-moment level. Other researchers (e.g., Bardram, 1997) have suggested that plans are formed at one level and implemented at another level.

3. Feedback loops play an essential role in executing plans and responding to environmental uncertainty (Bardram, 1997; Clancey, 1997; Miller et al., 1960).
4. Researchers who support the situated action view treat individuals' accounts of their actions as unreliable (Suchman, 1996) despite the fact that such accounts are central to understanding a situation (Deutsch, 1968; Ross & Nisbett, 1991) as individual actors are the principle executors of the plan.

Table 2.2 summarizes the different views related to the major issues in the plan–action relationship, indicating disparate arguments.

Table 2.2: Different Views of Major Issues in the Plan–action Relationship

	Psychological Theory of Planning	Situated Action Perspective of Plans
Position of the Planning Phenomenon	• Central to understanding human behavior	• Planning is peripheral to understanding human behavior • Improvisation is central to understanding human behavior
Goals	• Precede actions	• Post-hoc (i.e., after-the-fact) rationalizations
Structure of the Actions	• Shaped and controlled by goals	• Entirely a product of moment-to-moment interactions
Plans as a Control Mechanism	• Control actions	• Do not control actions
Level of Analysis	• Multiple hierarchical levels	• Mostly single level (moment to moment)
Unit of Analysis	• Cognitive mechanisms of information processing	• Two or more individuals acting in a setting (i.e., social interactions)
Preferred Empirical Method	• Mostly controlled laboratory experiments	• Observing humans in natural settings (only acceptable method)

Chapter 3
Theoretical Background

This chapter addresses the question of how the plan–action relationship works. The current study's model draws on field theory developed by Kurt Lewin (1936), which relates to action in the here and now. The model also draws on basic-level categories and prototype theories of categorization, both of which were developed primarily by Eleanor Rosch (1978). Lewin's (1936) field theory is used to analyze the dynamic process of the plan–action relationship as the actor perceives it whereas Rosch's (1978) theories are utilized to analyze the actor's knowledge of his/her future situation.

This chapter is organized as follows. The first section explains field theory, followed by a discussion of the notion of plans in field theory. Next, theories of the perceived internal structure of categories (i.e., prototype and basic-level category theory) are presented. Finally, the combination of field theory and categorization theories into a model of plan–action relationship is explained according to a number of hypotheses.

3.1 Field Theory: Dynamic Properties of the Situations

Lewin exerted considerable influence in the field of psychology, particularly in studying the interrelationship between individuals and their environment. He influenced such work as behavioral settings theory, ecological psychology (Heft, 2001), and the activity theory developed in Russian psychology (Stadler, 1988). His field theory, from which the current study's model draws, is a theory of action situated in the here-and-now.

The fundamental notion behind field theory is that behavior is a function of a total situation that consists of an individual and his or her psychological environment. Lewin (1936) described behavior (B) as a function of both person (P) and environment (E) in the formula $B = F(P, E)$. Thus, field theory is concerned with how individuals and their environments are interrelated or interdependent (Lewin, 1936). Field theory stresses the importance of the actors' view of their experiences and how the individuals interpret their situations. Indeed, field theory uses individuals' interpretations of their situations to gain an understanding of their behavior (Derbentseva, 2007; Deutsch, 1968; Ross & Nisbett, 1991). In this context, according to Deutsch (1968), field theory uses phrases such as "at a certain moment," "at a given time," "the time just past," and "here and now" to refer to a psychological unit that is meaningful from the actor's perspective.

A central concept in field theory is life space. The terms *life space*, *psychological field*, and *total situation* all refer to the psychological environment that exists in an individual's subjective experience (Deutsch, 1968). Life space represents all activities that can possibly occur. Within life space, an individual is positioned within a region of activity that corresponds to his or her immediate situation. Regions of activity are psychological units representing spaces in which the individual exists, moves, and perceives other events in the life space (Lewin, 1936). For example, a high school student is in a given place at a given time (i.e., immediate psychological situation), considering four options for how to spend her day: studying for an exam, taking a driving lesson, going to a movie, or working at a part-time job to earn some money. These possibilities are regions of activity that currently exist in the student's life space (Deutsch, 1968). Any single region of activity can be further differentiated into a number of parts or sub-regions. For example, when the student moves into the "taking a driving lesson" region of activity, the lesson may be about how to drive a manual transmission, for which the student must focus on each and every movement (e.g., shifting gears and depressing the clutch). Such movements are examples of sub-regions, or parts, of the driving activity. On the other hand, expert drivers do not think about shifting gears when changing lanes or passing cars; for them, these sub-regions have disappeared into a single region of activity.

Another central concept related to an individual's movement in the life space is locomotion. As previously discussed, at any given time an individual is positioned psychologically in a region of activity. This position is dynamic and constantly changing; hence, the individual is always moving through different regions or sub-regions of activity in his or her life space. Such movement is referred to as locomotion. Locomotion constantly changes one's life space and its characteristics. Movement among regions and sub-regions of an activity can be either possible or impossible as a result of the perceived boundaries between these regions or sub-regions (Derbentseva, 2007).

Meanwhile, *boundaries* refers to separating different regions of activities, whether physically (e.g., the walls of a prison or the edges of a bathtub) or psychologically (e.g., perceived threat). The separation refers to a continuum that ranges from completely allowing free movement among regions or sub-regions to completely prohibiting such movement. If one is unable to move freely in the life space, this restriction is called a *barrier*—namely, "boundaries (boundary zone) which offer resistance to psychological locomotion" (Lewin, 1936, p. 108). Different barriers create different degrees of resistance. Returning to the example of the student who is considering how to spend her day, suppose that the student decides to go to a movie. Such a decision might require passing through two regions of activity: first, "taking a bus," and second, "buying a ticket." If the student does not have enough money to buy a ticket, a barrier to "watching the movie" arises. Missing the bus would also create a barrier as the student would no longer be able to get to the theatre in time to watch the movie. However, if the student has other transportation options (e.g., taking a taxi, walking, or going with a friend), new paths become available, enabling her to reach the "watching the movie" region.

Another concept associated with regions of activity is valence. Lewin defines *valence* as "a certain object or event, which is experienced as an attraction (or repulsion)" (1935, p. 51). Both negative and positive valences exist (Lewin, 1936), and each region of activity within a life space may possess a valence that is either positive (e.g., liked by the individual) or negative (e.g., disliked by the individual). The psychological forces created by positive valences will attract an individual to the region, whereas forces created by negative valences will repel the individual. Valences are not static, but rather dynamic as they depend on the needs and motives of the actor in each situation.

A *goal state* in a goal-directed activity is a region of activity possessing a positive valence (attractiveness), creating forces that push the individual toward the goal state. Barriers that prevent the individual from reaching the goal state correspond to forces with a negative valence for the actor. Consequently, if an individual initially perceives a path toward a goal state but then finds it blocked by a barrier, the need arises for the individual to work around the barrier; this is accomplished by taking a detour to reach the goal state via an alternative path consisting of a sub-region that bypasses the barrier. Thus, goals are dynamic, meaning that they can be modified during the course of an action (Derbentseva, 2007).

With respect to plans, field theory introduces the concept of irreality—or unreality—to explain how individuals experience the psychological future (e.g., plans, wishes, fears, daydreams), which refers to expectations or thoughts (Barker, Dembo & Lewin, 1941; Deutsch, 1968). According to Barker et al. (1941), movement is more fluid at the level of irreality than at the level of reality (life space), making goal attainment seem more probable/easier to an individual. In this context, to have a plan is to construct as-yet undetailed regions for future activity. For example, a student who earns an undergraduate degree may begin to envision getting a certain job. At this point, the student is at the level of irreality (i.e., before the job is actually attained) and goes through several undetailed regions to arrive at the goal region; the student may also bypass (i.e., ignore) some negative regions along the way (Deutsch, 1968).

In summary, Lewin's (1936) theory addresses an individual's immediate psychological situation, which determines behavior. To reiterate and summarize the terminology used, the *psychological situation* represents the interdependence between an individual and his or her perceived environment. The immediate situation is the *life space,* consisting of different *regions of activity*. At any given time, an individual is always located in one region of activity, which may be divided into sub-regions or collapsed into greater regions—all of which are perceived as meaningful psychological units of action. *Locomotion* refers to the movement among different regions of activity or their sub-regions; such movement is influenced by positive (attractive) or negative (repulsive) *valences* inherent to every region of activity. Although individuals generally seek to satisfy goals, a *barrier*—whether psychological or physical—may require the individual to find ways to work around it by taking a *detour*. In Lewin's theory, the concept of *irreality* refers to psychological future that includes plans. At the *irreality* level, regions of activities are undetailed.

In the current research context, although field theory addresses actions in the here and now (i.e., situated actions), it lacks detailed explanation of plans. To overcome this shortcoming, categorization theories are introduced.

3.2 Categorization Theories: Typifications of Experience

Human experience relies on categorizing, which treats different things in a similar manner according to given names (Chrysikou, 2006; Lakoff, 1990; Quinlan & Dyson, 2008; Rosch, 1978). For example, the category of "birds" includes robins, owls, and penguins whereas the category "black things" includes black hair and black tea. Categories can be formed based on perceptual similarities between different objects (Markman, 2005). Lakoff (1990) asserted that:

> Every time we see something as a *kind* of thing, for example, a tree, we are categorizing. Whenever we reason about *kinds* of things—chairs, nations, illnesses, emotions, any kind of thing at all—we are employing categories. Whenever we intentionally perform any *kind* of action, say something as mundane as writing with a pencil, hammering with a hammer, or ironing clothes, we are using categories. The particular action we perform on that occasion is a *kind* of motor activity (e.g., writing, hammering, ironing), that is, it is in a particular category of motor actions. They are never done exactly in the same way, yet despite the difference in particular movements, they are all movements of a kind, and we know how to make movements of that kind (pp. 5-6; emphasis in original).

As such, categorization is central to understanding how individuals think, perceive, and act (Lakoff, 1990; Murphy, 2004). Indeed, the purpose of categories is to help individuals make sense of and manage rich information in their surrounding environments (Quinlan & Dyson, 2008).

Classical views of categorization have asserted that, for an object to enter a category, the object has to satisfy certain features considered to be necessary and sufficient conditions. Although this view remains true for some formally defined categories (e.g., odd numbers), how people experience categories psychologically differs substantially from this view. Evidence suggests that individuals think about categories in terms of best examples, frequent features, and central tendencies, implying that categories do not consist of equal status examples, but rather involve a structure in which individuals organize and process them (Lakoff, 1990; Rosch, 1974; Tversky, Zacks & Hard, 2008).

According to Rosch (1978), a category's structure has both hierarchical and horizontal elements. For example, in the category "birds," robins, owls, and penguins are horizontal elements (see Figure 3.1) whereas the category "animals" includes the subcategory "birds," which in turn comprises the various subcategories in a hierarchical structure.

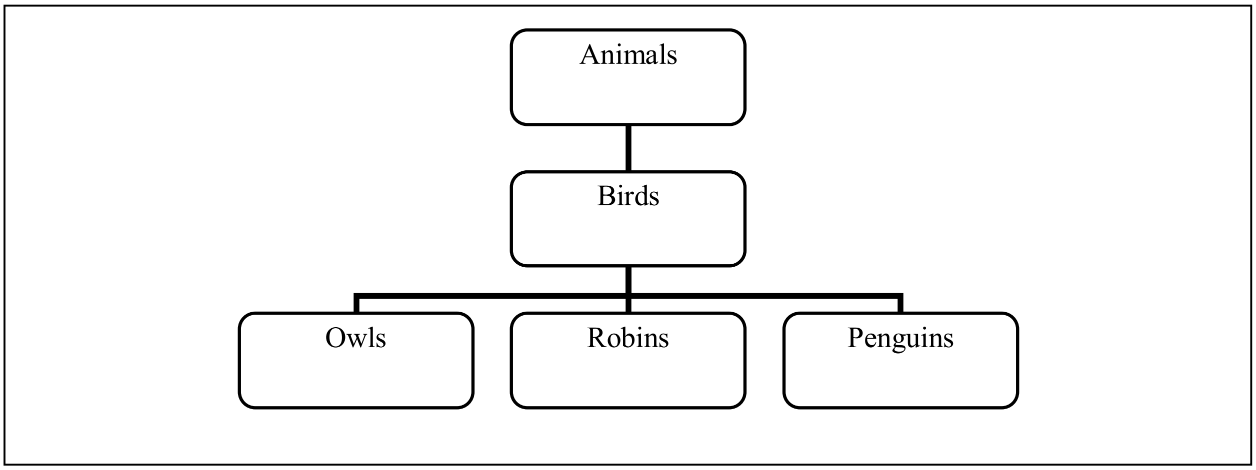

Figure 3.1: Example of hierarchical and horizontal elements

Rosch (1978) proposed the prototype theory to explain the horizontal structure of a category. A category prototype is defined as "the collection of properties most likely to be true of members of a category" (Smith & Kosslyn, 2007, p. 540). For example, features of the category "birds" include flies, sings, and lives in trees. For most North Americans, a robin is the best real-world exemplar and therefore prototypical of the "birds" category as it possesses most of the category's features (Barsalou, 1991; Lakoff, 1990).

The argument that some objects of a given category best represent the category suggests that not all objects exhibit equal status within a category. For example, chair, radio, and refrigerator do not have equal status in representing "furniture" because a chair is more typical of the "furniture" category than a radio or refrigerator. This inequality of objects' status within a category can be called a graded structure

(Barsalou, 1991; Gabora, Rosch & Aerts, 2008; Quinlan & Dyson, 2008), which according to Kim and Murphy (2011) "has been found in virtually all categories that have been tested" (p. 1092). Barsalou (1983) defined graded structure as "a continuum of category membership, ranging from prototypical members through unclear cases to prototypical nonmembers" (pp. 211-212). Prototypes, or best examples, can be formed based on individuals' experiences and goals as well as the frequency with which individuals encounter or use the prototypes (Gabora et al., 2008). Prototypes also exhibit a high degree of typicality; as such, they can be called "most typical" (Rosch, 1978, 1999). The degree of typicality is defined as "how well a particular item fits [the subject's] idea or image of the category to which the item belongs" (Rosch, 1999, p. 65). For example, although a chair is a prototype or best example of "furniture," it may be unclear as to whether or not a radio even belongs in the category. Given the difficulty associated with determining category boundaries, Rosch (1978) asserted that a better way to identify whether an object belongs to a category is by determining its resemblance or similarity to clear cases.

To address such categorization issues, Rosch (1978) developed the basic-level category theory, which proposes that "categories that are cognitively basic are 'in the middle' of a general-to-specific hierarchy" (Lakoff, 1990, p. 13). From the perspective of a hierarchical structure, categories can be described at different levels of abstraction—from the most general to the most specific. For example, the "furniture" category includes table and chair subcategories, while chair has even further subcategories: kitchen chair, office chair, and garden chair. Within each level of the hierarchical structure, a prototype exists. For example, while the category "furniture" can have prototypes such as chair and table, the prototype that best represents the "chair" category might be desk chair rather than barber chair or electric chair (Quinlan & Dyson, 2008). In this example, "chair" is the basic level as defined by Rosch's (1978) theory, while the category "furniture" indicates a superordinate level. Meanwhile, kitchen chair, office chair, and garden chair occupy the subordinate level.

Several factors determine which category level is basic for a given individual. First, the features of the objects in a category are primarily stored in the memory at the basic level; that is, when an individual is asked to list the features of a given category, most features will be listed at the basic level (e.g., chair) rather than at the superordinate level (e.g., “furniture”). At the subordinate level (e.g., kitchen chair, office chair, and garden chair), knowledge about features does not increase as much as at the basic level (Lakoff, 1990). Second, the basic level is most commonly used in communication. For example, in a neutral context, when an individual is asked to describe an animal in front of a house, he/she may say “there’s a dog on the porch”; it would be unusual for that person to say “there’s a mammal on the porch” or “there’s a wire-haired terrier on the porch” (Lakoff, 1990). Third, aspects of information processing, such as remembering and recognizing, tend to be processed at the basic level. Finally, motor interactions are associated with objects at the basic level. For example, a chair affords a motor action for sitting; however, it seems difficult to apply a specific motor action to a superordinate category such as “furniture” (Lakoff, 1990). Similarly, it is difficult to differentiate motor actions for subordinate categories like desk chair and kitchen chair.

Although it would be expected that a single basic level exists for each category, according to Smith and Kosslyn (2007), the basic-level category is dynamic and changes based on the context. In fact, the dynamic of category structure can be seen from both hierarchical and horizontal elements. From hierarchical elements, in the aforementioned examples of basic-level category theory, a dog is the basic level in a neutral context; however, when transporting a dog into the United Kingdom, one encounters a law that states that all mammals are subject to quarantine for six months. This law is not specified at the basic level (e.g., dog or cat) but at the superordinate level (i.e., mammals) to ensure that the law applies to all different kinds of pets.

Rosch’s (1978) theories of prototypes and basic-level categories were developed based on common taxonomies (e.g., the category of “animals”), in which categories serve as the basis for many developments and extensions within studies of categorization (Lakoff, 1990). The current research is primarily concerned with the categorical knowledge of plans (e.g., “taking a trip to Toronto next Saturday”). In turn, three lines of research emerge that further develop theories of prototypes and basic-level categories relevant to the categorical knowledge of plans: the goal-derived category (Barsalou, 1991), the event category (Zacks, Tversky & Iyer, 2001), and the action category (Hemeren, 2008).

In contrast to common taxonomies, goal-derived categories are not fixed, but are instead "made up on the fly for some immediate purpose" (Lakoff, 1990, p. 45). Examples of goal-derived categories include "what to do for entertainment on a weekend," "things to take from one's home during a fire," and "things to take on a camping trip" (Barsalou, 1983; Barsalou, 2010; Chrysikou, 2006; Lakoff, 1990). Goal-derived categories are determined by goals reflected in the formation of these categories. Meanwhile, common taxonomies are mostly based on the perceptual similarity of relevant attributes. For example, members in the "birds" grouping, such as robins, owls, and penguins, are mostly grouped based on shared relevant attributes, such as flies, sings, and lives in trees (Barsalou, 2010; Lakoff, 1990; Murphy, 2004). In the goal-derived category (e.g., "things to take from one's home during a fire"), the structure of the category would reflect goals (e.g., taking valuable objects) while considering specific attributes (e.g., the weight of the objects and time needed to escape) (Barsalou, 2010).

Similar to common taxonomies, goal-derived categories exhibit typicality or a graded structure in which some members of a category are more typical than others (Barsalou, 1991; Barsalou, 1983; Lakoff, 1990). For example, the category of "things to take from one's home during a fire" includes things that an individual would be more typically inclined to take, such as photos, documents, and money. Goal-derived categories can be further divided into two types based on familiar and novel goals (Chrysikou, 2006). For example, the category of "things to pack in a suitcase" can be considered to be a category based on a novel goal, but only if the individual is invoking that category for the first time since the category has not been established in memory. If this category has already been invoked many times, the category is established in memory and can be considered to be based on familiar goals.

The second type of category relevant to this research is the event category (Zacks et al., 2001), which Zacks and Tversky (2001) defined as "a segment of time at a given location that is conceived by an observer to have a beginning and an end" (p. 17). Three broad types of event categories have been proposed: 1) goal-directed events; 2) non-goal-directed events; and 3) events that are independent of humans. A goal-directed activity such as "making a bed" is an event that has dimensions of both time (i.e., beginning and end) and space (i.e., location) (Tversky et al., 2008). Although some events are not goal-directed (e.g., falling from a ladder) and some events are independent of humans (e.g., a tsunami) (Zacks, Speer, Swallow, Braver, & Reynolds, 2007; Zacks & Tversky, 2001), goal-directed events seem to be the most relevant type of events for studying categorical knowledge of plans.

Both common taxonomies and events have a hierarchical structure; however, common taxonomies are hierarchically based on a kind of relationship (e.g., bird is a kind of "animal") whereas goal-directed event categories tend to be hierarchically based on a part–whole relationship (e.g., spreading the sheet is part of "making a bed") (Zacks & Tversky, 2001). Still, some event categories can be viewed as having a "kind of" relationship, indicating that basic, subordinate, and superordinate levels exist. For example, in an experimental setting, participants performed a category verification task, in which a brief story (e.g., screaming during the scary parts of a movie) from an event (e.g., watching a movie) was presented. Participants were then asked to verify the label of that story at one of the three levels: the subordinate level (e.g., horror movie), the basic level (e.g., movie), or the superordinate level (e.g., entertainment). It was predicted that it would take less time to verify the label of the scene as basic level than as subordinate or superordinate. The results indicated that participants were faster (i.e., requiring less time) in verifying the label of the scene at the basic level (Morris & Murphy, 1990).

The third type of categories relevant to this research is the action category. For instance, the action category "body movements" includes members such as walking, running, and waving. Studies of action categories usually employ a visual medium to present certain actions to experimental subjects, such as video clips and pitch-light displays (i.e., body-motion visual display based on light associated with body joints). Research has demonstrated that running is the prototype of the action category of body movements—that is, it is the central member around which other category members are organized (Hemeren, 2008). However, the researched action categories have not considered activities that involve more than one body movement action, such as driving, where planning and implementing a plan require a set of related actions. Within the context of actions category is the findings of Graesser, Gordon, and

Sawyer (1979) that scripted activities such as going to a restaurant are structurally graded. It is worth noting, however, that plans may have other components related to preparing for the plans that are not necessarily part of the script (Hudson, Sosa, & Shapiro, 1997).

To address the research questions, both field theory and categorization theories are combined. Field theory is used to represent the dynamics of the situations while categorization theories are used to model human experience.

3.3 Plan–action Relationship: Combining Field Theory and Categorization Theories

From a field theory perspective, according to Barker, Dembo, & Lewin (1941) and Deutsch (1968), plans, strategies, and schedules refer to future regions of activity. This is because these activities are intended but have not yet been performed. Field theory suggests that future regions of activity consist of subregions, which can be further differentiated into more detailed subregions. For instance, 'taking my wife from Waterloo to Toronto Pearson International Airport next Saturday' is a future region of activity which may include subregions such as 'driving on Highway 401 E,' 'taking Dixon exit,' and 'following airport signs to get to the airport.'

From a categorization perspective (e.g., Rosch, 1978), this research argues that individuals conceive (i.e. have knowledge) of plans as future activity categories with a range of possibilities. Further, the internal structure of a future activity category can have both hierarchical and horizontal elements. Hierarchically, the future activity category may be divided into subcategories and more detailed subcategories. For instance, the future activity category of 'taking my wife from Waterloo to Toronto Pearson International Airport next Saturday' includes subcategories such as 'driving on Highway 401 E.'

Horizontally, the future activity category can have a range of possibilities that describe different ways of doing the activity. Some of these possibilities are more likely to happen (i.e., more typical) than others. For example, the future activity category of 'driving on Highway 401 E' can have a range of possibilities such as different ways of driving including aggressive driving, moderate driving, and cautious driving; in this case, moderate driving may be most typical of the category.

Additionally, the future activity category can have attributes that describe characteristics of the situation in which the activity takes place. Each of these attributes has a range of possibilities, some of which are more typical than others. For example, the future activity category of 'driving on Highway 401 E' can have attributes such as 'traffic' and 'weather.' In the range of possibilities for the attribute 'traffic,' the most typical possibility on Saturdays is light traffic. However, while the 'traffic' on Saturdays is less likely to be heavy or extremely heavy, it is still possible. The 'weather' attribute also has a range of possibilities, such as clear, sunny, snowing, and windy. In the winter, the most typical possibility for the attribute 'weather' might be snowing; it is less likely, but still possible, for it to be clear or sunny.

As the above examples illustrate variability within the future activity category is due to both variability in how the activity is performed and variability in the situation in which the activity takes place. For the future activity category and its attributes, the possibilities range from more typical to less typical and atypical. According to Rosch (1973), this range of possibilities represents a graded structure in which some possibilities are more likely to happen than others. Thus, the following hypotheses can be stated:

H1. *Individuals tend to conceive of plans as future activity categories with a range of possible attributes.*

H2. *Future activity categories tend to exhibit a graded structure.*

Within the context of the plan-action relationship, categorization theories can be related to field theory. Individuals' conception of a future activity as an activity category that has attributes in categorization theory is related to future regions of activity in field theory. Specifically, the typical possibilities of the future activity category correspond with the future regions of activity about which individuals form plans.

During the execution of the activity category, according to Lewin's (1936) theory, the individuals' locomotion between regions of activity in the life space might not be possible due to a barrier (i.e., situational contingencies). To overcome such a barrier, an adjustment is required. The adjustment is an alternative path or detour taken toward the goal region.

The researcher argues that there is a range of barriers that could arise. For a given barrier, there is a range of possible ways to adjust. Thus, for an activity category, it seems that a range of possibilities can occur for 1) the barriers and 2) the adjustments for a given barrier. These possibilities can range from more typical to typical and atypical. That is, not all barriers are new, but some of these barriers are more typical and therefore more, expected than others. Also, adjustments that an individual may take in response to a barrier are for the most part not constantly new, but can be reasonably expected based on an amalgamation of past experience. In the Toronto airport trip example, if 'bad' weather is quite typical in the winter, leaving home earlier with my wife to get to the airport on time may be a more typical adjustment than speeding on the highway.

Furthermore, the required adjustment is based on the extent to which a barrier can affect the activity. That is, some barriers prevent the individual from executing the activity entirely, while other barriers require an adjustment that does not prevent them from executing the activity. For example, heavy 'traffic' may slow down the 'driving on Highway 401 E,' but does not prevent executing the activity "taking my wife from Waterloo to Toronto Pearson International Airport next Saturday." However, if the 'traffic' shuts down the highway, then the trip will need to be rescheduled.

It can be argued that the decision of the actual adjustment taken by an individual is related to the individuals' knowledge and awareness of the range of possible adjustments and their typicality (graded structure). In the previous example, it can be said that the actual adjustment taken by leaving home earlier is influenced by my knowledge and awareness of the range of possible adjustments in the bad 'weather' condition, such as leaving home earlier and speeding on the highway. On the other hand, in the previous example my categorical knowledge of how trips to airport vary and how to adjust in response to variability is based on experience of behaving similar situations in the past. The general case is formalized in the following hypothesis:

H3. There is an association between an individual's knowledge of typical adjustments relevant to the activity category and the individual's actual adjustment in the activity category.

3.4 Summary

As can be seen from the discussion of the theoretical framework in this chapter,

- Plans as future activities have a categorical relationship with the future actions to which they refer;
- Future activity categories have internal structures that are both hierarchical and horizontal;
- The horizontal structure of the future activity category exhibits a graded structure, meaning that there are possibilities that are more likely to happen than others; and
- In the case that an adjustment is required due to a presented barrier, there is an association between individuals' knowledge of the future activity and the actual adjustment they make while performing the activity. .

Part II

Empirical Part: Case Study and Laboratory Experiment

"A psychological construct, if it is to prove valid and adequate, must be as valid and adequate in handling the stuff of ordinary human affairs as in handling the controlled variables of the laboratory experiment." (p.12, Sharif and Cantril, 1947)

Chapter 4
The Case Study: Setting the Stage

An in-depth field study was conducted at Ready-Mix Company (RMC) to examine the proposed research hypotheses. The decision to conduct a field study was based on the desire to observe both planning activities and categorization in a natural setting, as many researchers have recommended (e.g., Agre & Chapman, 1989; Murphy, 2005). The choice of RMC is conducive to this specific research because observing and drawing conclusions about jobs are easier tasks when the jobs involve physical work than when they do not (Scribner, 1984).

This chapter begins with an overview of the case context. Then, the case study's two-phase method is presented. Thereafter, a discussion of the validity and reliability of the collected data is described. The results of the researcher's observations, document analysis, and interviews are presented in Chapter 5.

4.1 Study Background

The study was conducted at RMC, which produces and delivers ready-mix concrete. RMC is located in the Middle East and occupies two physical locations: the head office and the batching plant. The head office is responsible for management activities, including developing and securing new contracts, managing current customers' accounts, and preparing the daily schedule. The batching plant is operational and technical in nature; the plant's employees are responsible for production, delivery, quality service, inventory control, and laboratory scale samples.

RMC manufactures and delivers various ready-mix concretes, including 3,000 pounds per square inch (PSI) and 7,500 PSI formulas. These mixes consist of cement, water, sand, admixture, and aggregate. An interesting property of the ready-mix concrete industry is that its products are highly perishable and must be batched upon request and according to the customer's specifications, which results in a complex logistical problem (Naso, Surico, Turchiano, & Kaymak, 2007). Typically, scheduling in such an industry is handled by experts (Lu & Lam, 2005; Naso et al., 2007); RMC is no exception. Expert schedulers offer the opportunity to study the plan–action relationship because, unlike automated scheduling software, they provide primary access to individuals who conceive of schedules and how an activity is described. Human beings can also evaluate if such activities progressed according to the plan. The remainder of this section is based on an interview conducted with RMC's schedulers about their main job responsibilities.

Scheduling is a resource allocation process (McKay et al., 1995). At RMC, scheduling starts by signing a contract between the project owner/contractor and RMC. The contract specifies the approximate total of required volume and specifications, project description, project duration, site location, and cost. Over the course of the project, orders are typically placed three to four days in advance, with an order confirmation being submitted the day before the order delivers. The three- or four-day lead time is mainly used to order raw materials, plan for truck mixers, and manage batching plant capacity. Late orders that are placed on the day of the delivery cannot be guaranteed. The scheduler receives orders and codes the following information for each order:

- Date of concrete pouring: In some cases, customers are placed on a waiting list if they are willing to receive their order based on availability.
- Preferred time of concrete pouring: The customer chooses one of three time slots—morning, afternoon, or evening—based on a first-come, first-served basis. It is worth noting that the first-come, first-served basis is not followed strictly; contractors who need a continuous daily supply of concrete for their large projects are given priority over other customers.
- Requested volume: The customer specifies the required volume as precisely as possible.
- Concrete specifications: The customer chooses from among a selection of predefined mixes at RMC.
- Site location: Sites in restricted areas (e.g., airbases, jails) require advance permission for specific trucks, pumps, and drivers to enter the area. Local municipalities in which RMC operates also impose regulations on the downtown area, restricting concrete pouring to a limited number of hours approved by the traffic department.

- Type of pouring: The customer specifies the type of pouring, such as column, slab, or foundation.
- Concrete discharge method: If the order requires a pump, the customer must ask for a pump to discharge the concrete from the truck mixers to the construction sites. For example, pouring a slab on the sixth floor of a structure requires a pump.

Based on this information and plant available capacity, the scheduler decides either to accept the order or delay the order to a later date. One day before the delivery, the scheduler confirms the order's requirements with the customer and ensures that the site is ready for delivery. In this way, the scheduler can prepare the next day's schedule. If an order is not confirmed, the order is cancelled (except for small orders of one truckload[5]). As a result, other customers might be contacted and shifted one or two days earlier to replace the cancelled orders. If an order is cancelled by RMC on the day of the delivery, the scheduler may negotiate delaying the delivery date and time with other customers to accommodate cancelled orders. Usually, the schedule is released and sent to the plant the evening before the delivery. Appendix A includes an example of the daily schedule at RMC.

For the purpose of the present study, according to corporate records of daily schedules, the major activity category that organizes scheduling is "delivering orders," which varies based on 1) volume of concrete, 2) PSI grades, 3) concrete pumps, 4) site locations, and 5) delivery time (see Figure 4.1). These attributes are defined formally in the daily schedule and reporting system at RMC. The present study individually analyzes each of the attributes on the occasions of delivering orders (hereafter, occasions of shipment), with the exception of the delivery time attribute as RMC does not record actual delivery time.

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[5] A truck base unit is a widely used unit at RMC. Most trucks at RMC have a maximum capacity of 9 m^3.

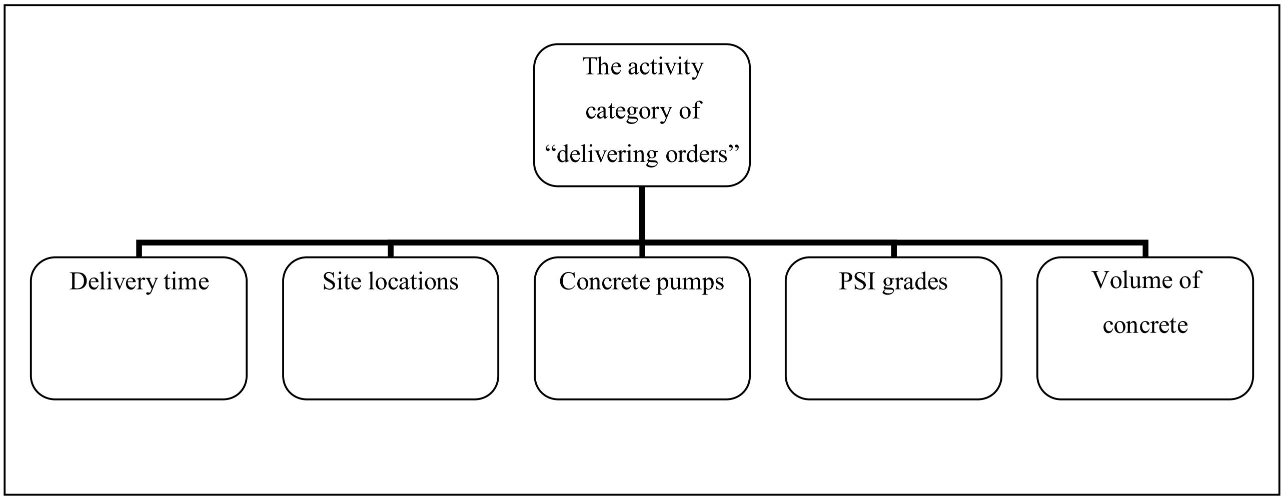

Figure 4.1: Attributes of the "delivering orders" activity category

4.2 Methods

The data collection for this study, which involved two phases—the preliminary and main phases—took place between June and September 2009. The first phase, preliminary collection, was exploratory in nature, with a goal of gaining a general understanding of ready-mix concrete. The second phase, main collection, consisted of participant-observation and semi-structured interviews to explore the nature of the "delivering orders" activity category and test the proposed research hypotheses. The second phase was followed up by additional communication to collect further data to clarify the data and assist with analysis. In the following subsections, each phase is discussed in detail, including the goal of the phase and the instruments used to collect data.

4.2.1 Preliminary Phase

The goal of the preliminary phase was to identify RMC's general background and the structure of the company's planning and scheduling systems. This phase involved establishing an appropriate level of trust and social rapport for the study, preparing an atmosphere in which staff members could express their opinions openly and establish contact with key staff members. During this stage, the following items were examined: the length of the scheduling cycle (i.e., scheduling horizon), how schedules were created, how schedules were communicated or distributed to staff members, and how schedules were coordinated with related parties (e.g., customers). Furthermore, key actors and entities involved in planning and scheduling were examined, including individuals (e.g., schedulers and dispatchers), groups (e.g., customers), and artifacts (e.g., scheduling software).

RMC's general manager was contacted by phone in March 2009 to request approval to study the company's planning and scheduling activities. The focus of the study was defined broadly in the area of planning and logistics operations, particularly with regard to how people develop and use operational plans and how these plans affect the way in which operational activities actually unfold in practice. The researcher informed the general manager that he was most interested in meeting with staff members in operational and planning roles, including those engaged in converting raw materials into finished goods, maintaining industrial machinery, and using information systems to support planning and operations. After obtaining the general manager's approval, to begin the preliminary phase, the researcher met with the general manager, who introduced the researcher to the key staff members at the head office, including the deputy general manager, sales manager, financial manager, and schedulers. The researcher also accompanied the general manager during a visit to the plant. At the plant, the general manager coordinated a meeting to introduce the researcher to the plant's key staff members, including the plant manager, assistant manager, quality control supervisor, and maintenance supervisor. In mid-June 2009, the researcher spent a week at RMC observing the planning and scheduling activities and informally interviewing several individuals. In addition, various documents and records related to daily production schedules were reviewed and evaluated.

In setting up this study, it was challenging to determine the optimum place in which to observe the scheduling activities as they unfolded as these activities were distributed geographically among the construction sites, the head office, and the plant. After several visits to different locations where scheduling activities took place, it seemed that the dispatch office would be the best place to observe operations and collect data on scheduling activities. This conclusion corresponded with the plant manager's recommendation to situate the study in the dispatcher office. In addition, the researcher also frequently visited construction sites and the head office.

4.2.2 Main Phase

The purposes of the main phase were to understand the "delivering orders" activity category and examine how staff members experience their job tasks as they unfold. With respect to the "delivering orders" activity category, information was obtained during interviews by identifying sets of job tasks and subtasks that a staff member performed in relation to developing and executing daily schedules. For example, the dispatcher might describe his or her task as "delivering an order," with a subtask such as "giving directions to the site." Interviewees were also asked to provide specific examples of typical and atypical instances of job tasks and subtasks to identify the range of possibilities.

The interview questions were constructed based on the "echo method" originally developed by Bavelas (1942). This method can be used to analyze the interactions, communications, and interdependency of roles relative to a particular task structure (Barthol & Bridge, 1968; Poile, 2008). The echo method has been applied to various settings, including manufacturing (Scala, Purdy, & Safayeni, 2006), organizational communications (Duimering, 1997), project management (Alojairi & Safayeni, 2012) and education (Schaefer, Bavelas, & Bavelas, 1980). Interviews involved questioning staff members about their experiences and tasks in their current and previous positions. Interviewees were asked to provide examples of what they considered to be helpful and unhelpful behaviors exhibited by both themselves and others in assisting other staff members or units in accomplishing their job tasks. (See Appendix B for the interview questions used in the present study.)

Nine interviews were conducted and recorded (with permission); lasting for an average of an hour and 15 minutes each. Interviews were conducted with schedulers, dispatchers, the plant assistant manager, the quality control supervisor, a quality control technician, site inspectors, and the sales manager. Interviewees had between 2 and 15 years of experience at RMC, with an average of 9.8. Blue-collar workers, such as truck drivers and pump operators, were excluded because most of these workers were not fluent in either of the languages the researcher speaks, which would have resulted in communication and interpretation barriers, thereby limiting the number of potential interviewees. According to Syverson (2008), blue-collar workers at ready-mix concrete plants typically account for more than 75% of the plant staff; RMC was no exception. As the percentage of these workers is so high and the researcher was not able to interview them, the study focused on other sources of data.

The other primary source of data from the main phase was collected via participant observation. In the interest of maintaining consistency in collecting the data over the course of the study, both a systematic data collection process and a data collection template were developed (see Appendix C for the details of the process used to develop these tools and Appendix D for the data collection template). Although recorded information was collected, validated, and cross-checked with the staff members after the observations, this information was not formally analyzed. Instead, these data formed the basis for the field notes that the researcher drew upon in analyzing anecdotes presented in the case study. In addition, over the course of the study -from June to September 2009- 35 hours of audio and video recordings were made of the daily activities at different locations (e.g., head office and construction sites), including 18.5 hours recorded in the dispatcher office. These recordings were used in conjunction with the field notes. Although the recordings were made with management's permission, in some cases the researcher was instructed to stop recording due to the sensitivity of these cases.

The data collected were mainly in Arabic, which is the official language of the country in which the company is located (and thus the language in which the study was conducted). To ensure a high-quality translation from Arabic to English, an iterative translation method was employed. Translation is not purely a linguistic task; rather, it requires many skills beyond language fluency, such as familiarity with the content of the material being translated (Green & White, 1976; Milliman & Glinow, 1998). In the present study, three bilingual graduate students, including the researcher, conducted the process of iterative translation. Each person completed the translation individually; the translators then compared their work. Discrepancies were noted and discussed until consensus was reached.

A follow-up study was carried out primarily to further clarify aspects of the case study. For example, additional data related to the procedures used at RMC to test the quality of delivered concrete were collected. These follow-up data were mainly collected through email correspondence between the researcher and general manager and quality control supervisor from April to May 2011.

During the data analysis stage, the interviews, field notes, and recordings were coded for analysis. The coding process involved identifying categories and their specific examples by segmenting, sorting, and then summarizing the data. The analysis focused on the patterns in the various data collected and the emergent themes as evidence to test the hypotheses (Charmaz, 2006; Maxwell, 2005; Strauss, 1987). In addition, various documents and records were collected, providing a quantitative basis for testing the research hypotheses.

4.2.2.1 Measuring the Graded Structure

One of the hypotheses in the present study is that individuals tend to conceive (have knowledge and awareness) of plans as future activity categories that are structurally graded. Over the last four decades, extensive research of human categorization processes has examined the prevalence of graded structure; this research has produced robust empirical results in which no single study failed to report a graded structure (Kim & Murphy, 2011; Murphy, 2004). A graded structure is typically examined quantitatively by typicality ratings, whereby survey instruments are used in experimental settings to measure how well a member of a given category fits the subjects' understanding of the category. Specifically, graded structure suggests that some members belonging to a given category are a better fit to the category than other members. For example, when asked to rate on a 9-point Likert scale how well different members fit the category of "furniture," if subjects judge that "sofa" is a better example (i.e., member) than "television," then the "furniture" category can be said to exhibit a graded structure (Barsalou, 1985; Murphy, 2004; Rosch, 1973, 1999). Graded structure studies have also found that members within a category that are judged to be different in their fitness with the category (e.g., degree of typicality) are correlated with different behavior measurements in psychological research. For example, when subjects were asked to press a button as quickly as possible, also called reaction time, to indicate that an object appearing on a screen belonged to a given category, researchers found that objects that better fit a given category were associated with faster responses than objects that fit the category poorly (Barsalou, 1985; Lakoff, 1990; Rosch, 1999).

However, within the context of RMC, obtaining reliable typicality ratings was difficult because the number of subjects who could perform any given task was small. Thus, an alternative approach was developed, suggesting that different behaviors that occur during different occasions of shipment are associated with different degrees of typicality of these occasions. For example, atypical occasions of shipment were associated with harsh language and cursing. Whereas typical occasions of shipment were associated with phrases such as “usually” and “always happens.” The dataset used in this approach consisted of a set of anecdotes based on the transcript of the 18.5 hours of data recorded in the dispatcher’s office. The study sought evidence to indicate whether RMC staff members can discriminate between different degrees of typicality for different occasions of shipments. (section 5.1.1.1 discusses the details of the dataset used and the coding procedures). To validate the developed qualitative approach, the evidence found in the qualitative data was correlated with corporate records, as described in section 5.1.1.2.

4.2.2.2 Unit of Analysis

In the present study, observational data are based on the perception of key staff members within RMC who had sufficient knowledge of the company and its operations. The analysis represents a collective perception of these key staff members of RMC, which suggests that the unit of analysis takes place at the plant/organizational level rather than the individual (staff member) level. Furthermore, official scheduling records used in the present study represent corporate data at the plant/organizational level, which is also not necessarily related to particular individuals.

4.2.2.3 Assumptions of the Case Study

This study, like many other studies investigating plan–action relationships (e.g., Suchman 1987), assumes that people are following plans. However, according to Carroll (2003), this assumption might not always be valid. Assessing this assumption at RMC is difficult as producing and delivering concrete are complex tasks that require multiple people to work simultaneously at different geographical locations.

In addition, following previous studies of plan–action relationships (e.g., Suchman & Trigg, 1991), this study uses schedules instead of plans to investigate the relationship. Thus, plans and schedules are assumed to be equivalent within the context of the plan–action relationship. Although in this case study both plans and schedules data were available for analysis, the decision was made to study schedules because, at RMC, the raw material availability and the reliable suppliers almost guarantee a continuous supply that keeps the amount of planning at RMC at a minimum. Furthermore, a larger sample size was obtained by focusing on schedules due to scheduling cycles (i.e., the process by which schedules are created and executed) being shorter than planning cycles.

4.3 Reliability and Validity of the Case Study

This section seeks to answer several questions—namely: Is RMC's scheduling performance comparable to that of the ready-mix concrete industry? Are different sources of collected data reliable? What problems are associated with these sources of data?

Few studies have focused on performance measures in the ready-mix concrete industry (Wang & Anson, 2000), and some researchers (e.g., Wang & Anson, 2000; Wang, Ofori, & Teo, 2001) have argued that the ready-mix concrete industry does not possess accepted performance measures that can be used for benchmarking. Wang and Anson (2000) suggested comparing different measures reported in the literature to assess the performance of ready-mix concrete plants. Therefore, various measures of scheduling performance at RMC, such as the mean difference between scheduled volume and actual volume delivered, are computed and compared with findings in the existing literature.

In the present study, the first scheduling performance measurement used to assess RMC is the mean of difference between scheduled volume and actual volume delivered (Anson, Tang, & Ying, 2002). According to data reported in Anson et al. (2002), the mean of the difference between scheduled volume and actual volume delivered is 24.2%, with a standard deviation of 7.4%. At RMC, the mean difference between these two measures is 9.8%, with a standard deviation of 7.8%. Thus, it appears that RMC has higher performance based on the mean of difference between scheduled volume and actual volume delivered than the performance found by Anson et al. (2002).

The second performance measure reported in the literature to measure ready-mix concrete plant performance is the difference between the initial number of orders per day and the actual number of orders delivered. For example, Anson et al. (2002) found that the mean of difference between the number of orders initially placed and the number of orders actually delivered per day was 62.9%, with a 21.1% standard deviation. At RMC, the mean of difference between the number of initial orders and the actual orders delivered is 20.9%, with a standard deviation of 7.4%. Thus, it appears that RMC demonstrates much higher in consistency between the number of orders initially placed and the number of orders actually delivered per day.

The third performance measure is the average volume per order (Anson et al., 2002; Anson et al., 1996). Anson et al. (2002) reported an average of 30.48 m^3 per order, whereas Anson et al. (1996) reported an average of 32.5 m^3 per order. These two figures are close to the 29.7 m^3 recorded average volume per order at RMC. Overall, as shown in Table 4.1, data on the performance measures of scheduling suggest that RMC has higher performance than reported studies.

Table 4.1: Performance Measures of Scheduling at RMC Compared with Reported Studies

No.	Performance Measures	Anson et al. (2002)	Anson et al. (1996)	RMC
1	% of the difference between scheduled volume and actual volume delivered per day	*M* = 24.2% *SD* = 7.4%	Not reported	*M* = 9.8% *SD* = 7.8%
2	% of the difference between initial number of orders and actual number of orders delivered per day	*M* = 62.9% *SD* = 21.1%	Not reported	*M* = 20.9% *SD*=7.4%
3	Average volume per order	30.48 m^3	32.5 m^3	29.7 m^3

With respect to the validity and reliability of the collected data, the present study uses methodological triangulation in which multiple sources of evidence—namely, formal interviews, scheduling reports, and participant observation—are used to establish a chain of evidence to examine the proposed theoretical framework and enhance the study's validity (Yin, 2003). The first set of data was obtained from formal interviews with a standard set of questions, which were helpful in capturing the real task situation and understanding the "delivering orders" category. Two issues must be noted regarding the formal interviews. First, the number of interviewees available was limited by communication barriers with the blue-collar staff, as previously discussed. Second, interviews are considered second-hand information, requiring interviewees to reconstruct real-life events (Duimering, 1997). To overcome these issues, direct observation of the events was used because observational data might be more reliable for capturing events as they unfold rather than reconstructing these events after the fact.

The second set of data is the observational data, such as audio and video recordings. This very rich data represents the work at RMC as it is unfolding. Observational data also provide opportunities to draw comparisons between different events and examine emergent patterns. One of the issues with observational data is that human perception is a highly selective process. According to Sacks (1984), "The question is why did you choose the particular data? Is it some problem in your mind that caused you to pick up this data?" (p. 26). To overcome the selectivity of human perception, the observational data were gathered in two forms: 1) structured field notes and 2) audio or video recordings. Together, these two formats offer a structured and more comprehensive dataset than using a single form. The other issue associated with recordings is that, in a few sensitive situations at RMC, recording was not possible.

The third set of data is corporate records, including scheduling and quality control reports, which allow comparisons to be drawn between scheduled and actual production. These reports are limited by the fact that they do not give the reasons for the changes in the daily schedules (e.g., replacing scheduled pumps with other pumps or changing the volume of concrete).

Chapter 5
Case Study: Results and Analysis

This chapter synthesizes the qualitative and quantitative data, creating triangulation to sensibly interpret the actual situations observed and documents analyzed to extract a coherent meaning. In addition, the examined attributes of the daily schedule (volume, PSI grades, pumps, and site locations) offer independent lines of evidence to test the hypotheses as these attributes are neither related to nor affected by each other. For example, placing an order for a certain volume of concrete is not affected or controlled by the choice of a certain PSI grade (as any volume of concrete can be provided in any PSI grade).

The chapter is subdivided into two sections. The first section is devoted to discussing the results and analysis of the category structure (H1 and H2). The nature of adjustments (H3) is subsequently examined.

5.1 Category Structure

In this context, occasions of shipment of the activity category "delivering orders" are examined with respect to each of the daily schedule attributes (volume, PSI grades, pumps, and site locations). For each attribute, the analysis starts with the first hypothesis. Thereafter, qualitative and quantitative analyses are devoted to examining the second hypothesis.

5.1.1 Volume

Volume is an attribute of the "delivering orders" activity category and specifies the volume of concrete to be delivered to a given customer. Although estimating the total volume of concrete required for an entire construction project can be done in advance at a satisfactory level, estimating the volume of each order delivered at specific time over the course of the project is very difficult. This difficulty, combined with the fact that customers are charged for the volume ordered—whether it is used or not—results in some tension in the process of placing orders at ready-mix concrete plants. Accordingly, a common practice among customers is to order less concrete volume than is actually required and then ask for additional concrete on short notice if it is needed. Ordering less concrete than needed has led RMC to establish a policy of limiting customers to one additional truckload per order on short notice. In executing the daily schedule, this policy is considered central, yet sometimes it is not strictly followed due to the relative size of the order. With large orders, for example, one extra truck accounts for a relatively small percentage of the order; therefore, two or more extra trucks might be inevitable according to the dispatchers.

The policy of limiting customers to one additional truckload is evidence of the variability in volume, which suggests that staff members at RMC are aware that an order delivery can have a range of possibilities up to a full truckload from the original booking. This knowledge and awareness among staff members about possible deviations supports the first hypothesis that individuals tend to conceive plans as future activity categories with a range of possibilities.

5.1.1.1 Analyzing the Qualitative Data

This section reports anecdotes and quotes to examine the graded structure hypothesis (H2), which includes identifying deviations between scheduled and actual delivered orders, the degree to which these deviations are typical, and the behaviors associated with each deviation. The focus here is on the deviations within particular occasions of shipment as the study was conducted within the context of the plan–action relationship, which emphasizes the consistency between scheduled and actual shipments. The qualitative analysis applies to each of the daily schedule attributes (i.e., PSI grades, pumps, and site locations), which will be discussed later in this chapter.

The 18.5 hours of recordings that captured daily activities at the dispatcher's office serve as the foundation of this analysis. The procedures for coding and analyzing shipments are as follows. First, orders that had deviated from the schedule during the 18.5 hours were identified using RMC's daily schedule reports: 14 orders deviated regarding the volume of concrete, 4 deviated from PSI grade, 8 deviated regarding concrete pumps, and 1 deviated from site location. Second, using the transcription of the 18.5 hours, the researcher traced and coded the details of the deviated orders, noting how typical these deviations were (e.g., usual and one-of-a-kind) and their associated behaviors (e.g., welcoming words and harsh language used, such as shouting and screaming).

Not all of the deviated orders had enough detail to be coded as staff members (e.g., schedulers) dealt with some of the deviated orders without consulting the dispatch office where the recording was occurring. As a result, the researcher supplemented the analysis with data collected from interviews that indicated typical and atypical deviations.

In the first piece of evidence, an episode suggested that different staff members possess different understandings of what constitutes a deviation:

> **Researcher**: What is going on with [customer]?
> **Dispatcher**: He booked 95 [m^3]. Maybe the customer was not sure how much he would actually need; it may be 90 [m^3], or 100 [m^3], or maybe 105 [m^3].
> **Researcher**: So, usually one truck, right?
> **Dispatcher**: No, it's very usual to take 2 [m^3], 3 m^3, 5 m^3 less or one truck more [i.e., 9 m^3]. It's very usual for every customer. So, for example, [the customer] could take up to 105 [m^3] more. That is a truck extra.
> **Researcher**: What if he takes 90 [m^3]? Is that okay?
> **Dispatcher**: Yeah, that is very reasonable. I told QC [Quality Control] that the booking is 100 [m^3], so how many bags do I need to order? They said "four hundred ice bags." I increased it [the customer booking[6]] to 100 [m^3].
> **Researcher**: Do you tell QC how many cubic meters and then they inform you how many bags?
> **Dispatcher**: Yes, because they control the temperature.
> **Researcher**: Don't they put a margin of 10 or 20 bags?
> **Dispatcher**: No. I easily can supply up to 105 [m^3] because I already ordered 100 [m^3] and accumulated 20 bags extra from last night.

This episode shows that staff members, such as dispatchers, who interact directly with shipping orders understand reasonable and usual deviation at RMC. However, other staff members, such as quality control technicians, who do not interact directly with shipping orders do not understand deviation. According to this episode, a conflict arises when the staff members who do understand deviation coordinate their work with staff members who do not understand deviation. In other words, some staff

[6] The actual booking was 95 m^3.

members experience and recognize that deviation is happening, whereas others do not. As a result, those who do understand deviation use a padding mechanism by adding extra concrete equivalent to the expected deviation. The padding mechanism is shown when a staff member who does not understand deviation was informed of a volume that includes 5 m^3 extra. The staff member who does not understand deviation calculates that the number of ice bags (used to control concrete temperature in the summer) based on the volume that includes this padding, not the customer's original booking.

A second anecdote provides evidence of a usual deviation:

Dispatcher: We [RMC] sometimes suffer from being late because of 1 or 2 [m^3].
Researcher: Isn't there one truck extra?
Dispatcher: Usually, one truck is 1 to 2 m^3 more or 2 to 3 m^3 fewer.
Dispatcher: But for a big slab, a big quantity may be one full truckload or two trucks.

In the previous example, one of the staff members talked about the difficulty that RMC staff members experience when customers ask for 1 or 2 m^3 extra, which delays the schedule. Although the quote indicates that sending a larger quantity of extra concrete is an unpleasant situation for RMC staff members, sending a few extra cubic meters and up to one additional truck is common. Large orders are the exception, as they might ask for more than one extra truckload.

A third anecdote shows a more typical deviation:

Dispatcher: I sent 25 [m^3], but only 24 [m^3] were necessary to complete the job.
Researcher: He [customer] paid for the 25 [m^3], right?
Dispatcher: He paid for the 25 [m^3]. This always happens. In ready-mix customers are unable to give exactly how much concrete they will need. Customers can't estimate the required volume with perfect accuracy. You see there [pointing outside his office to a dump trailer] is [the customer's] excess concrete.

In this episode, two deliveries had excess concrete. In one of these two cases, the 1 m^3 excess was sent to a subsequent customer, whereas in the other case, the excess concrete was unloaded into the dump trailer to be sent to the dumping area because the concrete was not fresh enough to be sent to another customer. Again, the episode stressed that deviations are not unusual at RMC.

A fourth anecdote illustrates an interesting example from the interviews regarding the helpful behavior a dispatcher displayed toward the scheduler. In this example, the dispatcher wanted the head office to contact the customer when the last truck of an order was about to be sent to double-check with the customer as to whether he or she needed extra concrete. The scheduler considered this very helpful behavior:

> **Scheduler**: Okay, a customer had an initial order of 100 m^3. The dispatcher called me [scheduler], and I left with 3 m^3 to finish his booking. Would you [scheduler] please check if the customer needs an extra truck [over the booking of 100 m^3]?

The fifth anecdote relates to a customer who ordered a lot of extra concrete—an unusual deviation. Its consequences are apparent based on the discourse.

> **Dispatcher**: This is another **** [curse]. You know that if he [a particular customer] orders 20 m^3, he may order 10 [m^3] more [laughing]. If he orders 100 m^3, he might needs 50 [m^3] more, or if 100 m^3, he may ask for another 200 [m^3]. I supply him very carefully, checking the site. If he places an order of 50 m^3, I ask [the site inspector] to examine the construction site [to estimate how much concrete the customer will actually need versus how much he initially orders].

In the sixth anecdote, an example of another unusual deviation and its consequences are again noticeable.

> **Dispatcher**: One day, I got angry. I wasn't able to control myself. [The customer] ordered 40 m^3 and took nearly 100…After the 40 m^3, he [the customer in three separate instances] said "Send 20," again, "Send 20," and then, "Send 20." I told him, "You tell me what you want at one time." He said, "I'm an engineer." I said, "Whether you're an engineer or not is not the question. Okay, you're an engineer. Tell me the right quantity so that I can adjust."

In the preceding example, the dispatcher became angry with a customer who asked for many extra truckloads, using harsh language, curse words, and raising his voice. The dispatcher took several actions in subsequent dealings with the same customer(s), such as asking the customer to be honest and relying on RMC site inspectors to obtain an accurate estimate of the required volume rather than relying on the customer's estimation.

These anecdotes and quotes highlight shipments with typical and atypical deviations. Specifically, typical deviations (which had a maximum of one additional truck) were easier to cover through a willingness to send a few extra cubic meters. These typical occasions were described with phrases such as “very usual,” “very reasonable,” “every customer,” “usually,” and “always happens,” which indicates these shipments are more likely to happen. On the other hand, atypical deviations (customers who require more than one additional truck) were more difficult to cover and associated with mistrust, harsh language, and very negative tone often of cursing. Overall, these anecdotes and quotes provide support for the second hypothesis that occasions of shipment in the “delivering orders” activity category exhibits a graded structure in which some occasions of shipment are more likely to happen (small deviations equating to a maximum of one truckload) than others (large deviations equating to more than one truckload).

5.1.1.2 Analysis of the Quantitative Data

In this section, a quantitative approach is developed and performed to determine if the graded structure, found in the previously presented qualitative analysis, is also present. In addition, the purpose here is to determine/demonstrate that prior data are not special cases; but that they are typical and that the results are generalized to all shipments at RMC. The procedure used for the quantitative analysis is as follows. Based on daily schedule reports for 43 days of operation and 1,109 identified orders, undelivered and unscheduled orders were excluded, leaving 702 orders to analyze. The researcher then computed the deviations in the shipments with respect to each attribute of the daily schedule. For example, the deviation for the attribute volume was calculated by computing the difference between scheduled and delivered volume for each order. The computed deviations were grouped in two ways: 1) staff members’ opinions of the permissible and not permissible deviations obtained in the qualitative analysis and 2) a two-step clustering technique. Two independent methods were used to group the deviations for the purposes of cross-validation.

With respect to volume, based on the company's policy of limiting customers to one additional truckload, deviations were grouped into the following: 1) orders within the policy (i.e., 0 to 9 m^3) and 2) orders that deviated beyond the policy. Table 5.1 indicates that 82% (573 orders) fall in the first group while 18% (129 orders) fall in the second group. These data show that orders are most likely to fall within the permissible range, whereas it is less likely for orders to fall beyond the permissible range.

Table 5.1: Groups Created Based on the Policy of Limiting Deliveries to One Additional Truckload

Groups	*n*	%	Range (m^3)	Range (*trucks*)
G1p within the permissible range	573	82	(0 to 9)	(<= one truck)
G2p beyond the permissible range	129	18	(> 9)	(> one truck)
	702	100		

The two-step cluster technique[7] used to find the optimum number of groups was performed on the computed deviations (SPSS, 2001). After performing the two-step cluster technique, three groups were identified. The Silhouette measure, an index used to compare the width of each group produced with the width of the entire dataset, was used to validate the number of groups produced. The result of the Silhouette measure is a single number between -1 and 1. If the Silhouette index is close to 1, it is considered to be a very good grouping; if the index is close to 0, it means another cluster can be preformed; and if the index is close to -1, it is considered to be a misgrouping of the dataset (SPSS, 2001). For the three groups of the volume, the index was computed as 0.7, which is considered to be a good grouping.

As shown in Table 5.2, the first group includes 85% of the orders (596), which deviated from the scheduled volume by values between 0 and 11 m^3. Table 5.2 also shows a relatively large standard deviation (*SD* = 17.2) for G3c, which suggests that G3c includes a wide range of values for the deviations and has a very large dispersion.

[7] This technique's procedures consist of two steps. In the first step, many small subgroups are produced based on a sequential clustering approach that uses a distance criterion. Here, the data are examined sequentially to determine whether each record is a best fit with the existing group(s) or requires a new group. In the second step, the technique finds the optimum number of groups automatically and then converts the many small subgroups that were produced in the first step into the automatically generated groups (SPSS, 2001).

Table 5.2: Groups Created Based on the Cluster Analysis

Groups	*n*	%	Mean (*m*^{3})	SD (*m*^{3})	Range (*m*^{3})	Range (*trucks*)
G1c	596	85	2.3	3.00	0 to 11	approx. <= one truck
G2c	79	11	21.2	6.80	12 to 38	approx. 2 to 4 trucks
G3c	27	04	59.5	17.2	>= 39	approx. > 4 trucks
	702	100				

Figure 5.1 indicates that Group 1, created by the cluster analysis, matches 96% of RMC's policy of limiting customers to a maximum of one extra truckload per order (i.e., 0 to 9 m^3). Figure 5.1 further indicates that the cluster technique differentiates between orders that deviated by two to four trucks in Group 2 and orders that deviated by more than four trucks in Group 3. However, Groups 2 and 3 are treated in a similar fashion to RMC's policy because they fall into one group beyond the permissible range. Therefore, because RMC's policy does not differentiate between Groups 2 and 3, it can be said that—to a large extent—the groups created by the cluster technique are consistent with the groups created based on RMC's policy. Specifically, in the "delivering orders" activity category, shipments with respect to volume are most likely to be delivered within the permissible range and less likely to be beyond the permissible range.

The quantitative analysis is consistent with the qualitative analysis that suggested that some occasions are more likely to occur than others. On the whole, the results presented in the qualitative and quantitative analyses indicate that, with respect to volume, shipments are most likely to be within the permissible range and less likely to be beyond the permissible range. These results demonstrate that volume exhibits graded structure, supporting Hypothesis 2. That is individuals tend to conceive of plans as future activity categories that exhibit a graded structure in which some occasions are more likely to occur than others.

Figure 5.1: Match between the groups created based on the cluster analysis and the groups created based on the policy of one additional truckload

5.1.2 Pounds per Square Inch Grades

Pounds per square inch (PSI) grades (hereafter, grades) is an attribute of the "delivering orders" activity category that refers to the compressive force required to cause the concrete to fail (Lee, 1989). RMC has a high standard of safety in which an ordered grade should provide a strength that equals at least the ordered grade plus 500 PSI. For example, if a customer orders grade A, the delivered concrete will be at least grade A plus a minimum safety factor of 500 PSI. In the general manager's words: "We design the mix to give at least a 500-PSI margin above the target." Indeed, the safety factor is considered to be central in executing the daily schedule.

The safety factor of adding a minimum of 500 PSI defines the minimum, but not the maximum, limit of the PSI added, which introduces variability. This variability suggests a range of possibilities that may include any number higher than or equal to 500 PSI additional strength to the ordered grade. Thus, the awareness and knowledge that staff members have about possibilities resulting from the inclusion of a safety factor in shipments provides evidence to support Hypothesis 1, which states that individuals tend to conceive of plans as future activity categories with a range of possibilities.

5.1.2.1 Analysis of the Qualitative Data

Shipments are investigated in relation to the difference between originally ordered grades and the actual grades delivered to customers. To evaluate this factor, the dataset's anecdotes and quotes were analyzed following the procedures discussed in section 5.1.1.1.

The following quote discusses the consequences of pouring concrete at the wrong site:

> **Dispatcher**: Yeah, I have to be very careful since we are pouring concrete at two different sites in the same area. One time when we poured concrete at two sites in the same area, one truck driver went to the wrong site. I was lucky that both sites had similar grades.
> [The researcher then asked the dispatcher whether he remembered a case when the delivered grade was lower than the original order.]
> **Dispatcher**: Yeah, about seven years ago. It was costly. We had to remove the concrete and replace it. We also paid for the manpower.

From this quote, it can be concluded that the consequences of mistakenly sending concrete to the wrong site would depend on the grade. If both sites required identical grades, the mix-up would not be a problem. However, if the sites required different grades, this would require replacing (at RMC's expense) the concrete at the site that received the grade lower than originally ordered. Indeed, RMC has experienced this situation as noted.

Sometimes concrete is sent from one site to another site. In these cases, the grade of the concrete has to be identical to or higher than the originally ordered grade. The next episode shows the role of grades in the process of transferring excess concrete between sites.

> **Dispatcher** [on the phone with the scheduler]: Hello, Sir. One m^3 left from blinding, two and a half hours. Can I send it to [customer]? Oh, okay.
> **Dispatcher** [to plant operator]: One-six-four [truck number] has one m^3 inside. Send it to [customer number 17].
> **Researcher**: Only one m^3?
> **Dispatcher**: The customer doesn't need it. It's excess.
> **Researcher**: Oh, excess. So, you will send it to [another customer].
> **Dispatcher:** Yes, another site.
> **Researcher**: You will add more, right?
> **Dispatcher**: One m^3 in the truck, and I'll add 8 m^3.

In this episode, one m^3 of excess concrete from one customer was sent to another customer. Although the discussion in the episode did not address the grade of the concrete explicitly, the grade was indirectly indicated by identifying it as blinding concrete. According to the scheduler, different kinds of structures, such as blindings, foundations, and slabs, have standard grades. Because blinding concrete is usually of a grade that is identical to the target the customer originally ordered, grade was not an issue.

The next quote is an example of a miscommunication between schedulers in which each thought that the other confirmed an order from a customer. Ultimately, the concrete was loaded onto the truck before anyone noticed the miscommunication. The quote indicates that the concrete was sent to another customer.

> **Scheduler:** I'm going to send [the already loaded truck] to [customer]. He ordered grade 2,500, but I'm going to send grade 4,000. He is lucky. It's a loss, but what can I do? The bookings are completed, and no one wants concrete right now.

This case was subject to sales manager approval because the loss was approximately US$270. The problem resulted in sending higher-grade concrete than the customer had ordered, which was justified in this case because it was the end of the daily operation, the daily schedule was almost finished, and no other customers were willing to take concrete at that time.

Collectively, these quotes and anecdotes illustrate the impact of sending concrete with a different or identical grade than the originally ordered grade. Sending concrete from one site to another site is not problematic if both sites use an identical concrete grade; however, sending higher-grade concrete than originally ordered was less typical and associated with phrases such as "management approval," "no one wants concrete right now," and "lucky." Sending a lower concrete grade than originally ordered violates RMC's policy, which means it only occurs as an error. According to the dispatcher, this mistake had occurred only once in the last seven years. This evidence suggests that grades in shipped concrete are most likely to be identical to or higher than the originally ordered grades and not lower than the originally ordered grades. Thus, it can be said that the "delivering orders" activity category exhibits a graded structure because some occasions of shipped grade are more likely to occur than others. This evidence supports Hypothesis 2, which notes that individuals tend to conceive of plans as future activity categories that are structurally graded.

5.1.2.2 Analysis of the Quantitative Data

This section examines the graded structure following the procedures presented in section 5.1.1.2. The daily schedule reports show the originally ordered grades and the delivered grades without reporting the included safety factor. Accordingly, the researcher investigated alternative data beyond the daily schedule reports. Quality control reports of the frequently tested subsets of delivered concrete were very helpful as these reports showed the included safety factor. The general manager described the testing process as follows:

> Concrete is tested by crushing samples in line with International Standards to measure the point at which the concrete fails a stress test under load. We have a calibrated concrete crushing machine in our laboratory used to carry out this test. We are producing various grades of concrete in accordance with relevant specifications. Usually, our concrete is sampled on site at the point of delivery and is cured and tested in our laboratory. Individual samples are usually in sets of 3 cylinders. One is crushed at 7 days and the remaining two at 28 days. We sell our product to a guaranteed minimum of 28 days' strength. The 7-day result is expected to be between 70% and 80% of the result of the average of the two 28-day results.

Based on quality control reports that covered a four-month period from January to April 2011, the present study examined 207 samples of an average[8] of two crushed cylinders at 28 days from three different grades. As shown in Table 5.3, the grades are 3,000 PSI (Grade A) with 13 samples; 3,500 PSI (Grade B) with 13 samples; and 4,000 PSI (Grade C) with 181 samples. Regarding the small number of samples, the general manager stated: "We cannot sample and test too many mixes other than our control mix and those required for special projects."

[8] The reported tested samples at 28 days are based on the average of two crushed cylinders, not on a single crushed cylinder. This practice at RMC is in line with the recommendation of the American Concrete Institute Building Code 318 (ACI 318) (Artuso & Wargo, 1998). Although averaging in itself is a variability reduction mechanism, the averaged two crushed cylinders are collected, cured, and tested in the same way, using the same machines, which may result in higher homogeneity.

Table 5.3: Description and Frequency of the Examined Samples of Grades

Grade	Description (*PSI*)	*n*	%	Mean (*PSI*)	SD (*PSI*)	Range (*PSI*)
A	3,000	13	06	3,644	64.6	3,528 to 3,717
B	3,500	13	06	4,062	158.6	3,783 to 4,250
C	4,000	181	88	4,733	65.3	4,653 to 5,046
		207	100			

The added safety factor per tested sample was extracted for the three grades, A, B, and C. Samples were then grouped into 1) meeting the safety factor and 2) not meeting safety factor. As shown in Table 5.4, 98% (203) of the samples met the safety factor of a minimum of 500 PSI, whereas only 2% (4) of the samples did not meet the safety factor. It is worth noting that no sample was recorded below a customer's original order. These data indicate that orders most likely meet the safety factor while it is unlikely for orders not to meet the safety factor.

Table 5.4: Groups Created Based on the Safety Factor

Groups	*n*	%
G1f (i.e., meeting safety factor of minimum 500 PSI)	203	98
G2f (i.e., not meeting safety factor of minimum 500 PSI)	4	02
	207	100

Based on the added safety factor, a two-step cluster analysis technique was performed, which resulted in four groups. To validate the quality of the clustering, the Silhouette measure was performed, resulting in an index of 0.6. Since it is greater than 0.5, the groups produced are considered to be a good clustering. As shown in Table 5.5, G1c, G2c, and G3c of 197 (95%) samples are above the safety factor, whereas G4c of 10 (5%) samples tends to represent the readings that were below or close to the safety factor. The range includes readings between 283 PSI and 569 PSI (not just < 500 PSI). From a financial perspective, G1c is quite impractical due the unnecessary cost since going about 500 PSI additional beyond the safety factor increases the cost by about 23%.

Table 5.5: Groups Created Based on the Cluster Analysis

Groups	*n*	%	Mean (*PSI*)	SD (*PSI*)	Range (*PSI*)
G1c	15	07	913	63.40	841 to 1046
G2c	89	43	740	20.20	718 to 792
G3c	93	45	686	23.60	602 to 717
G4c	10	05	471	102.2	283 to 569
Total	207	100			

As suggested by Figure 5.2, G1c, G2c, and G3c created by the cluster analysis match approximately 97% of the G1f for meeting the safety factor. This suggests that shipments in G1c, G2c, and G3c are treated in a similar manner as shipments in G1f regarding the safety factor since these shipments meet the safety factor. Although G4c of the cluster analysis is equivalent to G2f of not meeting the safety factor, this description is imperfect because G4c of the clustering includes readings just above the boundary of the additional 500 PSI safety factor, such as 521 PSI and 528 PSI. Overall, it can be said that the presented analysis of the safety factor and cluster analysis suggests that delivered grades mostly meet the safety factor and are very unlikely to fall below the safety factor.

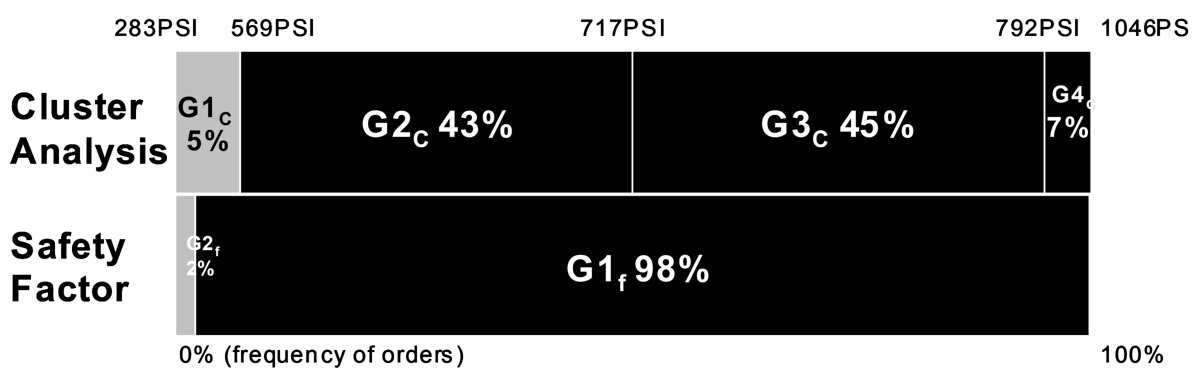

Figure 5.2: Match between the groups created based on the cluster analysis and the groups created based on the safety factor

The quantitative analysis is consistent with the qualitative analysis in which some types of shipments are more likely to occur than others. In terms of the hypothesis, both qualitative and quantitative analyses indicate that shipments with respect to grades are more likely to be delivered as requested by the customer or higher including the safety factor. It is less likely that shipments will fall below the customers' requirements when including the safety factor. These results support Hypothesis 2, which states that individuals tend to conceive of plans as future activity categories that exhibit a graded structure in which some instances are more likely to occur than others.

5.1.3 Concrete Pumps

Concrete pumps are used to discharge concrete from the truck mixers at a construction site. Due to the limited number of pumps, schedulers assign pumps in advance to construction sites. In response to the researcher's question about criteria by which different pumps are assigned to sites, the scheduler responded, "it isn't [the expertise of the operators] necessarily. It depends on the pump's boom height." Boom height is central to the decision to assign pumps to construction sites. The match between the pump's boom height and the site requirement is typically based on two factors: the height of the building and the pump setup location and its proximity to the concrete pouring area—namely the closer the pump is to the concrete pouring area, the less boom height the construction site requires. Table 5.6 shows details of the pumps at RMC.

Based on the boom height, pumps with identical boom heights can replace one another (e.g., P8 of 32m can be replaced by P9 of 32m), and shorter pumps can be replaced by longer ones (e.g., P8 of 32m can be replaced by P1 of 42m). Accordingly, boom height introduces variability in replacing pumps. Staff members' knowledge and awareness about boom height in replacing pumps suggest that staff members are aware of the range of possible replacements for a given pump. This knowledge and awareness about the range of possible replacements for a given pump supports Hypothesis 1, which states that individuals tend to conceive of plans as future activity categories with a range of possibilities.

Table 5.6 Pumps Fleet at RMC

Fleet Number	Boom height (*meters*)
P1	42
P2	36
P3	47
P4	42
P5	42
P6*	----
P7	42
P8	32
P9	32

* P6 was out of service during the course of the study.

5.1.3.1 Analysis of the Qualitative Data

This section reports anecdotes and quotes that were analyzed following the procedures discussed in the analysis of the qualitative data of volume (section 5.1.1.1). For different shipments, the focus was on replacements between scheduled and actual pumps that went to construction sites.

The following quote is an exchange about the replacement of two pumps:

> **Dispatcher**: Yeah, P8 [32m] and P9 [32m] are the same. In the schedule it's P8, but today I'm using P9.
> **Researcher**: You changed P8 with P9?
> **Dispatcher**: Yes, sir.
> **Researcher**: What happened to P8?
> **Dispatcher**: P8 will go to inspection [Periodical Motor Vehicle Inspection].
> **Researcher**: But he [scheduler] wrote here [pointing to the schedule] P8. Did he know about the inspection?
> **Dispatcher**: If he didn't know, it's not a problem; I can change it.

In this exchange, the change between P9 and P8 was described as "the same"; both pumps have a boom height of 32m. The process of changing was done without consulting the head office and was the decision of the dispatcher located in the plant.

The next quote is a phone call between the scheduler at the head office and a dispatcher at the plant. A sudden breakdown in one of the pumps required a replacement. Although the quote represents only the scheduler's side of the call, the scheduler suggested two alternatives for the sudden breakdown in one of the pumps.

> **Scheduler [talking to the dispatcher over the phone]**: Hello. Did P9 come to the plant or not yet?
> **Scheduler**: Still not yet! P2 went already, right?
> **Scheduler**: P1 and P7 already went, and they are back.
> **Scheduler**: Now what? [loud voice] Oh oh oh. Bad news! Bad news.
> **Scheduler**: Okay, thank you.
> **Staff member in the schedulers' office**: What is the bad news?
> **Scheduler**: P2, P2, remove it from tomorrow's schedule!

In this exchange, the head office called the plant to obtain an update about the operations. A sudden breakdown in P2 affected both the current operations and the next day's schedule. As shown, P1 and P7 were finished with their assignments and could be good replacements for P2. It seems that the head office was more concerned about the next day's operation, whereas the decision to choose one of the two replacement candidates, P1 or P7, was delegated to the dispatcher located in the plant.

In a third example, P3 arrived at the customer's site and poured 12 m^3. After that, it broke down due to a hydraulic problem. The maintenance staff went to the site to fix P3, but the problem required fixing P3 at the workshop. It took a very long time to fix the problem, from 6:45 a.m. to 3:00 p.m. The order was thus postponed to 12:00 pm the next day. P3 was not a good replacement because of its height (i.e., 47m). Thus, the order was postponed.

These quotes provide examples of the impact of the sudden replacement of pumps. Replacing a pump with another pump that has an identical boom height invokes phrases such as "the same" and "it's not a problem," which suggest that these replacements are typical. In addition, these replacements are associated with phrases such as "not consulting the head office." Replacing a pump with a taller one was not considered a problem and did not even deserve much discussion, further indicating the typicality of this kind of replacement. The cases of replacing pumps with identical or higher boom heights were deemed to be good replacements. However, in the last event, the replacement of the highest boom height's pump was not possible due to the lack of any other pump that could do the job. This is considered atypical because the customer was delayed until the pump was fixed. Acts of delaying the customer and postponing the order to the next day are associated with cases of not having a good replacement. These shipments are evidence that pumps were most likely to be sent as scheduled or replaced with identical or higher boom heights. Yet it is very unlikely that a taller pump can be replaced with a shorter pump. Thus, Hypothesis 2, which states that individuals tend to conceive of plans as future activity categories that exhibit a graded structure in which some occasions of shipment are more likely to occur than others, is supported.

5.1.3.2 Analysis of the Quantitative Data

In this section, we again follow the procedures described in section 5.1.1.2. After excluding the orders that did not require a pump to discharge concrete, 447 orders were obtained (see Appendix E for frequencies of pump assignments).

Based on the difference in the boom height between scheduled and actual pumps sent to a site, shipments can be grouped into 1) within the permissible range, which refers to pumps sent as scheduled or pumps replaced with the exact or higher boom heights, and 2) beyond the permissible range, which refers to replacement with shorter pumps. Table 5.7 shows that 91% (408) of the orders fall within the permissible range, whereas 9% (39) of orders fall beyond the permissible range (for a detailed breakdown of the two groups per pump, see Appendix F). These data show that orders are most likely to be within the permissible range quantitative approach whereas it is less likely for orders to fall beyond the permissible range.

Table 5.7: Groups Created Based on the Boom Heights

Groups	*n*	%
G1h beyond the permissible range (i.e., replacing a pump with a shorter pump)	39	09
G2h within the permissible range (i.e., replacing a pump with an equal or higher pump)	408	91
	447	100

Replacing a pump with a shorter boom height (i.e., beyond the permissible range) may seem illogical because it should not be possible for a shorter pump to do the job of a higher pump. Within the context of RMC, two explanations emerge regarding these replacements. First, in some cases, when the boom height is shorter than the required height, a hose can be attached to the boom to match the site requirement and boom height. However, notably, the process of attaching the hose is complex and time consuming. Second, it is possible that, when a pump was assigned, its boom height was higher than the minimum height required to adequately service the construction site, making it possible to replace it with a shorter boom pump. Although assigning a pump with a higher-than-required boom height is a possible explanation, the notion of not optimizing the boom height based on the site is the exception due to the limited number of tall pumps (e.g., 47m). In the scheduler's words, "Sometimes I send P3 [the pump with the highest boom] to a site at which any pump can do the work because I don't have any other job for P3."

Using the same dataset of 447 orders previously identified in this section, each pump is assigned a value in meters. The values are computed based on the difference in boom height between the scheduled and the actual pumps sent to sites. Given this basis, 314 orders that went as scheduled were given a value of zero because the pumps in these cases did not change. In the other 133 cases of pump replacements, three possibilities arose. First, a pump was replaced with a pump of the exact boom height, which resulted in a value of zero. For example, if P8 of 32m was replaced by P9 of 32m, the result was zero (i.e., 0 = 32-32), showing the difference in height between the actual pump sent to the site and the scheduled pump. Second, a pump replaced with another pump possessing a higher boom height resulted in a positive value. For example, if P1 of 42m was replaced by P3 of 47m, the result was +5 (i.e., 5 = 47-42). Finally, replacing a pump with a shorter one resulted in a negative value. For example, replacing P1 of 42m with P9 of 32m resulted in a value of -10 (i.e., -10 = 32-42). Using these values, a two-step cluster analysis technique was performed, which resulted in three groups, as shown in Table 5.8. G1c of 9% represents replacements that had negative values or replacements of schedule pumps with a shorter pump. G2c accounts for 84%, which represents orders with values of zero. In other words, G2c represents both pumps that went as scheduled and pumps replaced with other identical boom height pumps. G3c refers to replacements that had positive values in which the scheduled pumps were replaced with higher boom pumps. To validate the quality of the grouping, the Silhouette measure was used, which resulted in 0.9—namely, an excellent grouping.

Table 5.8 Groups Created Based on Cluster Analysis

Groups	*n*	%	Mean (*m*)	SD (*m*)	Range (*m*)
G1c	39	09	-5.8	2.0	-11 to -4
G2c	377	84	0.0	0.0	0.0
G3c	31	07	+6.7	2.7	+4 to +15
	447	100			

As shown in Figure 5.3, G1c identified by cluster analysis matches G1c identified by boom height, which represents replacements beyond the permissible range. With respect to G2c and G3c identified by cluster analysis, from the boom height perspective, these two groups can be combined into a category within the permissible range. This is the case because for staff members it does not make a difference whether a replacement has an exact or higher boom height than the scheduled pump. Indeed, both exact and higher boom heights of the scheduled pump represent a good replacement. Overall, it can be said that cluster analysis is consistent with boom height analysis. This result suggests that pumps are most likely to be sent within the permissible range and less likely to be sent beyond the permissible range.

Figure 5.3: Match between the groups created based on the cluster analysis and the groups created based on boom height

On the whole, the results of the quantitative analysis and qualitative analysis suggest that shipments are most likely to be fulfilled such that a pump is sent as scheduled or replaced with a pump that has the same or a higher boom height, both of which represent the condition of within permissible range. However, it is unlikely that a pump is replaced with a shorter pump, thus falling into the condition beyond the permissible range. These results support Hypothesis 2—namely, that individuals tend to conceive of plans as future activity categories that exhibit a graded structure in which some instances are more likely to occur than others.

5.1.4 Site Locations

The location of sites, referring to the physical address of the construction sites where concrete is scheduled to be delivered, is one of the attributes of the "delivering orders" activity category at RMC. Two sources of variability exist in the site locations. The first is the discrepancy between scheduled and actual site locations. At RMC, this kind of discrepancy is considered to be an error. The second source of variability is the discrepancy between scheduled and actual level of details of the address. More precisely, on some occasions the scheduled address and directions are correct, but the details are not sufficient for the truck to reach the location, particularly because the towns in which the study was conducted do not have a postal code system. Notably, the construction sites of large projects to which RMC delivers concrete do not typically require detailed addresses the way that new or infrequent sites require.

Regardless of the source of the variability, for all shipments, the staff member (e.g., the dispatcher) must have knowledge and be aware of the possibility that the site locations could differ. This knowledge and awareness of the range of possibilities support Hypothesis 1 that individuals tend to conceive of plans as future activity categories with a range of possibilities.

5.1.4.1 Analysis of the Qualitative Data

To investigate the graded structure with respect to site locations (i.e., Hypothesis 2) from different shipments, this section studies anecdotes and quotes for evidence of how staff members treat differences between actual and scheduled site locations. The procedures used were described in section 5.1.1.1.

The first piece of evidence is a quote showing the minor, acceptable, and manageable range of errors.

> **Dispatcher**: Aqrabeyia, Golden Belt, and Bandaria are very close to each other. Sometimes [the scheduler] writes “Golden Belt,” thinking that the site is located in the Golden Belt, but it’s in Aqrabeyia. If [the scheduler writes one but means the other] he writes “Aqrabeyia” or “Golden Belt” area, it’s not a problem. I can change the location.

From this quote, we can see that if the error in the schedule is between two different sites that are “very close to each other,” the phrases associated with the error that necessitates the change are “it’s not a problem” and “I can change the location.” In this case, it seems that the mistake is minor and does not require much communication.

The second piece of evidence is a discussion among the dispatcher, the site inspector, the researcher, and a contractor’s engineer regarding how to fix an error of difference between two towns. The exchange is somewhat lengthy due to both the number of people involved in the situation and the difficulty in obtaining directions to the site.

> **Researcher:** Do you need to call someone?
> **Dispatcher:** Yes, a customer. A new site starts today. It’s Aqrabeyia [according to the schedule], but our site inspector checked the site, and it’s not Aqrabeyia. It’s Safwa, or, really, it’s the 91 or 71 area [areas in towns other than the assigned site location].
> **Researcher**: It’s written here [in the schedule] “Aqrabeyia”?
> **Dispatcher**: Yes. [The scheduler] wrote “Aqrabeyia” by mistake, but it’s not Aqrabeyia.

Researcher: The pump already went!

Dispatcher: The pump went out. I told him to hold, not to go to Aqrabeyia. I already said "don't go," and now I'm calling the customer.

Researcher: Is there an engineer at the site?

Dispatcher: Yes, sir.

Researcher: Does it [concrete being sent to the wrong location] happen frequently?

Dispatcher: No, only occasionally.

After a few minutes without a response from the engineer, the dispatch office phone rang. Note that it was only possible to record the dispatcher's side of the call. However, the call was followed by another exchange between the researcher and the dispatcher to confirm the researcher's understanding of the situation.

Dispatcher [answering the phone]: RMC. Yes, good morning, Mr. [contractor engineer]. Yes, I called you. You have a booking now, right?

Dispatcher: Where is this location, Mr. [contractor engineer]?

Dispatcher: Airport Road,

Dispatcher: Okay. 91 or 71 traffic signals?

Dispatcher: Okay. 71 traffic signal. Go straight toward the airport.

Dispatcher: Two bridges.

Dispatcher: And then after the two bridges, one main road to the Ministry of Interior Housing.

Dispatcher: Then go left, right-hand side.

Dispatcher: After the two bridges? [Dispatcher was confused by the directions he had just been given by the engineer.]

Researcher: The location is in [a town different than the one in the schedule].

Dispatcher: The Ministry of Interior Housing is very far.

The following call took place soon after the previous call between the dispatcher and the site inspector employed by RMC.

Dispatcher [phoning the site inspector]: Hello, Engineer [site inspector]. Would you call [contractor engineer] about Airport Road?

Dispatcher: After the 91 signal, you cross two bridges. After crossing two bridges, one road goes to the right. This is the Ministry of Interior Housing.

Dispatcher: Okay, you go right.

Dispatcher: Yes, the new Airport Road, then one road that goes to the right.

Dispatcher: I'll give you [contractor engineer]'s number. Better to call [contractor engineer] and make sure.

Dispatcher: He [contractor engineer] explained the location, but I couldn't understand it clearly.

In the former exchange, the site is a "new site." The error in site location, which is scheduled in a different town from the actual site, is atypical and was described as a "mistake" that has happened a "few times." Solving the error required several people to communicate: the dispatcher, site inspector, and the customer. Several courses of action were taken: "now I'm calling the customer," "the pump went out. I told him to hold," "I'll give my site inspector, Mr. [site inspector's name], your number. He'll understand it better than I," and sending the pump and one truck together. Notably, it was not possible to communicate with the scheduler because the order was sent to be delivered early in the morning, before the head office opened.

These exchanges demonstrate that site locations for shipments carry the possibility of being both typical within the permissible range and atypical beyond the permissible range. The typical occasions are associated with phrases such as "it's not a problem" and occur with sites that are "very close to each other." A typical site is linked to a course of action, such as "I can change the location." Meanwhile, atypical occasions that fall beyond the permissible range are described as "mistake[s]" that occur only a "few times." Overall, shipments are more likely to take place within the permissible range of deviations and less likely to take place beyond the permissible range of deviations. As a result, the site locations in the "delivering orders" activity category exhibit a graded structure, which supports Hypothesis 2.

5.1.4.2 Analysis of the Quantitative Data

The data used in this section to investigate site locations are based on analyzing the daily schedule of 43 days of operation, which resulted in 702 orders as outlined in section 5.1.1.2. Based on the discussion with the dispatcher, whether an error related to site location occurs depends on the level of detail provided regarding the site location, with the central aspect of site locations being the distance between the address recorded in the daily schedule and the actual address. To assess the site location in these orders, the researcher compared the distance between scheduled and actual site locations using Nokia Maps (http://maps.nokia.com). If no discrepancy was found, the site location was considered "as scheduled" and within the permissible range. If a discrepancy emerged, two conditions were possible: 1) the recorded and actual addresses were in neighborhoods close to each other (i.e., the distance was short), which was considered within the permissible range of deviations, or 2) the recorded and actual addresses were in different neighborhoods (i.e., the distance was substantial), which was considered beyond the permissible range of deviations. Table 5.9 shows that 97% (684) of the orders were within the permissible range whereas only 3% (18) orders deviated beyond the permissible range.

Table 5.9: Groups Created Based on the Distance between Scheduled and Actual Site Locations

Groups	***n***	**%**
G1d within the permissible range (i.e., neighborhoods close to each other)	684	97
G2d beyond the permissible range (i.e., different neighborhoods)	18	03
	702	100

A two-step cluster analysis technique examined the distance between the previously obtained scheduled and actual site locations. Two groups were created, as shown in Table 5.10; the first group (G1d) accounted for 97% (680) of the orders that have values of zero because these orders went as scheduled. The other group (G2d) of 3% (22) of the orders represented orders that had discrepancies between the scheduled and actual site locations. The Silhouette measure indicated the quality of the clusters. In this case, the index is equal to 1 and is considered a perfect grouping as the groups are clearly formed by the bias in the zero values.

Table 5.10: Groups Created Based on the Cluster Analysis

Groups	*n* (%)	Mean (*km*)	Range (*km*)	SD (*km*)
G1c	680 (96.8)	00	0	0.00
G2c	22.0 (03.2)	8	3.8 to 18.6	3.9
Total	702 (100)			

As shown in Figure 5.4, G1c identified based on the two-step cluster analysis technique (Table 5.10) matches G1d identified based on the distance between scheduled and actual site locations (Table 5.9). A small difference occurs between the G1c and G1d because G1c only includes orders that had no deviation at all ("as scheduled"), whereas G1d includes additional orders with a short distance deviation. Overall, it can be said that the results of the cluster analysis are consistent with the dispatcher's opinion of the distance between scheduled and actual site locations. This suggests that site locations are most likely to either be as scheduled or deviate with a short distance, both of which are considered "within the permissible range." Meanwhile, it is less likely that an order will have substantial deviation between scheduled and actual site locations.

Figure 5.4: Match between the groups created based on the cluster analysis and the groups created based on the distance between scheduled and actual site locations

To summarize, the qualitative and quantitative analyses revealed that shipments with respect to site locations are most likely to be delivered as scheduled or within a short distance of the scheduled site location, both of which represent the permissible range. Meanwhile, it is very unlikely that an order will have an error or not enough details to reach the location, resulting in a substantial difference between scheduled and actual site locations.

5.2 Nature of Adjustment

Adjustment refers to the way in which an individual deals with contingencies that might occur during occasions of shipments. In other words, if a customer is not ready and the truck mixer is already loaded with concrete, what can be done? If concrete is left over, how can the concrete be used? If a customer is waiting at the construction site and the pump suddenly breaks down, what happens? This section discusses adjustments that occur during occasions of shipment and then explores the link between the adjustment that staff members make and the way in which they tend to conceive of their occasions of shipment as discussed in section 5.1.

To collect different adjustments, a protocol was developed based on observing how staff members such as schedulers and dispatchers worked around frequent problems. Usually, when the researcher observed an adjustment used to solve a frequent problem, the researcher discussed it with the staff members who employed that adjustment. The discussion involved having the staff member explain the adjustment, the rationale behind the adjustment, and its impact on the occasions of shipments. For this research, reported adjustments must be an adjustment employed to solve a frequent problem. The researcher does not claim that these are all of the adjustments used at RMC; indeed, the reported adjustments are merely cited as illustrative examples.

A frequent problem at RMC is the last-minute cancellation of orders, which is not uncommon in the ready-mix concrete industry. According to Anson et al. (2002), a lack of planning and poor weather conditions are two major reasons behind cancellations. They further asserted that "[i]t is likely that contractors sometimes place orders speculatively in order to 'get on the list' just in case a pour preparation goes faster than expected" (p. 241). Over the course of the study (*n* = 43 days), as shown in Table 5.11, 16% (176) of scheduled orders were undelivered due to last-minute cancellations. A repeated adjustment associated with last-minute cancellations is added to unscheduled orders to reduce the negative impact of last-minute cancellations on total daily volume production. The 21% (231) of unscheduled orders were mostly generated from a list of flexible customers who make bookings a few days in advance but are willing to receive the concrete before the booking time, particularly on short notice from RMC. In addition, some of the unscheduled orders are placed by RMC's important customers and considered urgent.

Table 5.11: Frequency of Different Kinds of Orders over the Course of the Study

Kind of orders	*n*	%
Delivered orders	702	63
Unscheduled orders	231	21
Undelivered orders	176	16
	1,109	100

The characteristics of the unscheduled orders were explored to examine the criteria by which an order is selected to be added. The analysis indicated that 82% of the unscheduled orders used direct pouring (i.e., pouring without pumps or other special equipment), and the unscheduled orders tended to be small in volume, with an average of 12 m^3 per order (a standard deviation of 17 m^3). According to Anson et al. (2002), direct pouring without equipment such as pumps is the fastest way to pour concrete. In addition, small-volume orders are easier to accommodate in a running schedule because small-volume orders do not require much coordination.

Based on Lewin's (1936) theory, whenever an individual moving between regions of activity encounters a barrier that stops his or her locomotion in a life space, the individual tries to find a detour around that barrier to reach his or her goal. This general explanation suggests that, for RMC to reach the goal of scheduled volume, cancelled orders are barriers that require a detour such as adding unscheduled orders to reach the goal.

Polishing the daily schedule is another interesting adjustment discovered in response to last-minute cancellations. Staff members who have access to the scheduling software usually delete some of the last-minute cancelled orders. The tracing process was difficult because the original schedules are only kept in an archived hardcopy form, whereas the scheduling software shows only the polished schedules without referring to changes in the original schedules. Archived hardcopies of the daily schedule are of virtually no use; indeed, staff members rarely, if ever, refer to them. Comparing the daily schedule and the polished daily schedule over the course of the study (n = 43 days) revealed that 35% (62 of 176) of the last-minute cancelled orders were completely removed from the scheduling software. Figure 5.5 shows the frequencies of the 176 last-minute cancelled orders and the 62 deleted orders from the scheduling software over a period of 43 days. For example, on day 21, 11 orders of the original bookings were cancelled at the last minute. The scheduler deleted 5 of the 11 cancelled orders. Thus, the scheduler essentially rewrote the daily order history because in the scheduling database the polished schedule of day 21 shows that only 6 of the original bookings were cancelled, reducing the actual number of cancelled orders by 5.

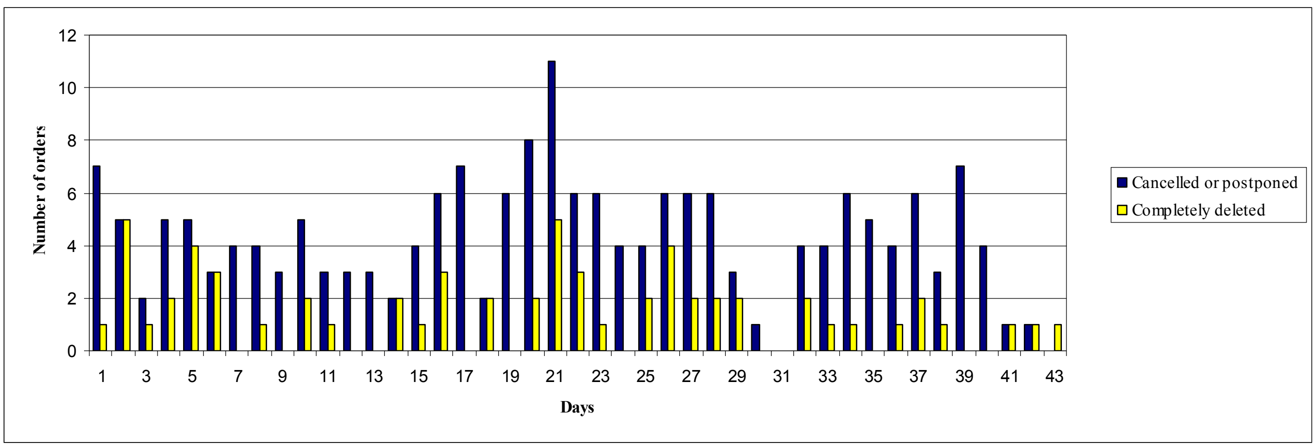

Figure 5.5: Frequencies of the 176 last-minute cancelled orders across the observed 43 days

Another adjustment discovered in response to the last-minute cancellations was adding unscheduled customers to the database after they received their orders. In one event, the scheduler instructed the dispatcher to add an unscheduled customer to the database. The dispatcher put the scheduler's request on hold until the customer actually received the order. Explaining the choice to not add the unscheduled customer to the scheduling database immediately, the dispatcher said, "If I do not supply him [the unscheduled customer], nobody will blame me because he was not in the schedule."

The tactics of rewriting the schedule history and only adding unscheduled customers after receiving their orders ensure that staff members do not report many scheduling pitfalls to management. For example, they may be attempting to improve the image of the scheduling activities by reducing the real number of cancelled orders. The explanation is plausible as staff members believe that management will hold them responsible, blame them, and question their ability to run the daily schedule if they show a high number of cancelled orders.

Another frequent problem at RMC is customers known to waver on their requested volume of concrete, which results in ordering many extra trucks. Some kinds of pouring (e.g., slabs) require a continuous supply of concrete; if the supply stops before finishing the entire pouring, technical problems such as cracks in the concrete could occur. Accordingly, staff members have developed a three-step adjustment mechanism. The first step is pressuring such customers by insisting at booking time that the company policy allows for only one extra truckload. The second step is to send site inspectors employed by RMC to check the accuracy of orders by visiting the construction site and estimating the required volume of concrete. The third step is keeping in contact with staff members located at the construction site during the concrete pouring time to estimate a need for extra concrete.

In Lewin's (1936) terms, at irreality, one can imagine that a customer's ordered volume is not accurate enough. As a result, an imaginary barrier arises that requires a detour. Because the barrier is still imagined, staff members may use different contingency behaviors to prevent the imaginary barrier from becoming a real one. Furthermore, contingency behaviors provide information about how staff members understand the structure of the typical activity category and how the activity category changes structure when events are less typical.

One frequent problem observed is the continuous breakdown of some equipment that negatively impacts the smoothness of operations. RMC's workshop department produced the Fleet Condition Daily Report to describe the status of various pieces of equipment. This report includes categories such as "working," "standby," and "breakdown," which are used in most ready-mix concrete plants to describe the status of fleet equipment such as pumps and trucks. Of the remaining categories in the report, one worth pointing out is “bad condition.” This category is peculiar because it appears in a handwritten format and is “added on” after the report is generated from the computer, unlike other categories in the report that are in printed format. Moreover, it was striking that the “bad condition” category consistently served only one specific pump. It is unusual that an organization would invent a category in a daily report to serve one specific piece of equipment. A quote about this unusual category provides an interesting explanation. In the dispatcher’s words, “the workshop does not want to say we cannot fix it [the bad condition pump], but they know that pump operators are not going to use it because of its condition.” The point is that the language in the report was used as an adjustment to help flag one specific pump to indicate that it would most likely break down if used and would subsequently negatively impact the operation. Thus, it appears that the “bad condition” category was created for two reasons: 1) to save the image of the workshop department, because if the pump was listed under the “breakdown” condition, it would require fixing it as soon as possible before management questioned it; and 2) to notify pump operators not to use that specific pump. (In follow-up contact with RMC two years after the study, the researcher learned that the “bad condition” pump was for sale.)

The adjustments that staff members make when they face problems during occasions of shipment—including adding orders on the day of the delivery, deleting some of the last-minute cancellations, developing steps to deal with customers known to waver on their requested volume of concrete, and using language by inventing categories—all reflect the different kinds of adaptations developed at RMC to deal with frequent problems. If these adjustments are assumed to be paths (as in Lewin’s [1936] theory), investigating the nature of adjustment is needed. The investigation involves the following issues: 1) the selection of a specific path, 2) the rationale behind this selection, and 3) whether the path that was selected is permissible. In addition, to understand the association between various kinds of adjustments made during occasions of shipment and the way staff members tend to conceive of their occasions of shipment, there is a need to identify 4) other paths available in the situation according to how the actor perceives his or her situation and 5) the rationale behind not selecting alternate paths. The data presented can help address the first three issues; however, it is very difficult to identify other possible paths available that are not selected. Due to the complexity of investigating the last two issues within the context of this case study and the fact that the researcher possessed no control over the various situations studied, the adjustment, and its association with the way in which individuals conceive of plans will be examined experimentally in the next chapter.

5.3 General Discussion

An in-depth case study was conducted in one organizational situation to examine aspects of the proposed theoretical framework related to the plan–action relationship. This section starts with an overview of the major findings of the case study, followed by a brief restatement of the main points of the developed case study research methodology as it relates to the literature. The section concludes with the limitations of the case study.

5.3.1 Overview of the Case Study Results

The case study provided support for the theoretical framework. As discussed in sections 5.1.1 through 5.1.4, the qualitative data demonstrated that staff members have knowledge and awareness about the variability of the attributes on shipment occasions (see Table 5.12 for details). These data support the first hypothesis, which states that individuals tend to conceive plans as future activity categories with a range of possibilities.

Table 5.12: Variability of the Attributes in the Occasions of Shipment

No.	Attribute	Variability
1	Volume	Between 0 and 9 m^3
2	Grades	A minimum of 500 PSI added
3	Pumps	Identical or longer boom heights
4	Site locations	Short distance (within the same neighborhood)

In addition, qualitatively (see sections 5.1.1.1, 5.1.2.1, 5.1.3.1, and 5.1.4.1) and quantitatively (see sections 5.1.1.2, 5.1.2.2, 5.1.3.2, and 5.1.4.2), the results indicate that individuals tend to conceive of plans as future activity categories that exhibit graded structure in which some occasions of shipment are more likely to happen than others (Hypothesis 2). The qualitative data include quotes and anecdotes in which some shipment occasions were described through verbal discourse such as very typical, usual, and reasonable whereas others were described as one of a kind, very unusual, or atypical. The quantitative data include corporate records from daily schedules over a period of three months; these records were grouped based on the central aspects of the examined attributes (e.g., one extra truckload policy, safety factors, and boom height) and the two-step cluster analysis. These two approaches to grouping corporate records were used for cross-validation purposes. Based on the data presented in sections 5.1.1.2, 5.1.2.2, 5.1.3.2, and 5.1.4.2, it appears that the groups created based on the central aspect are consistent with those created using the two-step cluster analysis.

5.3.2 Overview of the Case Study Methodology

As discussed in section 4.2.2.1, when examining graded structure in categorization studies, typicality ratings (a survey instrument) are generally used as the paradigm. However, typicality ratings did not fit the current study due to the relatively small number of potential participants. Thus, instead, a qualitative approach was developed and applied to the case study; this approach was informed by former categorization studies demonstrating the association between different behavior measurements in psychological research and the degree of typicality. In addition, the developed approach was informed by categorization researchers (e.g., Lakoff, 1987), who have argued that the speech of ordinary people indicates that some category members are typical while others are not.

In the quantitative analysis, two approaches were used to group the data (for details, see section 5.1.1.2). The first approach involved grouping the data based on the central aspects of the examined attributes; the second approach was based on the two-step clustering technique. Of particular importance was the central aspect concept, which refers to policies, standards, or staff members' personal views that define permissible and not permissible deviations (see Table 5.13 for details). These policies, standards, and staff members' personal views essentially refer to the important aspects that staff members have to carefully implement when meeting a schedule. The central aspect concept is in line with what categorization literature calls ideal dimension (also called relevant dimension). Meanwhile, the ideal dimension refers to the characteristic that is important within a category to fulfill the goal of the category (Barsalou, 1981, 1985). For example, in the category "things to take from one's home during a fire," the ideal dimension that is important to use is "being valuable" (Barsalou, 1985).

Table 5.13: Central Aspects of the Examined Attributes

No.	Attribute	Central Aspect
1	Volume	The policy of limiting one extra truck
2	Grades	The safety factor of a minimum of 500 PSI
3	Pumps	The permissible range is replacing a pump with equal or higher pump
4	Site locations	The permissible range of deviation is error within the same neighborhood

However, the central aspect used in the current research differs from the ideal dimension in several significant ways. First, some researchers (e.g., Barsalou, 1985) employ their own opinions to derive the ideal dimension, which Kim and Murphy (2011) described as problematic. In the current study, central aspects are derived from policies, standards, and staff members' personal views, which is inline with other researchers who have derived the ideals dimension of a category (central aspects) based on their subjects. For example, for the "fish" category, fishermen identify desirability as the ideal dimension (Burnett, Medin, Ross & Blok, 2005) while for the "birds" category, the Itzaj Maya—a tribe from Guatemala—identify beauty and the taste of the meat as the ideal dimensions (Atran, 1999). Second, in contrast to most previous studies that have defined the ideal dimension abstractly (e.g., efficiency and likeness) and relative to people, thereby making the interpretation of such data difficult (Kim & Murphy, 2011), the current study relies on RMC staff members, who use specific means such as numeric values to identify the central aspect (e.g., minimum 500 PSI).

5.3.3 Limitations of the Case Study

First and most notably, it was not possible to examine the association between the adjustments individuals make when they face contingencies and the individuals' conception of the future activity as graded structure due to the lack of relevant data as discussed in section 5.2. Thus, the laboratory experiment is designed to address this issue (see Chapter 6).

Second, categorization studies tend to employ data at the individual level of perception. However, the current thesis uses data at the plant/organizational level (e.g., corporate records and recordings from dispatch office). Although it can be argued that individuals' (i.e., staff members') concepts of occasions of shipment correlate with plant/organizational data, this argument is not empirically examined—a shortcoming addressed in Chapter 6—as the laboratory experiment is based on perceptual data.

Third, the qualitative data analyzed (sections 5.1.1.1, 5.1.2.1, 5.1.3.1, and 5.1.4.1) were relatively small. For example, a small number of shipment occasions were coded because not all orders that shipped during the 18.5 hours of recordings had sufficient details for coding. Although the collected data were sufficient to capture patterns in daily schedule execution, they were too small to warrant generalizations. Chapter 6 discusses a laboratory experiment conducted to examine the framework of the thesis in a completely different setting to enhance the validity and the generalizability of the theoretical framework of this thesis.

Fourth, this study examined four attributes of the daily schedule: volume, grades, pumps, and site locations. The researcher does not claim that the presented attributes are the only ones worth examining; rather, the choice was informed by the availability of the associated corporate records, as discussed in section 4.1.

Fifth, the assumption that RMC staff members were following a daily schedule was not validated. Although a few instances were observed that could be considered as an indicator that certain staff members were not following a daily schedule at RMC (see Appendix G for details about these instances), it can be argued that these instances are ad hoc and informal, meaning that they are far from showing a common pattern of behavior. In the laboratory experiment (see Chapter 6), this assumption is validated.

Sixth, it can be argued that conducting a single case study is not appropriate for testing a theoretical framework (Duimering, 1997). By using different kinds of data (qualitative and quantitative) and analyzing these data in various ways to demonstrate the consistency between the pattern in the daily schedule execution and the hypotheses derived, the theoretical framework provides supportive evidence for this research framework. The laboratory experiment in Chapter 6 tests certain hypotheses quantitatively and enhances the theoretical framework of the thesis.

Finally, the limited number of interviews is a weakness as most of the blue-collar workers were not fluent in either of the languages the researcher speaks, resulting in communication and interpretation barriers and thereby limiting the number of potential interviews. However, in order to overcome the limited number of interviews, other sources of data such as corporate records and audio and video recordings were utilized.

Chapter 6
Laboratory Experiment

To test the research hypotheses quantitatively, a laboratory experiment was conducted. The experiment includes two tasks in one session, which was devised based on the French card game *la Belote* (hereafter, Belote). The first task examines the hypothesis that individuals tend to conceive plans as future activity categories with a range of possibilities (H1). The experiment also examines the hypothesis that individuals tend to conceive plans as future activity categories which exhibit a graded structure (H2). The second task is designed to explore how an individual, while performing a planned activity and facing contingencies, adjusts to variations (H3). Within the context of this experiment, plans are operationalized as the strategies of the card game Belote.

This chapter discusses the major experimental tasks employed in the previous planning studies and issues with these experimental tasks. The chapter describes the two tasks of the experiment which were conducted in the same study. The description of each task is followed by results and discussion. Finally, a general discussion and limitations of the experiment are presented and discussed.

6.1 Previous Experimental Tasks

This section describes and evaluates the major experimental tasks used in previous literature within the psychological theories of planning and situated action perspective of plans—the two major approaches used to examine the plan–action relationship. This review is designed to help develop appropriate experimental tasks for the current research. In psychological studies of planning, the Tower[9] and the errand-running tasks are the most often discussed in the literature (Mayhew, 2009; Scholnick, Friedman, & Wallner-Allen, 1997). The Tower task, originally designed by Simon (1975), requires participants to create their own plans, based on rules provided by the experimenter, to place five disks of decreasing size onto three pegs of equal height. Although studies that used the Tower task have some variations (e.g., the

[9] It is also called Towers of Hanoi (Patsenko & Altmann, 2010).

number and height of the pegs), the basic notion remains the same (Mayhew, 2009). In the errand-running task, originally developed by Hayes-Roth and Hayes-Roth (1979), participants were examined in a laboratory setting. The participants were provided with a grocery list and a layout of a town that showed different stores. Participants were asked to create plans and navigate through the layout to acquire the items on the list within a specific time period. In some versions of the task, the shopping was actually done at malls and grocery stores (Mayhew, 2009). For detailed descriptions of the Tower task and the errand-running task and their variants, see Scholnick et al. (1997) and Mayhew (2009).

In the situated action perspective of plans, studies tend to be conducted in natural settings; however, a few existing studies have been conducted in experimental settings. Two particular studies manipulated specific aspects of the plan–action relationship. The first is Suchman's (1987) photocopy machine experiment, which was discussed thoroughly in the literature review. Of importance here is the fact that in the photocopy machine experiment, only first-time users were employed in a very structured situation with predefined steps that participants were required to follow in order to accomplish the task. The second study, conducted by Ng (2002), asked participants to make and use plans to retrieve information from a database. Although participants were required to create their own plans, the plans were limited to a range of 50 to 100 words. To differentiate participants based on their experience, the study employed first-time ("novice") and second-time ("expert") users.

6.2 Issues with the Reviewed Experimental Tasks

The aforementioned experimental tasks are evaluated in this section to determine whether they are appropriate for this study. The evaluation includes the structure of the experimental situation, the participants' level of experience, and the participants' plans. Furthermore, because the experimental tasks have been conducted in natural and laboratory settings, both types of settings are assessed. It is worth noting that "situation" is a holistic concept that refers to both the person and the environment, as discussed in the theory chapter (see section 3.1)

6.2.1 Structure of the Situation

As presented in the theory chapter, the dynamic properties of the situation encompass the entire process of adjustments, which includes barriers, detours, and paths. A barrier—whether psychological or physical—that an individual faces when he/she seeks to satisfy goals may require the individual to adjust by finding paths to overcome it. This is also called a detour.

The reviewed studies did not systematically investigate the dynamic properties of the situation and its effects. Specifically, the photocopy machine task in Suchman's (1987) study and the Tower task in Simon's (1975) study are both very structured situations that feature a specific sequence of steps (i.e., "a path," to use Lewin's (1936) term) to follow in order to accomplish the task. Although the researchers might know the path that satisfies the experiment's goal, the participants are not familiar with the task, which results in problem-solving or maze-like situations. Thus, the photocopy machine and the Tower task require more than planning; for example, they require problem solving as well. Other studies, such as those with errand-running tasks, include multiple paths that can be followed to accomplish the task. This may result in disagreement among the participants regarding the existence of some paths. Accordingly, the researcher cannot establish a situation in which participants necessarily perceive the situation similarly, thereby creating a concern with the study. Therefore, the devised task in the present study must deliberately define different structural properties of the situation, such as barriers, detours, and paths. In addition, the researcher must ensure that the participants and the researcher share and perceive the structural properties similarly.

6.2.2 Participants' Level of Experience

To manipulate participants' level of experience, most previous studies have assumed no prior experience (Scholnick et al., 1997). Accordingly, the participants' level of experience is said to be similar because all the participants can be considered novices. However, a few studies have investigated familiar activities that are part of participants' everyday lives, such as grocery shopping. When using tasks derived from an everyday life activity such as grocery shopping, the participants' experience levels can be assumed to be similar because participants are familiar with the activity. Generally speaking, presenting tasks that are either new to participants or are very familiar are two approaches that can be used to ensure that participants share a similar level of experience regarding the task. In the present study, the choice was made to devise a task based on a very familiar activity because devising a task based on a new activity may lead to a situation that requires more than planning, such as problem-solving skills.

6.2.3 Participants' Plans

Although the studies discussed in this chapter tended to ask participants to create their own plans (e.g., Ng, 2002), these plans were controlled to a certain level of detail (e.g., number of words or time limit to develop the plans). In contrast, allowing participants to create their own plans in their entirety may ultimately make comparisons between plans impossible. In Suchman's (1987) study, participants were given a plan (step-like instructions) to follow. As discussed in the structure of this situation, participants were classified as "novice," which resulted in more than simply following the plan (i.e., problem solving).

In the present study, to compare plans precisely, participants should be given plans that are familiar to them. One possible way to overcome this challenge is to devise a task that has commonly shared plans built into the activity. For example, professional chess players may have commonly shared strategies or plans (e.g., opening moves and endgame). These plans are not part of the rules of playing chess, yet are commonly known to professional players.

6.2.4 The Settings of the Reviewed Experimental Tasks

The reviewed studies employed two different settings. The first setting was scenario-based, in which participants performed the task in the laboratory (e.g., grocery shopping using a layout). In a scenario-based setting, participants are provided with background information about the situation and actors. Background information may be presented in various formats, such as textual stories and video scenes that first introduce and elucidate the situation and then ask participants what they would do in such a situation. The second setting is the natural setting, in which the participants perform the task in a real-life situation as the activity unfolds (e.g., shopping at a grocery store). Both settings are possible candidates for the present study.

6.3 The Characteristics of the Required Task and Setting

Based on the above discussion of the reviewed experimental tasks, three possible variables can be manipulated to test the research model: 1) the structure of the situation, 2) the participants' level of experience, and 3) the participants' plans. These three variables can be examined by varying one while controlling for the others. Because the focus of the current study is to investigate the effect of the dynamic properties of a situation, the choice was made to vary the structure of the situation and control for the participants' experience levels and plans.

Several conclusions can be drawn with regard to the task and setting required to investigate the plan–action relationship. The developed task requires:

1) Plans:
   i. Plans must be built into the task. In other words, plans are neither developed by the participants to satisfy the researcher's request, nor dictated by the researcher to the participants.
   ii. Plans are common and shared among participants as well as between the participants and the researcher.
2) Structure of the task:
   i. The researcher must have control over the task structure, which is more easily achieved in the laboratory than in the natural setting.
   ii. The researcher and the participants must perceive the structure of the task and the courses of action taken to adjust in a similar way.
   iii. The researcher can differentiate between courses of action taken to adjust that fall within the initial plan and those that fall beyond the plan.
3) The participants should share a similar level of experience.
4) The task has a recognizable cognitive unit or "unitization," which refers to how individuals typically perceive and draw boundaries between different parts of the task. For example, items to be bought in the shopping task can be divided into aisles, which are recognizable units that divide the activity into subparts.

6.4 Card Game

To satisfy the characteristics of the required task and setting, the French card game Belote is utilized. Belote is a popular game in France, Eastern Europe, the Middle East, and Western and Central Africa (Levy, 1999; Seban, 2011). Although the card game has some variations in different parts of the world, the basic game uses 32 cards of one standard 52-card deck, excluding all cards with denominations between 2 and 6. In other words, it uses the 7, 8, 9, 10, Jack, Queen, King, and Ace of each of the four suits (♣, ♥, ♦, ♠). As shown in Table 6.1, each card has a scoring value that is used to count awarded points per team. The game is played with two teams of two players each, with the first and third player forming one team and the second and fourth player forming the other. Play proceeds counter-clockwise. A round consists of four played cards (i.e., one card per player). The player who plays the card that matches the suit of the first card played and has the highest scoring value wins the round and begins the next round (Seban, 2011).

Table 6.1: Scoring Values of Non-trump Suit

Card (♣, ♥, ♦, ♠)	Scoring value
7, 8, 9	0
Jack	2
Queen	3
King	4
10	10
Ace	11

The game can be played in two ways—namely, either with or without a trump suit. In the non-trump version, players must follow the suit played by the first player unless they do not have any cards of that suit, in which case they can play any card. In the trump version, one dominant suit always wins over the other suits. The current experiments are developed based on the non-trump version since its rules and strategies are simpler than those of the trump version. Additional details of the game rules are beyond the scope of this experiment's design (for more information, see Seban, 2011, and http://en.wikipedia.org/wiki/Belote).

The Belote card game fits the task and setting requirements of the experiment. With respect to planning, the card game has plans or strategies (e.g., opening strategies) that are not part of the rules of the game but are conventions generally understood by all competent players. In other words, these strategies are not introduced by the researcher or created by the players to satisfy the researcher's request; rather, they are built into the game itself. As a result, these strategies are known and common among competent players.

With respect to the structure of the task, a scenario can be created in which a single participant is provided with all required information about his/her teammate and opponents, after which the participant is asked to play under different conditions. In addition, the game provides an ideal situation wherein the researcher and the participants share knowledge about the structure of the situation. This shared knowledge includes cards per hand and cards that can be played according to the rules of the game. In addition, given certain conditions (e.g., opening strategy), competent players can predict the most probable cards. They can also determine which cards satisfy a given condition (i.e., fall within the strategy) and which do not. The details of the strategies are discussed shortly in the design of the first experimental task.

With respect to the cognitive unit, players distinguish four hierarchal levels of activity in game play. The lowest level is a move, which refers to single move (i.e., one played card) for a single player. The next higher level is a round, which consists of four moves (i.e., one single move per player). Next, the level of a play consists of eight rounds. Upon completing a play, points are awarded to each team. The highest level is the game, which concludes when one team reaches 152 points to win the game. It usually takes a number of plays to complete a game.

In the developed task, the plan is operationalized as strategies of the Belote card game and the activity is operationalized as a single card move. Accordingly, in this study, the unit of analysis used is the relation between strategy and a single card move. The devised task requires the participants, on an individual basis, to perform the activity of playing a single card under different strategies. More specifically, a single participant is invited to the laboratory, where he or she is presented with information required to complete a round. The task requires the participant to play a card that fits the given information. The choice of the relation between strategy and the single card move as the unit is used because it occurs at the individual player's level rather than at group level (i.e., team level). The individual level better fits the theoretical framework of the present study as Lewin's field theory (1936) and Rosch's categorization theory (1978) are developed at the individual level.

In order to test the research hypotheses quantitatively, two experimental tasks were designed and conducted at the University of Waterloo between February and April of 2011. Task one was designed to test the structure of the future activity categories (H1 and H2). Task two was designed to examine the association between individual's knowledge of typical adjustment and the individual's actual adjustment under various experimental conditions (H3).

In the following sections, the discussion begins with the method, followed by results and discussion for each task. Finally, the general discussion of the two experimental tasks and concluding remarks are presented.

6.5 Task one

The purpose of task one was to examine the structure of future activities (H1 and H2). H1 states that individuals tend to conceive of future activities as categories with a range of possible attributes. H2 states that categories of future activities tend to exhibit a graded structure in which members of the future activity categories range from highly typical to typical to atypical.

6.5.1 Method

Participants. Thirty males from Arabian Gulf States (also called Arab states of the Persian Gulf) who live in the Waterloo Region participated in the experiment (task one and task two). The participants were Belote card game players who were recruited through a snowball sampling method (i.e., the researcher contacted a few players, who then suggested other potential participants; Babbie, 1992). Upon completing the experiment, participants received a $20 gift card for their participation.

Materials. In task one, various strategies from the card game Belote served as the stimuli. The lack of formal documentation describing such strategies posed a challenge for the study. In order to identify strategies, the researcher conducted a handful of informal interviews with competent players, observed several games, and videotaped a full game played by players invited to the laboratory. A number of strategies were observed; the four most common were selected: 1) "play your strength," 2) "support your partner's play," 3) "don't play below the ace," and 4) "don't leave your 10 alone." Table 6.2 provides a brief definition for each of these strategies.

Table 6.2: Strategies Used in Task One and Their Definitions

No.	Strategies	Definition
1	Play your strength	First player opens the round with his/her strength (i.e., three or more cards of the same suit).
2	Support your partner's play	First player's partner plays a high-value card to support his/her teammate's opening play.
3	Don't play below the ace	If a player has an ace and other cards of the same suit, he/she plays either the ace of that suit or any card of a different suit.
4	Don't leave your 10 alone	A player does not play a 10 before another card of the same suit.

After selecting the strategies, hands were assigned to each strategy. Each hand was drawn randomly from the full set of 32 cards, then assigned to one of the strategies. The researcher ensured that the hands matched the selected strategies, replacing hands if necessary (e.g., if a given hand did not have three or more cards of the same suit for the "play your strength" strategy). Of the permissible hands, 5 different hands were chosen for each strategy, for a total of 20 hands (see Table 6.3 for the full set of hands used in the task).

Table 6.3: Full Set of Hands Used in the Task

	Card1	Card2	Card3	Card4	Card5	Card6	Card7	Card8
Strategy 1: Play your strength								
Hand1	K ♥	Q ♦	9 ♣	9 ♠	J ♠	8 ♥	A ♠	J ♥
Hand2	J ♥	A ♥	8 ♦	7 ♦	8 ♠	9 ♠	10 ♠	K ♠
Hand3	J ♥	A ♦	9 ♥	8 ♦	Q ♥	Q ♣	7 ♠	10 ♠
Hand4	8 ♣	9 ♥	10 ♥	10 ♠	K ♠	7 ♦	10 ♦	A ♦
Hand5	8 ♦	A ♦	J ♠	Q ♥	K ♥	10 ♥	A ♥	J ♣
Strategy 2: Support your partner's play								
Hand1	8 ♥	J ♣	8 ♠	9 ♣	10 ♠	10 ♥	K ♣	10 ♣
Hand2	7 ♦	9 ♣	9 ♥	10 ♥	8 ♠	K ♣	8 ♦	J ♣
Hand3	8 ♦	9 ♦	10 ♣	K ♣	J ♣	7 ♥	J ♥	K ♥
Hand4	9 ♣	10 ♥	J ♣	K ♠	A ♥	Q ♠	K ♦	9 ♥
Hand5	J ♠	A ♦	10 ♣	A ♣	Q ♠	7 ♦	Q ♣	Q ♦
Strategy 3: Don't play below the ace								
Hand1	J ♥	A ♠	J ♦	8 ♣	7 ♦	10 ♥	A ♦	Q ♥
Hand2	K ♠	7 ♥	J ♠	9 ♥	7 ♠	Q ♥	A ♥	A ♠
Hand3	J ♦	J ♣	10 ♦	A ♦	A ♥	9 ♦	9 ♠	J ♥
Hand4	7 ♣	8 ♦	K ♠	A ♥	J ♣	7 ♥	A ♦	Q ♦
Hand5	9 ♦	Q ♠	8 ♥	K ♦	8 ♣	A ♥	9 ♣	A ♣
Strategy 4: Don't leave your 10 alone								
Hand1	A ♣	10 ♣	8 ♣	10 ♠	10 ♦	9 ♥	J ♣	10 ♥
Hand2	10 ♦	Q ♠	J ♠	9 ♥	10 ♠	K ♣	A ♦	K ♥
Hand3	Q ♥	J ♠	10 ♦	9 ♥	J ♣	7 ♥	10 ♠	10 ♥
Hand4	8 ♦	J ♣	A ♣	Q♥	7 ♣	Q ♦	10 ♥	7 ♠
Hand5	Q ♥	J ♣	10 ♦	Q ♠	K ♥	10 ♥	A ♣	Q ♦

Although Belote is played with four players (see section 6.4), in task one only one participant performs the task at a time. Indeed, participants were in a scenario-based situation where the researcher provided all required information, such as the moves of other players (played cards). In task one, participants were in the first player position (i.e., their moves were not preceded by any other move), so each participant was required to know only his own hand when applying strategy 1 (“play your strength”), strategy 3 (“don’t play below the ace”), and strategy 4 (“don’t leave your 10 alone”; see Table 6.3). Unlike the other three strategies, strategy 2 (“support your partner’s play”) required additional information about the previously played cards as it requires the participant to be placed in the third player position. For this particular strategy, the researcher selected the first and second players’ cards based on his knowledge of the game (see Table 6.4).

Table 6.4: First and Second Players’ Cards for Strategy 2

	First player	Second player
Hand1	K ♥	J ♥
Hand2	A ♥	J ♥
Hand3	A ♣	Q ♣
Hand4	J ♠	9 ♠
Hand5	J ♦	K ♦

Procedures. The study was conducted in a laboratory setting with one participant at a time. Task one lasted for 45 minutes on average. All sessions were videotaped, with permission from the participants. Upon starting the experiment, participants received a data collection instrument, including a cover page that showed the general instructions of the experiment. Participants were allowed time to read the instructions, and the researcher was available to help or answer questions, as necessary. The general instructions are shown in Figure 6.1.

Instructions:
Thanks for participating in this study. This experiment is part of a study on how individuals use strategies. While working on each of the two tasks, you will be asked to complete a short questionnaire. All answers should be based on your personal experience. Please try to think aloud while you are performing the task.

For the two tasks, you will play the non-trump suit version of Belote (i.e., SUN condition). In other words, there is no dominant suit for this version of the game. You will be given a hand (i.e., eight cards) in which the first player may play any card, but you have to follow his/her suit. If following the suit of the first player's card (i.e., the dominant suit) is not possible according to the rules of the game, then you can play any card as the rules of the game permit. There is no single correct way of playing this game; I am seeking the way you regularly play in similar situations. Upon completing the two tasks of the study you will receive a gift card.

Remember: Please try to think aloud while you are performing the task.

Thanks again for your time and participation.
Good luck!

Figure 6.1: General instructions of the experiment

The general instructions were followed by general competency questions (Figure 6.2); participants were asked about their years of experience in playing the game, their age, their self-reported competency in the game on a scale of 1 (beginner) to 3 (very competent), and the frequency with which they had played the game the last six months. Participants were given time to read these questions on the data collection instrument; the researcher was available for help. The researcher did not ask the participants to write down their answers, but rather used their videotaped responses in the analysis.

1) How many years have you been playing Belote?
2) What is your age?
3) How would you describe you competence with the Belote?
   Beginner Average player Very competent
4) On average, in the last six months, how many times a month have you gathered with friends to play Belote?

Figure 6.2: General competency questions

These questions were followed by the instructions for task one (see Figure 6.3). Participants were given time to read the instructions; the researcher was available for help.

In the first task, you will be presented with four different Belote strategies.

1. You will explain and give an example of each of these strategies.
2. You will apply each strategy to five different hands.
3. For each hand, you will be asked to rate the typicality of applying the given strategy to this hand on a scale of 1 (highly atypical) to 5 (highly typical).

Note: Based on the rules of the game, you may indicate that playing a certain card would be an inappropriate move.

Remember:

- There is no single correct way of playing this game; I am asking about the way you regularly play in similar situations.
- Please try to think aloud while you are performing the task. Also, try to explain what you are doing and why.

Figure 6.3: Instructions for task one

After presenting the instructions for task one, participants were asked more specific questions to ensure their competency with respect to the particular strategies used in the task. In the data collection instrument, participants were asked if they were familiar with each of the four strategies ("play your strength," "support your partner's play," "don't play below the ace," and "don't leave your 10 alone"). If they answered yes, they were asked to describe the strategies and give concrete examples, which they could draw from the full set of 32 cards. If participants answered no, indicating their unfamiliarity with a strategy, the researcher provided a description of the strategy similar to the definitions provided in Table 6.2. Again, the researcher used the videotaped recordings of participants' responses in the analysis instead of asking them to write down their answers. Figure 6.4 provides an example of one of the four strategies.

1) Are you familiar with the "play your strength" strategy?
2) Explain the "play your strength" strategy.
3) Give a concrete example of the "play your strength" strategy (using the deck on the table).
4) You are the first player so, **define** then **apply** **"play your strength"** strategy on each one of the following hands:

Figure 6.4: Example of the strategies familiarity questions

In the data collection instrument, each strategy was followed by five different hands (see Table 6.3 for all hands used as well as their corresponding strategies). For each hand, participants were asked to rate the probability of playing *each card* when applying the corresponding strategy, based on a 7-point scale (with 1 being least probable and 7 being most probable). Appendix H provides an example of the rating questions. Two versions of the data collection instrument were developed. Strategies in each version were randomly ordered.

Measures. Task one was designed to examine the structure of the future activity categories (H1 and H2). The first hypothesis, which states that individuals tend to conceive of plans as future activity categories with a range of possibilities, was tested by showing that players have knowledge and awareness about the range of possible hands that fit the strategy.

In this experiment the range of possible hands was shown by identifying aspects of each strategy that are central to participants in applying each strategy. More specifically, a qualitative analysis of the participants' descriptions of each strategy was performed to identify and categorize the aspects central for applying each strategy. The coding procedures started with transcribing the strategies' descriptions. Next, the researcher identified each strategy's central processes by focusing on the actions stated in the participants' descriptions, as suggested by Charmaz (2006), which indicate aspects of applying the strategies. After identifying the aspect(s) mentioned by each participant, the frequency with which these aspects occurred across participants was computed. Any aspect mentioned by 50% or more of the participants was deemed to be a central aspect of the corresponding strategy (see Appendix I for an example of the coding).

The second hypothesis states that individuals tend to conceive of plans as future activity categories that exhibit a graded structure. According to Barsalou (1983), a graded structure is demonstrated by high agreement among participants in rating members of a category. In the context of this experimental task, if the participants significantly agreed in their ratings of the cards of the hands presented, then a graded structure would be present. Two extreme possibilities could violate the graded structure: if participants agreed to giving all cards of a hand the same rating on the 7-point scale (e.g., all 8 cards of a hand rated as 7 on the 7-point scale) and if participants agreed to giving a card an equal rating across all points of the scale (e.g., first card rated three times on each point of the 7-point scale; Barsalou, 1983; Rosch, 1973). However, neither of these cases occurred in the course of the study.

To date, various approaches have been developed and introduced to measure such agreement in rating. The first approach involves using the chi-square statistic to test for significant differences between the actual and expected distributions of the ratings. The assumption inherent in this approach is that a significant difference between the actual and expected distributions represents agreement (non-randomness) in the ratings (Rosch, 1973).

The second approach involves using two statistics: Kendall's coefficient of concordance (*W*), a nonparametric test, and the interclass correlation coefficient (*ICC*), which is a parametric test (Barsalou, 1983). Both statistics are essentially used to measure the average agreement between each participant and every other participant. The coefficient of concordance (*W*) and interclass correlation coefficient (*ICC*) range from zero (no agreement) to one (perfect agreement; Cohen et al. 2003; Siegel, 1956). In the second approach the effects of the two extreme possibilities that could violate the graded structure were avoided by not allowing participants to assign more than one item at any given rank (i.e., forced rank; Barsalou, 1983). This approach assumes that if both statistics are significantly high, then the category possesses a graded structure.

The third approach was presented by Graesser and his collaborators in a series of studies (e.g., Graesser et al., 1979; Graesser & Nakamura, 1982; Smith & Graesser, 1981). A threshold measure based on the mean of items across participants was used to determine the agreement in ratings. The scale ranged from 1 to 6, with the threshold at 4.4 in some studies (e.g., Graesser et al., 1979) and 4.5 in others (e.g., Graesser & Nakamura, 1982). Accordingly, if an item's mean is above the threshold, then it is typical; otherwise, it is atypical. This approach did not investigate the two previously discussed extreme possibilities that could violate graded structure. Overall, in this approach the assumption is that high-rated items are typical items whereas lower-rated items on the typicality scale are unessential or unrelated to the category (Smith & Graesser, 1981).

Although all three approaches measure agreement, differences exist among these approaches. The chi-square statistic approach and Graesser's approach both measure agreement at the item level, which requires testing each item of a category on an individual basis. On the other hand, the coefficient of concordance and interclass correlation coefficient measure agreement at the category level, which takes into account all of the items in the category.

In task one, the coefficient of concordance and interclass correlation coefficient are used. This approach was selected because the graded structure is examined in a particular set of future activities (i.e., strategies), so in task one the goal of using a measure of agreement is to show that each one of these strategies is structurally graded. If the coefficient of concordance and interclass correlation coefficient are significantly high, they are interpreted to mean that participants agree that some cards are more likely than others to be played first under a given strategy.

Because using the coefficient of concordance requires a ranking scale, it was necessary to transform the rating scale used in the task into a ranking scale; a card rated as most probable (i.e., 7 on the 7-point scale) is transformed into rank one and so on. In addition, at an early stage of the task development in this study, competent players asserted that in some cases they do not have a preference about playing some cards over others (i.e., two or more cards are equally preferable in certain cases). Consequently, participants were allowed to tie ranks (i.e., place more than one item at any given rank); thus, a correction factor was introduced.[10]

6.5.2 Results

Task one was designed to assess participants' competency with respect to the card game Belote in general as well as specific Belote strategies. Three items were used to assess general competency: 1) number of years since participants started playing Belote (*M*=10.7 years, SD=5.4), 2) frequency with which participants played per month (*M*=3.8 per month, *SD*=4.7), and 3) participants' self-reported competency

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[10] Siegel (1956) asserts:

> The effect of tied ranks is to depress the value of *W* [coefficient of concordance] as found by formula (9.15). If the proportion of the ties is small, the effect is negligible, and thus, formula (9.15) may still be used. If the proportion of the ties is large, a correction may be introduced which will increase slightly the value of *W* [coefficient of concordance] over what it would have been if uncorrected (p. 234).

Since Siegel (1956) did not provide a measurement of small and large ties, this study computes the size of the ties by averaging the number of ties per hand across participants. This study further assumes that, if the average number of ties for any given hand is less than or equal to 30% of the maximum possible number of ties (i.e., 8 cards resulted in at most 4 ties as each 2 cards are considered one tie), then no correction factor was used.

on a 3-point scale (*M*=2.5, *SD*=0.6; see Table 6.5). These data suggest that the participants possessed a high level of experience.

Table 6.5: Descriptive Frequency of the General Competency Questions

No.	Question	Mean	SD	Range
1	Experience (Years)	10.7	5.4	1 to 24
2	Frequency of Play (Per month)	3.8	4.7	0 to 20
3	Self-reported Competency (3-point scale, 1 beginner to 3 competent)	2.5	0.6	1 to 3

Table 6.6 indicates participants' detailed knowledge of every strategy and its application. In no cases was a participant able to describe a strategy without also being able to provide a concrete example. Appendix J presents examples of each strategy provided by participants. Only 10 examples are shown per strategy as these examples are intended to be illustrative rather than show all combinations of cards the participants provided.

Table 6.6: Frequency of Participants' Familiarity with the Four Strategies

No.	Strategy	*n*	%
1	Play your strength	30	100
2	Support your partner's play	28	93
3	Don't play below the Ace	23	77
4	Don't leave your 10 alone	25	83
Mean		**26.5**	**88**

In order to examine the first hypothesis, which states that individuals tend to conceive of plans as future activity categories with a range of possibilities, two kinds of data were analyzed. The one is the fact that participants were able to generate different combinations of hands to fit each strategy, as shown in Appendix J. Different hands provided by participants demonstrate variability in the strategies by showing a range of possibilities.

The second kind of data is participants' knowledge and awareness of the important aspects that must be carefully implemented when applying each strategy. These aspects, as shown in Table 6.7, indicate the sources of variability in the strategies. In other words, each aspect defines a range of possible cards that fit the strategy. For example, strategy 1 includes the aspect of high-value cards, which refers to any combination of the five cards that have a scoring value (jack, queen, king, 10, and ace). The range of possibilities is any combination of these cards from the same suit. Also, the aspect “three or more cards of the same suit” may refer to three, four, five, six, seven, or even eight cards of the same suit, thereby encompassing a wide range of possible combinations. In strategy 2, the aspect “higher value card than the previously played cards” could range from a single possible card up to six possible cards of the same suit. The single possible card situation occurs when the 10 has been played previously, in which case the only higher scoring card is the ace. The situation involving six possible cards occurs when the 7 and 8 have already been played, in which case all other cards are higher (9, jack, queen, king, 10, ace). In strategies 3 and 4, the phrases “other cards” and “another card” refer to the wide range of the seven cards of the same suit. It can be said that, in the four presented strategies, central aspects define the range of possible hands.

Table 6.7: Central Aspects of Different Strategies

No.	Strategy	Central Aspects	*n*	%
1	Play your strength	1) High-value cards	28	93
		2) Three or more cards of the same suit	22	73
2	Support your partner’s play	1) Higher value card than the previously played cards	20	71
		2) Similar suit should be played first in the next round	28	100
3	Don’t play below the ace	1) Ace and other cards of the same suit	23	100
4	Don’t leave your 10 alone	1) 10 and another card of the same suit	25	100

Ultimately, the data about the concrete examples (Appendix J) and aspects of strategies (Table 6.7) provided by participants, which shows the participants’ knowledge and awareness of the range of possible hands that fit the strategies, support the first hypothesis—namely, that individuals tend to conceive plans as future activity categories with a range of possibilities.

To examine the second hypothesis, as discussed in the Measures section, the agreement among participants is computed using two measures: 1) Kendall’s coefficient of concordance (W) and 2) the interclass correlation coefficient (*ICC*). The averages for both tests across different hands are $W = .55$ and $ICC = .54$, which shows a relatively high agreement between participants, all hands being significant ($p <$

0.001; for details see Table 6.8). Therefore, the relatively high agreement among participants when rating the eight cards of each hand indicates that, under a given strategy, participants agreed that some cards are more likely to be played than others. As a result, the second hypothesis, which states that individuals tend to conceive of plans as future activity categories which exhibit a graded structure, is supported.

Table 6.8: Results Comparison between Coefficient of Concordance and Interclass Correlation Coefficient

	Coefficient of concordance		**Interclass correlation coefficient**	
	W	***P*-value**	***ICC***	***P*-value**
Strategy 1				
Hand1	0.24	$p < 0.001$	0.20	$p < 0.001$
Hand2	0.66	$p < 0.001$	0.33	$p < 0.001$
Hand3	0.12	$p < 0.001$	0.14	$p < 0.001$
Hand4	0.47	$p < 0.001$	0.57	$p < 0.001$
Hand5	0.51	$p < 0.001$	0.54	$p < 0.001$
Strategy 2				
Hand1	0.85	$p < 0.001$	0.89	$p < 0.001$
Hand2	0.73	$p < 0.001$	0.79	$p < 0.001$
Hand3	0.99	$p < 0.001$	0.81	$p < 0.001$
Hand4	0.84	$p < 0.001$	0.78	$p < 0.001$
Hand5	0.99	$p < 0.001$	0.87	$p < 0.001$
Strategy 3				
Hand1	0.20	$p < 0.001$	0.27	$p < 0.001$
Hand2	0.66	$p < 0.001$	0.77	$p < 0.001$
Hand3	0.68	$p < 0.001$	0.83	$p < 0.001$
Hand4	0.41	$p < 0.001$	0.50	$p < 0.001$
Hand5	0.31	$p < 0.001$	0.33	$p < 0.001$
Strategy 4				
Hand1	0.69	$p < 0.001$	0.82	$p < 0.001$
Hand2	0.24	$p < 0.001$	0.29	$p < 0.001$
Hand3	0.45	$p < 0.001$	0.47	$p < 0.001$
Hand4	0.10	$p < 0.001$	0.14	$p < 0.001$
Hand5	0.82	$p < 0.001$	0.42	$p < 0.001$
Mean	**0.55**		**0.54**	

6.5.3 Discussion

The first task examined two questions: How do individuals conceive of future activities? What is the structure of these future activities? Based on the theoretical model, it was suggested that individuals tend to conceive of future activities as categories with a range of possibilities and that these categories are structurally graded.

In this task, participants were asked to describe and give concrete examples of four common strategies used in the Belote card game. Participants were then asked to rate the probability of playing each card of a given hand when using a certain strategy on a 7-point scale. Participants were given 5 different hands per strategy, resulting in 20 different hands. The strategies and hands were manipulated; all participants were given the same strategies and hands. These strategies were randomly ordered in two different sets.

No previously developed measures existed for the first hypothesis, which states that that individuals tend to conceive of plans as future activity categories with a range of possibilities. Within the context of the experiment, the range of possibilities is represented by the range of possible hands that fit a given strategy, which is measured based on a qualitative analysis of the descriptions provided by participants. Since one might question the accuracy of this qualitative analysis, the procedures by which descriptions were analyzed are provided along with concrete examples of the steps involved in the analysis (see Measures, section 6.5.1). In dealing with concepts such as strategies, a qualitative analysis such as that used in the study seems unavoidable. The range of possibilities shown, based on both the qualitative analysis of the descriptions and the concrete examples, provided support for the first hypothesis.

With respect to the second hypothesis, the coefficient of concordance (W) and interclass correlation coefficient (*ICC*) can provide evidence of graded structure if a high level of agreement exists among participants. Accordingly, graded structure refers to agreement among participants on those items of a category that are more likely than others to occur.

The results show a relatively high level of agreement among participants ($W = .55$, $ICC = .54$), all of the hands being significant at ($p < 0.001$). In addition, the results did not show either of the two conditions that could violate graded structure. These results provide support for the second hypothesis, which states that individuals tend to conceive of plans as future activity categories that exhibit a graded structure. This finding is consistent with other research findings that suggest that taxonomies, goal-derived categories, and scripts are structurally graded (Barsalou, 1983; Graesser et al., 1979; Rosch, 1973).

One point that requires clarification in the results is the low agreement that yielded a high level of significance. More specifically, while the agreement on the third hand in strategy 1 ($W = .12$, $ICC = .14$) and the fourth hand in strategy 4 ($W = .10$, $ICC = .14$) is relatively low, the significance is high at $p < 0.001$, which seems odd. Statistically, Siegel and Castellan Jr. (1988) asserted that the chi-square distribution is used when $n > 7$ and $m > 20$, which is perfectly applicable to this experiment, where the number of cards (n) is 8 and the number of participants (m) is 30. However, since m (30) in the chi-square coefficient = $m*(n-1)*W$ is large, the chi-square coefficient becomes even larger after multiplying m by n and W. It seems that the low agreement with the high level of significance is a limitation in the results due to using the chi-square coefficient to compute the significance level.

6.6 Task Two

The purpose of task two was to examine the nature of the adjustment. In the experiment, adjustment refers to the process participants follow when—while executing a strategy—they encounter a barrier (i.e., situational contingencies) that requires a detour or an alternative path. This research argues that a participant's knowledge and awareness related to applying a strategy as a structurally graded category (H2) are associated with the adjustment that the participant makes to achieve his goal when prevented. The general case can be formalized as follows: An association exists between an individual's knowledge of a typical adjustment relevant to the activity and his actual adjustment in the activity.

6.6.1 Method

Participants. The 30 male persons who participated in task one also participated in task two during the same session of task one.

Materials. In task two, the two strategies of the card game Belote are the stimuli. These strategies are 1) "support your partner's play" and 2) "signaling" (see Table 6.9 for details). These two strategies were selected because they share a similar underlying structure in which the participant's decision to play a card depends on the previously played cards. For these two strategies, participants were placed in the third player position, in which the player needs information about the previously played cards in order to choose which card to play. The previously played cards provide the opportunity to manipulate the dynamic properties of the situations; in other words, cards played are the contingences that may create a barrier requiring the participant to adjust play by taking a new path that does not fall within the strategy.

After selecting the strategies, the researcher assigned one hand per strategy (see Appendix K for the assigned hands), then developed three conditions per strategy. While the participants kept the same hand, the researcher changed the cards played by the first and second players. The changes in the previously played cards represent contingences that created barriers requiring adjustment (see Appendix L for details).

Table 6.9: Strategies Used in Task Two and Their Definitions

No.	Strategies	Definition
1	Support your partner's play	First player's partner (i.e., third player) plays a high-value card to support his/her teammate's opening play. Within the context of "support your partner's play," the definition of *high-value card* depends on the previously played cards. In order to describe the card as a high-value card, the first player's partner has to play a card that has a higher scoring value than the other played cards.
2	Signaling	This strategy can be applied only when a player does not have a card of the same suit as the card played by the first player. In this case, according to the rules of the game, the player can play any card; however, a played card of a suit different than the first suit played in the round cannot win the round. Signaling refers to when the first player's partner needs to send a signal to notify the first player of the suit that should be played first in the next round. The first player's partner signals by playing a high-value card of the opposite color. Specifically, the convention is that playing a diamond means that first player's partner desires a club and vice versa. Similarly, playing a heart means that the first player's partner desires a spade and vice versa. Thus, the first-played card to open the next round should be based on the desired card.

An example will illustrate the process. In task two, for the strategy "support your partner's play," the first player played 8♦. Without knowing the second played card, the participants had three cards in their hands (K♦, J♦ and 7♦) that matched the played suit. The scoring value of these cards is 4 points for K♦, 2 points for J♦, and zero points for 7♦. Since 8♦ is worth zero points, the K♦ and J♦ have a higher scoring value, which in turn suggests that these two cards (K♦ and J♦) fall within the strategy of support for your partner's play. However, as 7♦ is worth zero points and the lowest card in the deck, 7♦ falls beyond the strategy.

Another example can be drawn based on "signaling." In task two, the first player played Q♥. Without knowing the second card played, the participant did not have any card that matched the played suit. Thus, according to the rules of the card game, the participants can play any card. However, based on "signaling" strategy, participants were notifying their teammates of clubs that should be played first in the next round as participants had four clubs (i.e., A♣, 10♣, J♣ and 7♣). As a result, participants played K♦ to follow the convention that states playing a high-value diamond card to get a club as the first card in the next round. Thus, playing the K♦ (4 points) falls within the strategy while playing other cards such as 7♠, 9♣, and 9♦ falls beyond the strategy.

Procedures. Participants were given time to read the instructions for task two (see Figure 6.5), and the researcher was available for help.

1. In the second task, you will be given hands and then asked to play following a given Belote strategy.
2. You should follow the strategy given by the experimenter unless you think it is not appropriate for the current round.
3. Whether the given strategy is appropriate or not, you need to justify your move.
4. After each hand, you will be asked to rate each card from 1 (least probable move) to 7 (most probable move) based on the given strategy.

Note: Based on the rules of the game, you may indicate that a card would be an inappropriate move.

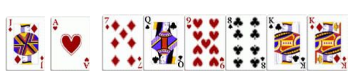
Remember:

- There is no single way of playing this game; I am seeking the way you regularly play in similar situations.
- Please try to think aloud while you are performing the task. Also, try to explain what you are doing and why.

Figure 6.5: Instructions for task two

In the data collection instrument, participants were presented with one strategy at a time. Participants were given time to read the instructions, and the researcher was available for help. Although participants were in the third player position (i.e., they would be expected to play their cards after the second player), they were asked which card they were going to play immediately after they were shown the first player's card. The reason for this was that the researcher wanted to encourage participants to give a description of their plan, including potential contingent moves that depend on the unknown move of the second player. The researcher did not ask participants to write down their answers, but rather used their videotaped responses in the analysis. The instructions are shown in Figure 6.6.

Strategy 1: Case 1:

Your hand: 

You are the third player, and you should follow the "support your partner's play" strategy unless you think it is inappropriate to do so. Please justify your move regardless of whether you follow the strategy or not.

The first player (your partner) played:

What you are going to play? Why?

Figure 6.6: Questions probing the decision-tree related to different possible moves

Next, after being shown the second player's card, participants were asked to rate on a 7-point scale (with 1 being least probable and 7 being most probable) how likely it was that they would select each card as their first move to apply the corresponding strategy (see Figure 6.7).

The second player played:

Your turn: Rate these cards on a scale of 1 (least probable) to 7 (most probable), indicating how likely it is that you would select each card as your first move to "support your partner's play."

Figure 6.7: The rating question

Measures. In order to investigate the association between individuals' knowledge of typical adjustment relevant to the activity and their actual adjustment in the activity (H3), data were collected for both participants' knowledge about typical adjustment and their actual adjustments. Participants' knowledge was extracted when participants were asked to follow a strategy and identify the possible outcomes. The actual adjustment was computed based on counting actual played cards.

Questions were used to stimulate participants' knowledge of the possible outcomes when following a strategy. For example, participants were in the third position (after the first and second players), yet they were asked to indicate which card they intended to play under the current strategy (e.g., support your partner's play) immediately after seeing the first player's card. It is important to distinguish between participants' knowledge about the possible outcomes and the strategies (e.g., support your partner's play) provided by the experimenter. Participants' knowledge about the possible outcomes focuses on how the strategies (provided by the experimenter) apply in a particular situation. More specifically, their knowledge about the possible outcomes draws on their past experiences in such a situation, which may include typical adjustments that are not part of the strategy. In the previous example, when the participants were asked to indicate what they intended to play immediately after seeing the first player's card, their responses could include typical adjustments that fell beyond the current strategy (e.g., support your partner's play).

The participants' description was transcribed and then coded. In the coding stage, the focus was on the indicators of branching responses, such as *if* and *in the case that*. The following is a quote that illustrates the coding.

> Okay, before seeing the second player's card, I would play the king or maybe the jack in the case that the second player's card is lower than a jack. If [the second player's card is] higher than a king, like a 10 or an ace, I'll play the 7, no doubt. (Participant 21)

This participant started with cards that could be played to satisfy the strategy. The participant further added that if the second played card had a scoring value higher than his cards, then he would not follow the strategy but would play the 7. Indeed, playing the 7 is part of the participant's knowledge about the possible outcomes that fall beyond the strategy. The use of phrases that indicate branching, such as *in the case that* and *if-then-else*, suggest that the participant has a knowledge about two branches that depend on the second played card; depending on this card, the participant could play a card that falls either within or beyond the strategy.

Thus, participants' responses can fall into one of three possible outcomes: their knowledge about playing a card falls only within the strategy, their knowledge about playing a card falls only beyond the strategy, or their knowledge about playing either within or beyond the strategy, depending on the second played card. The goal of identifying participants' knowledge in a given situation is to show the extent to which participants are aware of the possible outcomes.

A chi-square one-sample test was used to examine if a statistically significant difference exists between the expected and the actual outcomes. An equal probability is expected for the three outcomes. Based on chance, one third of participants would indicate the knowledge of playing a card that falls only within the strategy. Another one third would indicate the knowledge of playing a card that falls only beyond the strategy. The remaining one third would indicate knowledge about playing either within or beyond the strategy, depending on the second played card.

With respect to actual adjustment, the actual played cards were counted. For a given strategy after seeing the first played card, participants' cards were categorized into two categories: those that fall within or beyond the strategy (Appendix M shows the cards actually played and their corresponding categories). In the context of the Belote card game, a played card is classified as either within or beyond any given strategy (i.e., within and beyond are mutually exclusive categories). As a result, the played cards per condition either fall within or beyond the strategy. The significance of the difference between the expected and the actual was examined using a chi-square one-sample test. The expected probability of each category was estimated based on the number of cards that fall within or beyond a strategy relative to the total number of legal cards that can be played (see Table 6.10).

Table 6.10: Probability of Each Category and Corresponding Strategies

No.	Strategies	Cards fall within the strategy	Cards fall beyond the strategy
1	Support your partner's play	2/3	1/3
2	Signaling	5/8	3/8

6.6.2 Results

The purpose of task two is to test the third hypothesis, which states that an association exists between an individual's knowledge of typical adjustment relevant to the activity category and his/her actual adjustment in the activity category. A two-step measure was used to examine the third hypothesis, as outlined in section 6.6.1. In the following sections, the results of participants' knowledge about typical adjustment and their actual adjustments are reported separately.

6.6.2.1 Participants' Knowledge about Typical Adjustment

Following the coding procedures discussed in Measures (section 6.6.1), the percentages of participants who fall in each of the three possible outcomes are shown for each strategy (see Figure 6.8). In the "support your partner's play" strategy, 28 participants knew the strategy and described their knowledge about the possible outcomes. As shown in the first chart of Figure 6.8, 92.8% of those participants had knowledge about playing cards that fall either within or beyond the strategy. In the "signaling" strategy, 23 participants knew the strategy and were able to provide possible outcomes. The second chart in Figure 6.8 shows that 82.6% of those participants had knowledge about the cards that can fall either within or beyond the strategy.

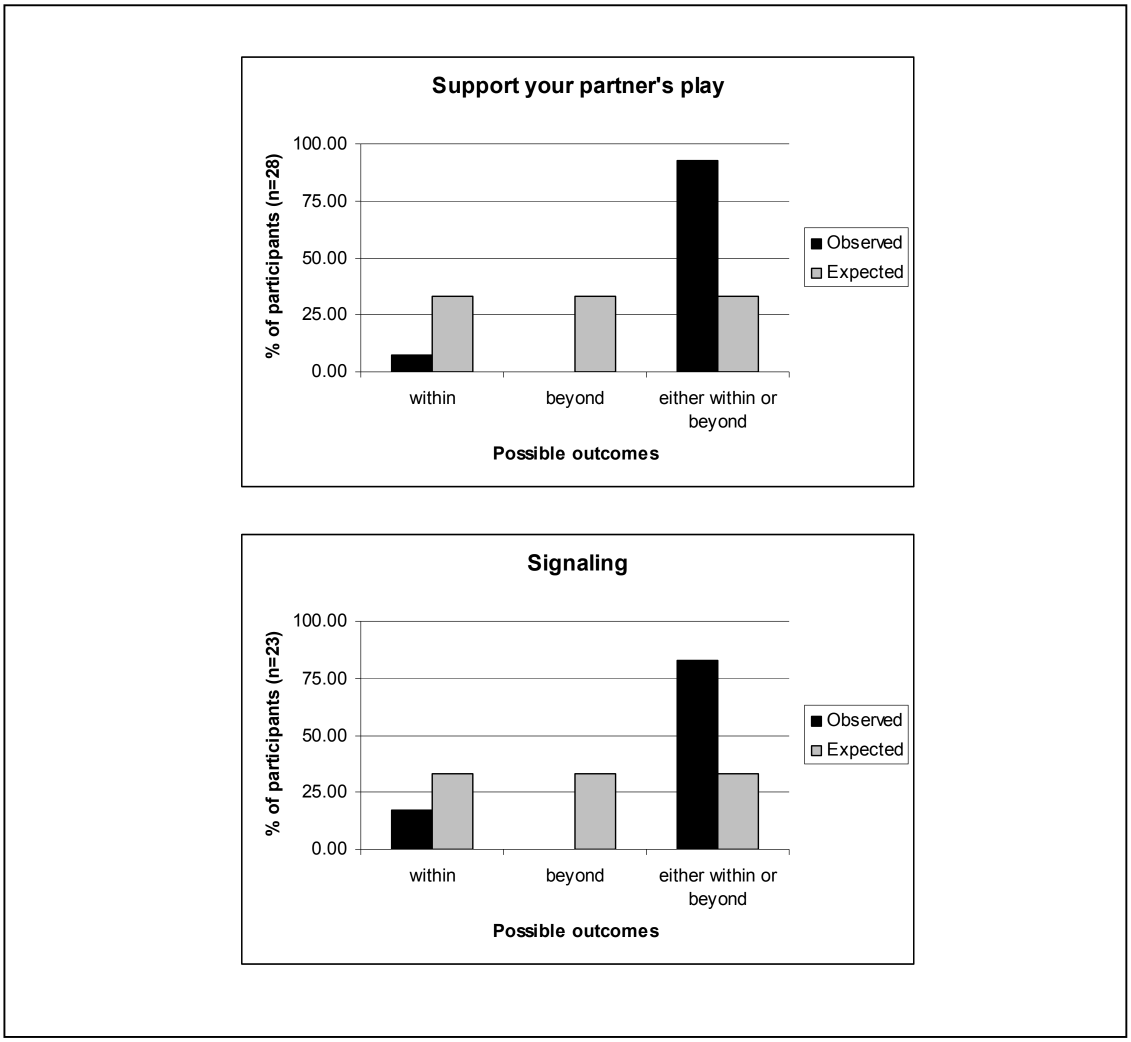


Figure 6.8: Percentages of participants possessing knowledge of possible outcomes for the two examined strategies

The majority of participants possessed knowledge about playing cards that fall either beyond or within the strategy, as shown Figure 6.8. In this experiment, the knowledge about playing cards that fall beyond the strategy is considered a knowledge about expected adjustment given that when participants played beyond the strategy, they could not follow the strategy. Participants who indicated their unfamiliarity with the strategies were excluded, as they lacked the knowledge about the possible outcomes.

The chi-square was computed for the two strategies (“support your partner’s play” and “signaling”) and was significant for both strategies at $p < 0.001$ (1-tailed), as indicated in Table 6.11. This result suggests that a real difference exists among the three outcomes. In particular, a large portion of participants demonstrated knowledge and awareness about typical barriers that may require adjustment.

Table 6.11: Chi-square for Participants’ Knowledge for the Possible Outcomes in the Two Strategies

No.	Strategy	Chi-square	*d.f.*	*N*	***P*-value** (1-tailed)
1	Support your partner’s play	44.806	2	28	$p < 0.001$
2	Signaling	26.214	2	23	$p < 0.001$

6.6.2.2 Actual Adjustment of the Participants in the Activity

In order to examine the association between participants’ knowledge of typical adjustment and their actual adjustment in the card game, the frequency of the played cards was counted. These played cards were then categorized into cards that fall within the strategy and cards that fall beyond the strategy. Next, the played cards (represented by black bars) were converted into percentages and plotted with expected probability of each of the two categories (represented by gray bars) (for details about how the probability was calculated, see Measures, section 6.6.1). This process was done separately for the two strategies (i.e., “support your partner’s play” and “signaling”).

With respect to strategy 1 “support your partner’s play,” it is clear from the charts in Figure 6.9 that the majority of the participants (represented by black bars) in each condition played their cards either within or beyond the strategy. In conditions 1 and 2, most participants were within the strategy while in condition 3 participants adjusted by playing card that fell beyond the strategy. The shift from being within the strategy to being beyond the strategy was due to previously played cards (i.e., situational contingences). In condition 3, the previously played cards created a barrier that encouraged participants to play beyond the strategy.

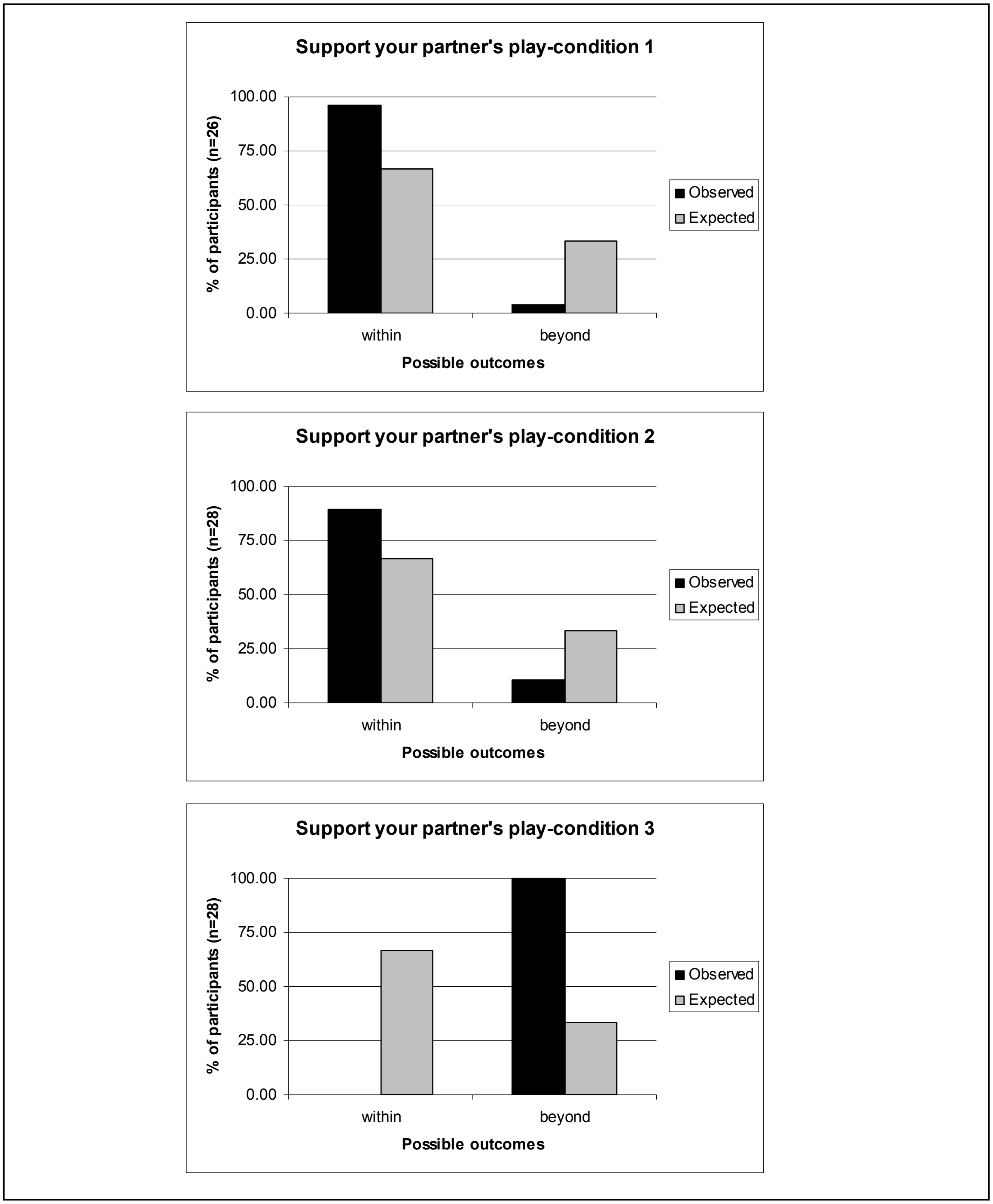


Figure 6.9: Percentages of actual and estimated frequency of cards played using the "support your partner's play" strategy

Furthermore, since two cards satisfy the strategy, it is possible to analyze the data at the card level rather than grouping cards into the category of within the strategy. In fact, some differences were observed in condition 1, as 19 participants chose the king while only 6 choose the jack. In condition 2, all participants (n=28) chose the king. Thus, the majority of participants in both conditions seemed to prefer the king regardless of previously played cards.

It should be noted that, according to Figure 6.9, the number of participants varies because participants not familiar with the presented strategy were excluded, as they were not able to comment on whether the card they played was within or beyond the strategy. In addition, as participants were given the option of selecting more than one card, in a few cases participants chose more than one card as a tie for their first choice. Accordingly, if one of these cards was within and the other was beyond the strategy, these participants were excluded as the categories of within and beyond are mutually exclusive.

With respect to strategy 2 "signaling," across different conditions and based on previously played cards, participants shifted between cards that fell within and beyond the strategy as shown in Figure 6.10. The shift beyond the strategy considered adjustment due to played cards (situational contingences). Charts 2 and 3 in Figure 6.10 clearly demonstrate that all participants played beyond the strategy as the situation did not support following the strategy of "signaling."

However, unexpectedly participants had three different interpretations of "signaling." Specifically, the design of the task required that participants notify their partners that a club should be played first in the next round because the hand provided for the "signaling" strategy includes the four of clubs. Participants notified their partners in condition 1 by playing the king of diamonds, queen of spades, or jack of clubs. Some participants argued that, to notify the partner of the need for a club, the participants needed to play a diamond. Others argued that playing a spade indicated the need for a club. The last group argued that notifying their partner that they needed club required playing a club. In the categories of within and beyond the strategy, these three interpretations do not affect the analysis because, in condition 1, regardless of which card participants chose (i.e., king of diamonds, queen of spades, or jack of clubs), all these cards fell within the strategy. However, these interpretations make the analysis at the card level impossible.

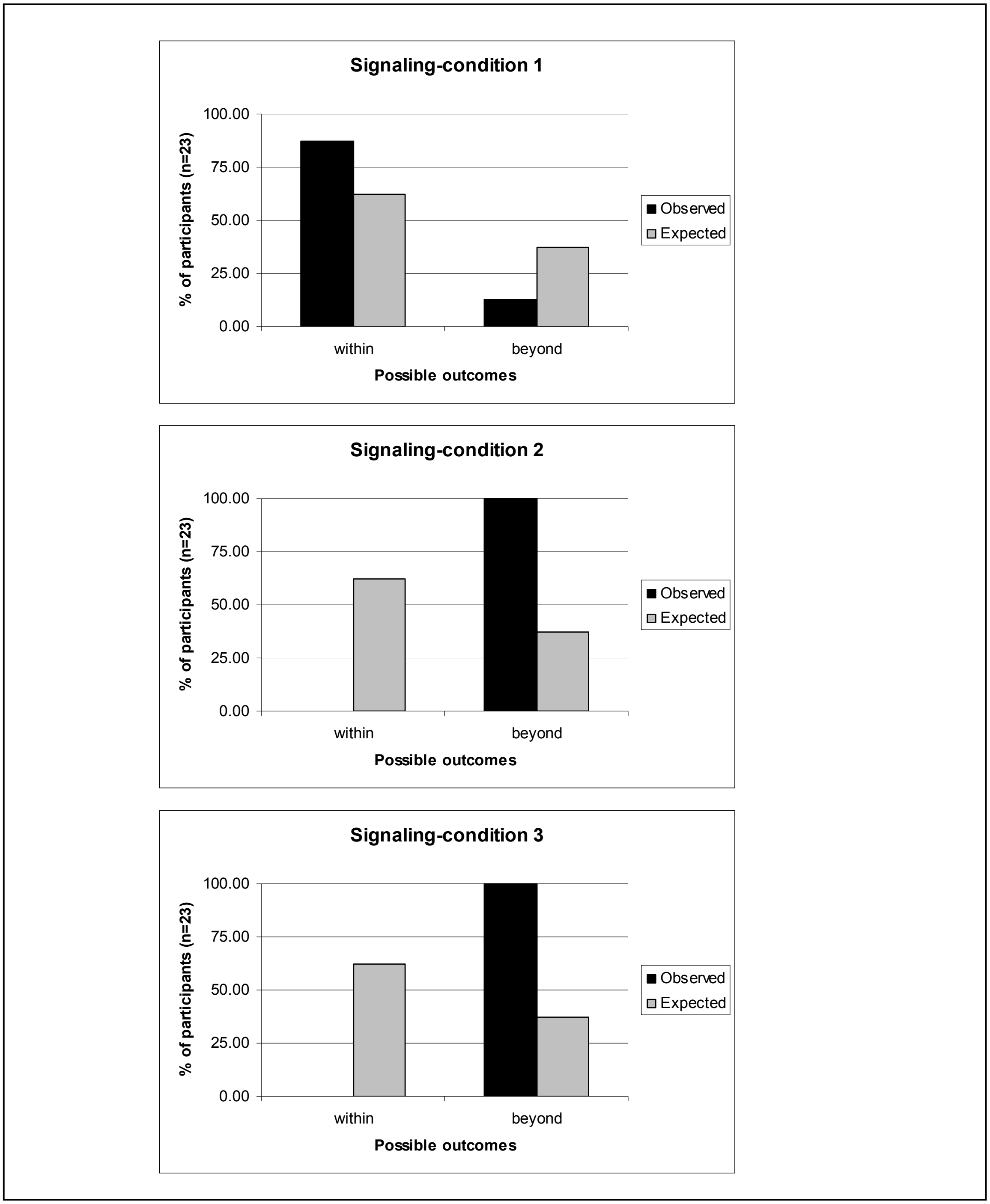


Figure 6.10: Percentages of actual and estimated frequency of cards played using the "signaling" strategy

The chi-square was also computed for each condition in the two strategies ("support your partner's play" and "signaling"). As shown in Table 6.12, in four conditions, the difference between played cards and estimated probability was significant at $p < 0.001$ (1-tailed). The other two conditions (Support your partner's play-condition2, and Signaling-condition1) were significant at $p < 0.01$ (1-tailed)

Table 6.12: Chi-square for Each Condition in the Two Strategies

No.	Strategy	Chi-square	*d.f.*	*N*	***P*-value** (1-tailed)
1	Support your partner's play				
	Condition 1	10.17	1	26	$p < 0.001$
	Condition 2	6.45	1	28	$p < 0.014$
	Condition 3	56.00	1	28	$p < 0.001$
2	Signaling				
	Condition 1	05.87	1	23	$p < 0.015$
	Condition 2	38.33	1	23	$p < 0.001$
	Condition 3	38.33	1	23	$p < 0.001$

6.6.3 Discussion

Task two examines the nature of the adjustment. Based on the theoretical model, it is hypothesized that an association exists between an individual's knowledge of typical adjustment relevant to the activity and his/her actual adjustment in the activity.

In this task, participants were presented with two strategies and asked about their knowledge of possible outcomes, which might include typical adjustments in the situation that the strategy does not apply. Participants were then asked to play under different conditions, where their decision of what to play was based on the provided strategy and the other played cards.

The researcher was able to manipulate the structure by changing the previously played cards. The manipulation was proven to be successful, as the choice of the frequency of the cards that fell either within or beyond the strategies reported was high.

A two-step measure was used to examine the association between individual's knowledge of typical adjustment and the actual adjustment. In the first step, the participants' knowledge about the possible outcomes that could fall within or beyond the strategies was coded. In the second step, the observed frequencies of played cards were examined against the estimated probability under different conditions.

In step one, the extraction of participants' knowledge was based on the descriptions provided by participants. The qualitative nature of the data and the interpretation involved in the process of coding may lead one to question the accuracy of the results. However, the focus on branching responses (*if-then-else*) in the qualitative analysis reduces the complexity of the coding. In fact, given the participants' high level of competency (see section 6.5.2), it is not surprising that the signal in the data is strong, as a majority of the participants (charts in Figure 6.8) indicated the possible outcomes that would fall within and beyond the strategy. Furthermore, using chi-square to test the difference between the expected and the actual outcomes indicated a significant difference ($p > .001$-one tailed) between the three possible outcomes for the two strategies.

In step two, each of the two created categories (within and beyond strategies) may include a number of cards. Thus, it can be argued that assigning a specific card in the category of within the strategy or the category of beyond the strategy involves subjective judgment. However, the cards of the participants were defined in advance based on the first played card as to whether a card was within or beyond the strategy, which reduced the effects of the subjective judgment.

In the second strategy of "signaling," the unexpected different interpretations of the strategy created a number of challenges in the analysis as it was not possible to analyze the data in the second strategy based on cards as each card that can be played is assigned an equal probability. As a result, to overcome this problem the researcher grouped cards that could be considered within the strategy together into the category "within the strategy" and those that coded not were labeled as "beyond the strategy."

Overall, based on the chi-square test, a significant difference emerged in the obtained knowledge of the possible outcomes, including typical adjustment of playing cards beyond the strategy at 1-tailed. In addition, based on the chi-square, the difference between the expected and the actual outcomes of the cards played within and beyond the strategy is significant at 1-tailed. Combining the results of the significant chi-square test for the obtained knowledge and the actual adjustment in one-tail provides support for H3. Thus, an association exists between an individual's knowledge of typical adjustment relevant to the activity and his/her actual adjustment in the activity. Indeed, observed adjustment was influenced by participants' knowledge about possible outcomes, including adjustments beyond the strategy.

6.7 General Discussion

An experiment comprising two tasks was carried out to examine the proposed theoretical framework. Three hypotheses outlining the plan–action relationship were formulated and tested quantitatively. This section provides an overview of the major findings of the experiment, followed by the experimental method that was developed, as both the major findings and the experimental method relate to the literature. The general discussion concludes with the limitations of the conducted experiment.

6.7.1 The Experiment Results

The major findings of the experiment are divided into two main categories. The first one is the knowledge participants have about strategies as graded structure future activity categories (H1 and H2). The second one involves the nature of adjustment (H3).

6.7.1.1 Knowledge about Strategies as Graded Structure Categories

The first task, which involved defining four Belote strategies, providing concrete examples of each, and applying the four presented strategies, supported the first hypothesis. As discussed in section 6.5.2, the analysis of the central aspects of the four presented Belote strategies suggested that participants had knowledge and awareness about the variability in the presented strategies (see Table 6.12 for details). Participants were able to specify aspects of strategies that are important in implementing these strategies. In addition, participants were able to generate many different concrete examples to fit the presented strategies. These data provide support for the first hypothesis that individuals tend to conceive of plans as future activity categories with a range of possibilities.

Table 6.13: Variability of the Central Aspects in Applying Four Belote Strategies

No.	Strategy	Central Aspects	Variability
1	Play your strength	1) High-value cards	Jack, queen, king, 10, and ace
		2) Three or more cards of the same suit	3, 4, 5, 6, 7 or 8 cards (same suit)
2	Support your partner's play	1) Higher value card than the previously played cards	Can be up to 6 different cards
		2) Similar suit should be played first in the next round	Can be up to 5 different cards
3	Don't play below the ace	1) Ace and other cards of the same suit	Can be up to 6 different cards
4	Don't leave your 10 alone	1) 10 and another card of the same suit	Any card other than ace (same suit)

It is important to note that, although the central aspects indicated the participants' knowledge and awareness of different card combinations that might fit the strategies, this research argues that participants formed strategies based on what they considered most likely to happen (i.e., most typical). This research makes this argument because, when participants were asked to give concrete examples of strategies, their examples tended to reflect typical and expected situations.

The difference between how participants conceived of strategies and how they formed strategies was evident in strategy 1, when participants described "play your strength" in terms of the aspect of "high-value cards"—a description that includes all five cards with a scoring value. The description of this aspect indicates the participants' knowledge and awareness about the wide range of possible cards that can fit the aspect. However, in strategy 1, the examples provided by participants tended not to show an extremely good example by combining all five high-value cards together. Participants tended to choose two to four of the five scoring value cards to illustrate the aspect of high-value cards. Similarly, three or more of the same suit could mean (unusually) six, seven, or even eight cards of the same suit, yet participants tended to provide combinations of only three to four cards of the same suit as examples, as shown in Appendix J. Based on this result, it can thus be suggested that strategy involves what is typical, while conceiving of a future activity that involves the knowledge and awareness of the wide range of possibilities.

Section 6.5.3 argued that participants possess knowledge that encompasses a wide range of possibilities that fit strategies. These possibilities were described in terms of central aspects important for implementing strategies (see Table 6.12). These aspects are similar to the concept of ideal dimension in the categorization literature (e.g., Barsalou, 1981, 1985). Although the ideal dimension is typically defined by the researcher (Kim & Murphy, 2011), in this study the central aspects were defined by the participants (i.e., not the researcher).

The central aspects stated at a broad level ignore a number of details. For example, when identifying high-value cards, participants did not refer to a specific card (e.g., ace or king) or a specific suit (e.g., heart or diamond); rather, they used the broader terms “high value” and “cards.” Thus, the question becomes by what process participants were able to distinguish relevant and irrelevant elements to form their descriptions of the strategies. A possible answer behind this process is the concept of chunking, which refers to a cluster containing items highly associated with each other and less associated with items contained in other clusters. Chunks can be formed based on goals (also called goal-oriented chunking; Gobet et al., 2001). In the same line of thought, Dreyfus (1992) argued that individuals divide their situations into relevant and irrelevant elements based on goals. Indeed, goals are like filters that enable individuals to perceptually divide situations in larger chunks and omit many irrelevant details (e.g., “heart,” “diamond,” “spade,” and “club”).

With respect to the second hypothesis, the results in section 6.5.2 indicate that variability in the examined hands is structurally graded, meaning that some cards are more likely to be played than others. The analysis was based on the agreement between participants on ranking cards using two statistical tests—namely, the coefficient of concordance and the interclass correlation coefficient.

6.7.1.2 Nature of adjustment

In the second task, participants’ knowledge regarding the range of possible cards was identified based on their discussion of the possible cards that could be played under each condition (see section 6.6.2.1 for details). Participants were asked to follow two strategies under different conditions (see section 6.6.2.2. for details). Using a chi-square test, the results indicate a significant difference at 1-tailed between the expected and the actual outcomes identified based on participants’ knowledge. In addition, using a chi-square test, a significant difference at 1-tailed was found between the expected and the actual groups (within the strategy and adjustments beyond the strategy). These two results of significance at 1-tailed provide support for the third hypothesis—namely, that an association exists between an individual's knowledge of typical adjustment relevant to the activity and his/her actual adjustment in the activity. However, these results should be interpreted with caution for several reasons: 1) the chi-square test is used in an indirect way, 2) grouping the cards into two categories of within and beyond the strategy might not be the best way to analyze the data, and 3) unexpected results of different interpretations were involved in the second strategy.

The argument that strategies are built based on what is expected to happen (i.e., what is typical) equally applies to the concept of adjustment. In this experiment, adjustment refers to the path a participant might take beyond the strategy if faced with a barrier to following the strategy. Although an individual certainly cannot imagine every possible barrier and its alternative path (adjustment), typical barriers can be reasonably expected. The fact that typical barriers exist is evident, specifically in terms of this experiment, because in the forethought (see section 6.6.2.1 for details), the majority of participants reasonably expected to adjust beyond the strategy if needed. However, it can be argued that the expected adjustment is due to the participants' level of expertise. More specifically, participants in this experiment are highly skillful players for whom predicting a different possibility is not a complex activity. This is probably true for most experts in different fields. Therefore, the argument that typical barriers exist needs to be interpreted with caution as not all barriers are totally new, although a particular individual may encounter a barrier for the first time or some barriers may be completely new (i.e., never having occurred to anyone in a given situation).

6.7.2 The Experiment Methodology

The experiment comprised two tasks and was conducted in one session. As the two tasks were derived from the card game of Belote, all 30 participants were experts in the game. The use of a qualitative measurement in the experiment was unavoidable because some aspects of the plan–action relationship require qualitative analysis such as the forethought of future possibilities. In fact, the use of both task-based on domain-specific activity (i.e., the card game Belote) and qualitative measurement is in contrast to other studies that investigate the plan–action relationship (Ng, 2002) and categories' internal structure (e.g., Barsalou, 1983; Rosch, 1973).

Based on the categorization literature (e.g., Barsalou, 1983), participants were not expected to need to use ties (i.e., place more than one card in the same rank). While conducting a handful of interviews to explore the card game, the researcher began to expect that participants needed to use ties. This was evident as participants in the experiment were frequently tied. This finding is in line with Kendall's (1945) argument that, in the real world ties, constitute the rule rather than the exception. Thus, based on the findings of this study, it is suggested that previous studies' use of ties is a questionable practice. A future study on the effect of ties on categories' internal structure is therefore recommended.

6.7.3 Limitations of the Experiment

Finally, a number of important limitations need to be considered. First, the sample size is relatively small (n = 30 participants). This is due to the limited number of potential participants who were competent players of Belote. In addition, each participant was tested individually for about an hour to complete both tasks of the experiment. The small population and time-consuming experiment made it difficult to find willing and available participants. However, the sample size in this experiment (n = 30 participants) is still larger than other experiments on graded structure, such as Barsalou (1983), who reported only 24 participants.

Second, limited stimuli (i.e., the strategies of the Belote card game) were studied. Limited stimuli were used in order to increase the analyzability while reducing the complexity involved in the experiment. Because this choice might affect the generalizability of the results, the researcher conducted both an in-depth case study and a laboratory experiment to enhance the generalizability of the findings.

Third, the experimental manipulation of the structure was designed at two levels. At the first level, the structure was manipulated, wherein played cards were classified as either within or beyond a given strategy. At the second level, the structure was manipulated at a fine-grain level, wherein cards that fell within the strategy were manipulated under different conditions. Although the first level of manipulation proved to be successful (see section 6.6.2.2), the current study was unable to analyze data of the differences between paths that fell within the strategy because in the first strategy, the majority of participants chose to play the king of diamonds in the two cases, which can be interpreted as being able to recognize the difference between the two cards while manipulation did not work. In addition, difficulty with the "signaling" strategy, which has multiple interpretations, made it harder to draw conclusions about the changes between paths (cards) with the strategy. It seems that the selected strategies, in particular "signaling," did not fit perfectly the fine-grain level of different paths within a strategy.

Finally, in the "signaling" strategy, participants had more than one interpretation of the strategy in condition 1. These different interpretations do not affect the basic idea of the "signaling" strategy, in which participants have to play a high-value card to be within the strategy. At the analysis level, grouping cards that fall within the strategy reduce the effect of the data analysis. However, these interpretations are a source of unnecessary variability that made the analysis at the card level impossible. Thus, it seems that other strategies that do not have multiple interpretations should be used in the future.

Chapter 7
Conclusions, Implications, and Future Research

Two major pieces of work have been presented in this dissertation. First, a theoretical framework was proposed to explain the phenomenon of the plan–action relationship. Second, an empirical investigation was conducted using two methods: an in-depth case study at an organizational setting and a laboratory experiment. This chapter briefly outlines the theoretical framework and summarizes the findings of the dissertation. This overview will be followed by a discussion of the degree to which other alternative theories could account for the dissertation findings. The theoretical, methodological, and practical contributions of the study will then be presented. Finally, the chapter concludes with potential future work.

7.1 Overview of the Theoretical Framework

In this dissertation, drawing on research on cognition and categorization theories, the plan–action relationship is conceptualized in terms of activity categories. Individuals tend to conceive (have knowledge and awareness) of a plan[11] and its attributes as a future activity category with a range of possibilities that are structurally graded. Although this dissertation argues that individuals have knowledge of a plan and its attributes as an activity category with a range of possibilities that includes those beyond the typical, plans and their attributes are formed based on what most is likely expected to happen (typical).

Furthermore, as the individual is moving toward the goal, plans are divided into sub-plans. However, if a barrier (i.e., a situational contingency) is presented that prevents the individual from the goal, an adjustment is required to overcome the barrier. In this dissertation, an alternative path or detour that an individual takes toward the goal is called adjustment. This dissertation argues that an association exists between an individual's knowledge of typical adjustment relevant to the plan and his/her actual

[11] As discussed in section 3.3, plans, strategies, and schedules are treated similarly as all three are intended activities that have not yet been performed.

adjustment during the execution of the plan because, for the most part, adjustments are not constantly new but can be reasonably expected based on an amalgamation of past experience. However, this dissertation does not argue that an individual can expect or have knowledge of every imaginable contingency.

7.2 Overview of the Case Study and the Experiment in Relation to the Theoretical Framework

Combining the case study and the experiment, the empirical findings support the theoretical framework in a variety of ways. The findings can be divided into two main areas: category structure and nature of adjustment.

With respect to the category structure, both the case study and the experiment demonstrated that individuals have knowledge and awareness of the schedules and strategies as structurally graded. More specifically, in the case study (sections 5.1.1 through 5.1.4), central aspects of the attributes of a daily schedule indicated that staff members have knowledge and awareness about the variability on shipment occasions. Similarly, in the experiment in section 6.5.2, central aspects of the presented Belote strategies suggested that participants have knowledge and awareness about the variability in the presented strategies. In addition, in the experiment, participants were able to generate many different concrete examples that fit the presented strategies. Overall, these data provide support for the first hypothesis, which states that individuals tend to conceive of plans as future activity categories with a range of possibilities.

This dissertation further suggests that plans and their attributes are formed based on what is most likely expected to happen (typical). It should be noted that the argument of typicality of plan does not contradict the argument that individuals have knowledge and awareness of plans as a range of possible attributes that include those beyond the typical because—if individuals are asked about what could happen—they may provide a wide range of possibilities. Thus, individuals are aware of the broader knowledge of the situation in which the plans take place. For example, the plan for “taking my wife from Waterloo to

Toronto Pearson International Airport next Saturday" is formed based on typical conditions related to traffic and weather conditions rather than every possible traffic and weather condition.

In the second hypothesis, this dissertation argued that the internal structure of the knowledge of plans tends to be structurally graded. In the case study, both qualitatively (see sections 5.1.1.1, 5.1.2.1, 5.1.3.1, and 5.1.4.1) and quantitatively (see sections 5.1.1.2, 5.1.2.2, 5.1.3.2, and 5.1.4.2), the results indicate that variability in knowledge about schedule is structurally graded in which some occasions of shipment are more likely to occur than others. Similarly, in the experiment (section 6.5.2), the coefficient of concordance and the interclass correlation coefficient tests demonstrated relatively high agreement between participants ($W = .55$, $ICC = .54$) at the $p < 0.001$ level of significance, suggesting that—in a given strategy—participants agreed that some cards are more likely to be played than others. In sum, these results provide evidence that the knowledge about future activities tends to exhibit a graded structure in which some members of the category of future activities are more likely to occur than others.

With respect to the nature of adjustment, in this dissertation adjustment refers to the way in which an individual deals with barriers that prevent him/her from reaching the goal during plan execution. In the case study (see section 5.2 for details), a number of typical barriers and their typical adjustments were documented. However, due to the nature of the case study, it was not possible to test the third hypothesis rigorously—namely, that an association exists between an individual's knowledge of typical adjustment relevant to the activity and his/her actual adjustment in the activity. In the experiment, it was evident (as discussed in section 6.7.1.2) that typical barriers can be reasonably expected and typical adjustments can be used to overcome these barriers. Furthermore, in the experiment, participants' knowledge regarding the range of possible cards (see section 6.6.2.1 for details) and the actual played cards (see section 6.6.2.2. for details) supported the third hypothesis. An extreme interpretation of these results may suggest that an individual may be able to predict every imaginable barrier; however, this interpretation is not intended as there are undoubtedly barriers that a particular individual may encounter for the first time.

7.3 Contributions

The findings from this dissertation make several contributions to the current literature. Theoretically, this study developed a novel theoretical approach to examine the plan–action relationship that differs from prevailing views. The abstractness of plan and the concreteness of action in the psychological theory of planning are connected by the decomposition of plans into sub-plans until the level of action (e.g., Miller et al., 1960). The situated action perspective (e.g., Suchman, 1987) shifted the emphasis to the action at the single level of moment-to-moment. Although the situated action perspective did not provide a theoretical explanation of the plan–action relationship (Suchman, 2003), based on the analysis of action at the moment-to-moment level, the situated action perspective criticized the idea that plans can be decomposed to the level of action. By contrast, it has been argued in this dissertation that the experience of the actors, as those actors perceive their situations, is the bridge between the abstractness of plans and concreteness of actions. Indeed, it is not the detailed plans at the level of action nor the action at the moment-to-moment level, but rather the actor's experience that links plan and action.

The theoretical framework presented in this dissertation further differs from psychological theory of planning by providing additional details about plan formation and adjustments. Plan formation and adjustments are based on the typical outcomes (i.e., what is most likely to happen) rather than individuals' knowledge about the wide range of possibilities that could happen.

The theoretical framework in this dissertation combined categorization theories about typifications of human experience and field theory of the action in the here and now, which no one had previously connected. From the categorization perspective, this dissertation provides a starting point to investigate the internal structure and variability in activity categories because, in categorization literature, little work has been done to investigate activities (Hemeren, 2008; Zacks & Tversky, 2001). From the field theory perspective, this dissertation shows another fruitful avenue for analyzing human experience by applying the field theoretical analysis. The application of field theory provides for a better understanding of human experience and presents a theory of situated action that has been overlooked in the literature.

Methodologically, this dissertation makes several noteworthy contributions. The case study attempted to combine observational method with theories of categorization in response to the call in the literature to observe categorization in a natural setting (e.g., Murphy, 2005). Furthermore, this dissertation developed qualitative and quantitative approaches to analyze the case study data, which could serve as a basis for future studies aimed at investigating categorization in natural settings.

With respect to the Belote card game, the experiment attempted to examine aspects of the plan–action relationship that could not be examined in the case study as well as quantitatively test certain hypotheses. The development of the tasks based on the Belote card game provided an avenue to study the dynamic properties of the situation in relation to planning, as discussed in section 6.3. Finally, combining both the field study and lab study contributed to the generalizability of the results.

Based on the current work, practical recommendations can be made about information systems design. What difference does this study make to information systems design? Earlier work on information systems design focused on computerizing office procedures, assuming that office work involves the execution of predefined procedures (Ehn, 1989; Suchman, 1982; 1983). However, other approaches (e.g., work-oriented approach) have argued that this assumption is not valid. Rather, they assert that information systems design has to be developed based on observational studies (e.g., videotape analysis) of the situated action (Suchman et al., 1999). For example, Robinson (1991) stated that "[t]he emphasis within the worldwide CSCW [Computer Supported Cooperative Work] community [is] on understanding the specifics of practical, situated action" (p. vii). This dissertation has argued that approaches of designing information systems based on situated action fail to provide the process by which the situated action on moment-to-moment bases is abstracted to a workable system. Advice such as observing people and making prototypes in the workplace do not indicate how to move from the details of everyday activities to the abstract of the information systems.

Based on this dissertation's theoretical framework and findings, it is suggested that a system can be better developed by viewing the knowledge of office workers about procedures as activity categories with a range of possibilities that are structurally graded. Thus, to develop a system, this dissertation suggests implementing office procedures based on what is typical or most likely to happen rather than what is ideal. For example, in the case study, ideally customers should not ask for additional concrete beyond the originally ordered volume; however, it was found that typically there is a one-truckload deviation. Accordingly, the information should support the permissible range of the one-truckload deviation. Furthermore, this dissertation suggests that information systems should account for typical problems (i.e., barriers) and their typical adjustments. For example, the case study demonstrated that order cancellation is a typical problem (sections 4.3 and 5.2) that has several existing solutions (i.e., adjustments) to reduce the negative impact or order cancellations for plant operation. Consequently, this dissertation suggests a better design for information systems to support adjustments that are typically made to overcome frequent problems.

7.4 Directions for Future Research

The present study can be seen as a starting point for a variety of potential future research directions. One potential direction is that several conceptual limitations require further examination. First, the connection between individuals' knowledge and typical barriers and adjustments requires further investigation. More specifically, it seems that a model explaining the mental process by which individuals retain the typical barrier and typical adjustment in memory is lacking.

Second, the concept of behavioural opportunities and their implications was not analyzed in this dissertation. This question is in part conceptual as, to the best of the researcher's knowledge, it is not entirely clear how the concept of opportunity is treated in field theory. It can be argued that opportunity and barrier are organized perceptually in the figure-ground, meaning that the barrier contributes to what one sees as opportunity, yet remains in the background. This implies that both the opportunity (figure) and the barrier (background) cannot both be seen at once. Although the background is often forgotten, it does modify, affect, and contribute to the way the figure is seen. It seems within the context of the plan–action relationship, opportunity and barrier offer directions for future research to clarify the relationship between both opportunity and barrier from the field theory perspective.

In addition, it is assumed in this dissertation that plans are formed based on what is most likely to happen (typical). However, this assumption is not empirically examined in this dissertation. Therefore, future work should test this assumption.

Another potential direction is exploring the process by which plans transform from an abstract level to a more specific level and vice versa. Within the organizational context, this transformation can be investigated in two directions. The first direction involves investigating the transformation processes at different time junctures within a single organizational role (e.g., planner). The second direction involves investigating the transformation processes at different time junctures among various organizational roles (e.g., truck driver, salesperson, and store manager).

Methodologically, several avenues are available for future research. One possible direction is to improve the design of the experiment to capture the paths within a strategy. The improved design should focus on selecting more representative hands, using other strategies, and developing steps that detect and analyze the fine-grain level of different paths. In addition, future studies could use the experimental set-up of the Belote card game to investigate the interaction among the strategies, the structure of the environment, and behaviors of individuals acting upon the strategies simultaneously. In this context, strategies and the structure of the environment can be captured by examining the level of fit among them (typicality rating). Participants' behavior can be represented by the degree to which they agreed on ranking the cards of each hand (coefficient of concordance).

In order to pursue an empirical investigation of the interaction among strategies, structure of the environment, and behavior, several issues should be conducted. Unlike the current study, the size of the data points should be quite large, using more than five hands per strategy. In addition, whereas this study used hands that were randomly drawn, the hands might cover a wider spectrum of typicality ratings, ranging from highly typical to typical to atypical for the corresponding strategy. Ideally, both variables—the typicality ratings and card rankings used to compute the coefficient of concordance—should be provided by different participants to control for possible bias. Finally, strategies used in the experiment should define a similar number of legal choices (i.e., cards) as some strategies define a much smaller number of legal choices (i.e., cards) than others.

Further research is also needed to better understand the effects of ties on the shape of the internal structure of categories. This research empirically found that it was not uncommon for participants to assign ties to members of a category (i.e., to assign the same rank to more than one member), which calls into question previous study results (e.g., Barsalou, 1983) that did not allow for ties (i.e., no more than one member at any given rank). Accordingly, further investigation and experimentation on the effect of ties on the internal structure of a category is recommended.

Practically, one of the potential directions is to enhance the modeling of scheduling at ready-mix concrete facilities. Few studies (e.g., Tommelein & Li, 1999) have described the reality of scheduling at ready-mix concrete facilities. Despite previous efforts to use sophisticated mathematical techniques, such as the genetic algorithm (e.g., Naso, Surico, Turchiano, & Kaymak, 2006), to model ready-mix scheduling, these models made unwarranted assumptions, such as assuming that demand is determined in advance (Schmid, 2007). However, as discussed in sections 4.3 and 5.2, the last-minute cancellation of orders is not uncommon within the ready-mix concrete industry. Furthermore, ordering additional concrete on short notice seems to be a common practice. Accordingly, it is recommended that further research be undertaken to model ready-mix concrete scheduling using non-deterministic demand.

Appendix A

An Example of the Daily Schedule at RMC

Reservations Progressive Report

Reserv. On Thursday 13/08/2009 08:

S.	Acc. #	Customer Name	R.Cbm	PSI Descrip	Batch #	PMP	Site Location	Time	D.Cbm	Remarks
*01	14101299	[illegible]	200.00	4000PSI/ICE	DA40	4	DAMMAM ABQAIQ ROAD	0530	200.00	0
02	14101299		0.00	4000PSI/ICE	DA40	1	DAMMAM ABQAIQ ROAD	--	0.00	0
*03	14101100		4.00	4500PSI STCC	ST45B	2	GOLDEN BELT AREA	1500	4.00	0
*04	14101034		5.00	3500PSI	BC20	2	RAKA	16--	5.00	5
*05	14101258		6.00	4000PSI	BC50	4	DAMMAM NADA AREA	15--	6.00	6
*06	14101258		30.00	2500PSI	BB60	4	DAMMAM NADA AREA	15--	30.00	30
*07	14101117		59.00	28MPa	BC60AB	P	DAMMAM ABQAIQ ROAD	0530	59.00	18
*08	14101117		9.00	28MPa7%MS	BC60MT	P	DAMMAM ABQAIQ ROAD	---	9.00	9
*09	14101184		10.00	4000PSI	BC50	1	DAMMAM JAMAYEEN AREA	15--	10.00	10
*10	14100183		14.00	4500PSI	BC70B	3	DAMMAM KING SAUD ST-14	0530	14.00	12
*11	14101171		10.00	4000PSI	BC50	3	NOZHAT AL-KHALIJ	11--	10.00	0
*12	14100944		32.00	4000PSI	BC50	3	DAMMAM RAYYAN AREA	15--	32.00	14
*13	14101287		37.00	50MPa	BD50A	9	DAMMAM 2ND IND AREA	0530	37.00	37
*14	14101248		32.00	2500PSI	BB60	9	AKRABIAH	11--	32.00	14
*15	14101024		25.00	2500PSI	BB60	2	DAMMAM 55 AREA	0530	25.00	16
*16	14100097		23.00	4000PSI	BC50	2	DAMMAM 37 AREA	11--	23.00	0
*17	14100965		38.00	2500PSI	BB60N	N	DAMMAM 2ND IND AREA	1000	38.00	27
*18	14100049		19.00	250Kg	BB50A	N	THUQBA	1000	19.00	0
*19	14101230		9.00	4000PSI	BC50N	N	DAMMAM ABQAIQ ROAD	1000	9.00	9
*20	14100053		3.00	4000PSI/ICE	DA40	N	DHAHRAN ARAMCO	1500	3.00	0
*21	14100010		5.00	2500PSI	BB60	N	THUQBA/NR DOSSARY HOSP	1000	5.00	0
*22	14100493		10.00	4000PSI	BC50B	1	DAMMAM 55 AREA	1500	10.00	10
*23	14101177		4.00	3500PSI	BC20	N	DOHA-A	1400	4.00	4

Reservat. Count : 23 584.00 CBM Delivered : 100.00% 584.00 J/P Total :

Date/Time Print. : 15/08/2009 08:07:46 L/P Total :

K/P Total :

CHECKED By: Sales Manager : Site Inspector 1 :

Q. A. Supervisor : Site Inspector 2 :

Appendix B

Interview Questions

Background Questions:

1) What is your official position or job title?

2) How long have you been in this position?

3) How long have you been with the company?

Job Overview:

4) Could you describe the primary activities you do with respect to the planning and scheduling process (your main job responsibilities or broad classes of job activity)?

Activity Category:

5) For the following major activities of the plan (activity categories),

a) What is involved?

b) What is involved in the sub-activities?

c) What is involved in the sub-sub-activities?

Task Networks:

6) In the course of working on the planning and scheduling process, you no doubt interact with a number of others, either within or outside the company.

a) For this major activity of the plan (activity category), I would like to know who you interact with in the course of doing your job. (Use the diagram)

b) Using the diagram, could you please identify other people (or groups, departments, etc.) and artefacts with which you interact most frequently as you do your job.

c) Can you rank order the interaction links that you have indicated, from most to least important, as they relate to your job in the planning process?

d) Could you identify the most and least positive working relations in the diagram of interactions?

Network Interactions:

For this major activity of the plan, I would like to ask about the kinds of interactions you have with each of the other people (or groups, departments, etc.) and artefacts. Naturally, these interactions may sometimes proceed normally, not so well, or very well as you do your job. You will have an opportunity to comment on the three kinds.

7) For each link identified:

a) For the planning process with respect to this major activity, could you give some specific examples of the kinds of things they do that take place under normal circumstances?

b) For the planning process that relate to this major activity, could you give some specific examples of the kinds of things they do when the plan does not proceed well?

c) For the planning process that relate to this major activity, could you give some specific examples of the kinds of things they do when the plan goes very well?

8) In the course of working on the planning process, what are the artefacts and planning software you use (e.g., white board and phones)?

a) Could you give some specific examples of the way in which the planning software is performing normally as you do your job?

b) Could you give some specific examples of the way in which the planning software is not performing well as you do your job?

c) Could you give some specific examples of the way in which the planning software is performing very well as you do your job?

9) For all links including the software (questions will be asked in relation to each identified behaviour or example):

a) Relative frequency and Impact: (not so well)

- How frequently does this "not so well" behaviour take place?
- What is the percentage of time out of 10 times?

-What do you do when that happens?

-E.g. – extra tasks or extra network interactions?

– Who do you need to talk with?

-How would that impact on the time required to complete the task?

-Overall, for all behaviours identified as “not so well”, how frequently did these behaviours take place? What percentage of the time out of 10 times?

b) Relative frequency and Impact: (very well)

- How frequent does this “very well” behaviour take place?

- What is the percentage of time out of 10 times?

-How does that help you?

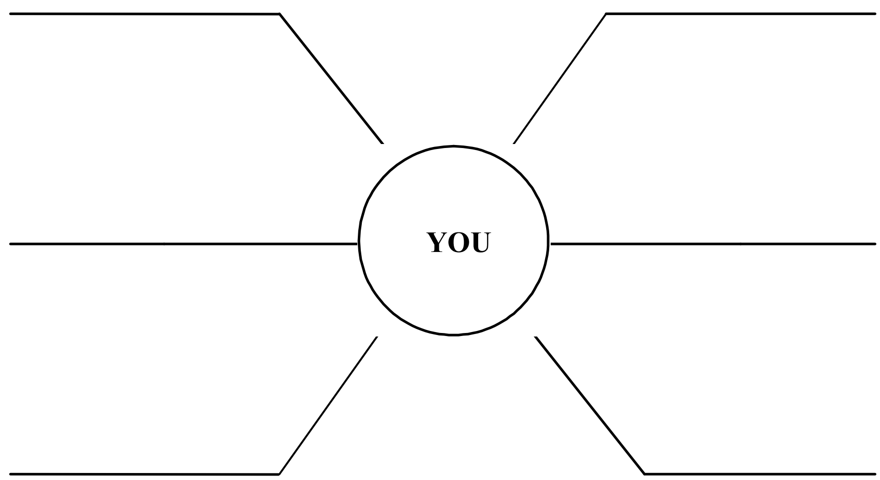
-E.g. – fewer tasks or fewer network interactions?

-How does that impact the time required to complete the task?

-Overall, for all of the behaviours identified as “very well”, how frequently do these behaviours take place? What is the percentage of time out of 10 times?

Diagram of interactions

People (or Groups, departments) Connected With Your Job



Appendix C

Data Collection Process

The data collection process began witha staff member being asked how to perform a job task or subtask as shown in the figure below. Then, the researcher observed the staff member's performance of the job task or subtask several times. During each observation, the researcher engaged in conversation with the staff member performing the task or subtask to collect information about problems that may have occurred during performance of the task. Whenever a problem was identified and explicitly commented on by the staff member, the researcher asked the staff member to judge the problem's typicality and impact. The staff member was asked to judge first the typicality and impact of problems with the subtask and then the typicality and impact of the task it relates to. The overall judgment takes place at the end of each observation. For example, during the observation of the subtask of 'unloading truck,' which is part of the larger task of 'delivering order,' the truck might get a flat tire. If the truck driver indicates that the 'flat tire' is a problem, the researcher asks the truck driver how typical a flat tire is, and how extensive its impact on performance of the subtask of 'unloading truck.' Then, after fixing the flat tire, the researcher asks the truck driver how typical a flat tire is, and how extensive its impact is in relation to the task of 'delivering order.'

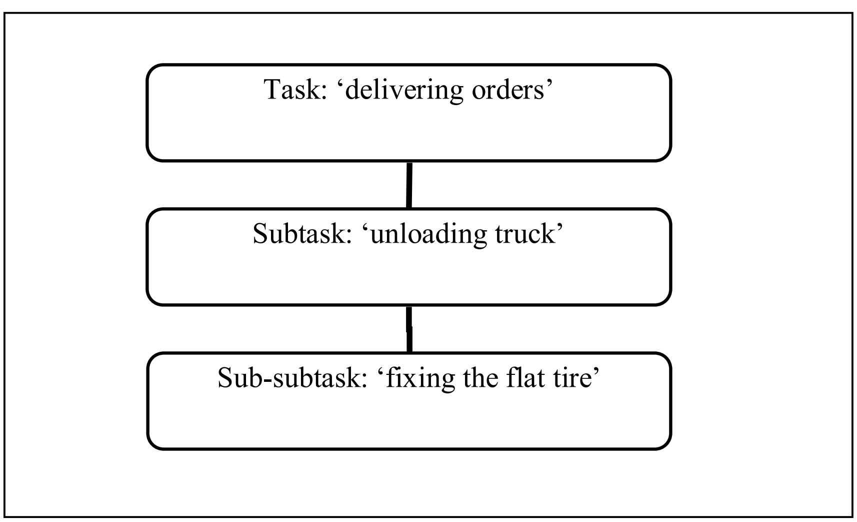


Figure C.1: Example of Tasks, Subtasks and Sub-sucbtasks

Appendix D

Data Collection Template

The data collection template (see the table below) was developed to record problems that occurred during the daily schedule execution (e.g. ‘flat tire’).

Date

Order	Disturbance/problem	How it is handled	People involved	Impact problem	General activity	How the problem fits the problem

Appendix E

Frequency of Pumps' Assignments

Fleet number	*n* (orders)	%
P1 (42*m*)	57	13
P2 (36*m*)	74	17
P3 (47*m*)	88	20
P4 (42*m*)	82	18
P5 (42*m*)	14	03
P7 (42*m*)	55	12
P8 (32*m*)	50	11
P9 (32*m*)	27	06
Total	447	100

Appendix F

Breakdown of the two Created Groups per Pump

Fleet number		within the permissible range				beyond the permissible range	
		As scheduled		exact or higher		shorter	
		n (orders)	%	*n* (orders)	%	*n* (orders)	%
P1	(42*m*)	39	8.7	16	3.6	2	0.4
P2	(36*m*)	53	11.9	17	3.8	4	0.9
P3	(47*m*)	62	13.9	0	0.0	26	5.8
P4	(42*m*)	59	13.2	20	4.5	3	0.7
P5	(42*m*)	10	2.2	3	0.7	1	0.2
P7	(42*m*)	41	9.2	11	2.5	3	0.7
P8	(32*m*)	27	6.0	23	5.1	0	0.0
P9	(32*m*)	23	5.1	4	0.9	0	0.0
	Total	314	70.3	94	21	39	8.7

There are two observations worth noting in the previous table. The first observation is that the table indicates that P8 and P9 have no replacements within the category of "not so good" since P8 and P9 are the shortest pumps (32*m*), so all pumps are considered "good replacements" for P8 and P9. The second observation is that table # shows that most of the "not so good" replacements (26 out of 39) took place for P3. This is because P3 has the highest boom height. Thus, for P3, the category of "good replacements" does not exist. In other words, when staff members at RMC face a problem with P3 and must replace P3, they really do not have any options, since P3 is 47*m* and no other pump has an exact or taller height.

Appendix G

Instances Show some Staff Members were not following Daily Schedule

1) It was brought to the researcher's attention that one of the truck drivers seemed to be unmotivated. In the dispatcher words, "if there is no push, he wouldn't take loads." The researcher observed a day when this truck driver did not take loads as frequent as other truck drivers. Even though this truck driver was not as productive as other truck drivers, the whole operation went smoothly since he accounted only for 5% (1 out of 20) of the drivers.
2) In another instance, the plant operator was late, which delayed the operation. Based on the researcher's observation, it seems that the overall production at the end of the day was not affected by the late start.

Appendix H

An Example of the Rating Questions

Rate these cards in which you consider each card as your **first move** to **"play your strength"**: (i.e. 7 is the most probable choice as being your first move, 1 is the least probable choice as being your first move and so on).
You can place a card or more as inappropriate move based on the rules of the game by writing (*) in front of the card.

1. :

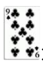
1 2 3 4 5 6 7

Least Probable Sometimes Most Probable

2. :

1 2 3 4 5 6 7

Least Probable Sometimes Most Probable

3. :

1 2 3 4 5 6 7

Least Probable Sometimes Most Probable

4. :

1 2 3 4 5 6 7

Least Probable Sometimes Most Probable

5. :

1 2 3 4 5 6 7

Least Probable Sometimes Most Probable

6. :

1 2 3 4 5 6 7

Least Probable Sometimes Most Probable

7. :

1 2 3 4 5 6 7

Least Probable Sometimes Most Probable

8. :

1 2 3 4 5 6 7

Least Probable Sometimes Most Probable

Appendix I

Central Aspects of Strategies: An Example of the Coding

The following quotes, in which two participants defined "support your partner's play," are offered as an example of the coding process.

Par10: "If my partner is opening the round and I have something like a queen, king, or 10 of the played suit, then I can support my partner's play."

Par18: "If my partner is playing a card, I'll try to support his play. I'll play a higher value card of the same suit. Then, if I win the round I'll return the favor to my partner by playing a suit similar to the suit my partner played in the previous round."

From these examples, it can be observed that there are actions and processes such as 'opening,' 'I have,' 'I can support,' 'playing,' 'I'll play,' and 'return the favor.' Overall, three important aspects that apply to the "support your partner's play" strategy emerged, as follows:

1. It is important to have high value cards of the played suit (**Par10 and Par18**). Although the participant in **Par18** only referred to high value cards in general, the participant in **Par10** gave specific examples of such cards (queen, king, or 10.)
2. The strategy applies when the player's partner opens the round (**Par10)**.
3. The player should open the next round with a card of the suit previously played by his/her partner (**Par18**).

Appendix J

Concrete Examples Provided by Participants

1. Examples of the strategy 1: “Play your strength”

No.	**Card1**	**Card2**	**Card3**	**Card4**
1	10 ♣	K ♣	J ♣	Q ♣
2	8 ♣	10 ♣	K ♣	------
3	A ♦	10 ♦	Q ♦	------
4	A ♦	10 ♦	7 ♦	8 ♦
5	A ♠	10 ♠	K ♠	Q ♠
6	A ♦	10 ♦	Q ♦	------
7	9 ♥	10 ♥	K ♥	Q ♥
8	K ♦	Q ♦	J ♦	------
9	K ♣	J ♣	7 ♣	8 ♣
10	10 ♠	K ♠	8 ♠	------

2. Examples of strategy 2: “Support your partner’s play”

No.	**Teammate***	**Participant****
1	Q ♠	10 ♠
2	9 ♣	A ♣
3	7 ♦	A ♦
4	10 ♥	A ♥
5	7 ♠	10 ♠
6	K ♦	A ♦
7	10 ♥	A ♥
8	K ♦	A ♦
9	8 ♥	A ♥
10	K ♠	A ♠

* Teammate plays his or her card first

** The participant follows his or her teammate’s played card

3. Examples of the third strategy: “Don’t play below the Ace”

No.	**Card1**	**Card2**	**Card3**
1	K ♥	10 ♥	A ♥
2	A ♥	10 ♥	Q ♥
3	7 ♦	Q ♦	A ♦
4	K ♥	7 ♥	A ♥
5	A ♠	K ♠	10 ♠
6	K ♠	A ♠	7 ♠
7	A ♥	Q ♥	8 ♥
8	A ♦	K ♦	----
9	A ♣	10 ♣	K ♣
10	A ♠	7 ♠	8 ♠

4. Examples of the fourth strategy: “Don’t leave your 10 alone”

No.	Card1	Card2
1	7 ♥	10 ♥
2	9 ♣	10 ♣
3	10 ♥	9 ♥
4	10 ♠	8 ♠
5	10 ♠	J ♠
6	10 ♥	K ♥
7	10 ♦	8 ♦
8	K ♥	10 ♥
9	10 ♣	9 ♣
10	10 ♥	7 ♥

Appendix K

Hands Used in Task Two

No.	Strategy	Card1	Card2	Card3	Card4	Card5	Card6	Card7	Card8
1	Support your partner's play	j ♦	A ♥	7 ♦	Q ♣	9 ♥	8 ♣	K ♣	k ♦
2	Signalling	k ♦	Q ♠	10 ♣	A ♣	9 ♦	9 ♣	7 ♠	J ♣

Appendix L

Conditions of Task two

Strategy 1	First player	Second player
Support your partner's play		
Condition 1	8 ♦	9 ♦
Condition 2	8 ♦	Q ♦
Condition 3	8 ♦	A ♦
Strategy 2		
Signalling		
Condition 1	A ♥	K ♥
Condition 2	Q ♥	K ♥
Condition 3	Q ♥	A ♥

Appendix M

Cards in Task Two and their Corresponding Categories

Strategy 1: Support your partner's play

Strategy Support your partner's play	**Within the strategy**		**Beyond the strategy**
	k ♦	J ♦	7 ♦

Strategy 2: Signalling *

Strategy Signalling	**Within the strategy**					**Beyond the strategy**		
	k ♦	Q ♠	J ♣	10 ♣	A ♣	7 ♠	9 ♣	9 ♦

Appendix N

Distribution of the Actually Played Cards in Task Two and their Corresponding Categories

Strategy 1: Support your partner's play

Strategy Support your partner's play	**Within the Strategy Frequency**		**Beyond the Strategy Frequency**
	k ♦	J ♦	7 ♦
Condition 1	19	6	1
Condition 2	25	0	3
Condition 3	0	0	28

Strategy 2: Signalling*

Strategy Signalling*	**Within the Strategy Frequency**					**Beyond the Strategy Frequency**		
	k ♦	Q ♠	J ♣	10 ♣	A ♣	7 ♠	9 ♣	9 ♦
Condition 1	11	7	2	0	0	1	2	0
Condition 2	0	0	0	0	0	12	1	12
Condition 3	0	0	0	0	0	12	1	12

* According to the design, the third player should notify the first player (teammate) that a club should be played first in the next round. However, it was found in the results that there were three interpretations of the strategy: 1. Some participants played k ♦. 2. Other participants played Q ♠.3. Few participants played J ♣. Participants played these three cards to notify the first player (teammate) that a club should be played first in the next round.

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