Project Management: A Socio-Technical Perspective

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

This dissertation presents a study on project management and its effectiveness in a multinational pharmaceutical company (MPC). A mixed qualitative-quantitative method consisting of a case study (33 managers) and a follow-up survey (122 employees) was conducted. The cybernetics theory and its related concepts were used to formulate the social and technical components of projects as a network of task-related social interactions within an organizational context. Interaction was defined as the variety or possible states one node generates for another node, while degree of coordination was defined as the extent to which a recipient node can handle the variety of interrelated nodes. Interaction Effectiveness (IE) was calculated based on the ratio of "helpful" to "not so helpful" behaviors between interrelated nodes. MPC's average organizational IE ratio of 1.03 was used as a baseline to determine the relative effectiveness of different interactions.

The IE ratio also revealed two structural network properties. First, a departmental-level analysis indicated that most network relationships were asymmetrical (76.5%), reflecting a significant discrepancy in perceptions between interrelated nodes. Second, the variability of IE ratios (standard deviation) ranged from 0.10 to 1.28, reflecting the degree of consistency among the relationships of each single node and its interrelated nodes. The results of a multiple regression analysis indicated a significant relationship between the perceived ranking of a node's performance and the node's IE ratio. Multiple regression analysis also indicated a significant relationship between the perceived ranking of a node's importance and the total of that node's helpful and not so helpful comments. Finally, the results showed that the IE ratio was almost double for employees' positive working relationship links compared to links with which they reported negative working relationships.

The qualitative findings also provide significant evidence of the method's sensitivity to capture project management's most crucial element of "time." Categorizing the impact of not so helpful comments corresponded mostly to "delays" (68.87%), whereas the impact of helpful comments

corresponded mostly to “saving time” (68.14%). Furthermore, categorizing decisions to handle variety revealed the dominance of “adhocracy” mechanisms (62.18%) to handle input variety as opposed to “procedural” variety handling mechanisms (20.63%). Categorizing the comments related to the not so helpful category of “unreasonable expectations” indicated that 51.4% of all comments pertained to “role overload” followed by “role conflict” (36.5%), with only 12.1% of all comments corresponding to “role ambiguity.”

The quantitative follow-up survey’s primary objective was to test the research hypotheses regarding the relationship between “variety”-related concepts and different degrees of project complexity (complex versus simple). The survey supported all hypotheses except Hypothesis 7 regarding project management software.

Results, limitations, potential improvements to the current study, and future research directions are discussed.

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Dedication

For my parents and family

You have given me so much.

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Chapter 1
Introduction

In practice, project management is a problematic endeavor, with many projects suffering from late delivery, cost overruns, and dissatisfied customers (Shenhar & Dvir, 2007; White & Fortune, 2002). The process of managing projects is becoming more complex with hundreds, sometimes thousands, of interrelated tasks. Further, project environments are becoming more difficult to handle and predict, particularly with ongoing, dramatic changes in technology and compressed product life cycles.

Despite the rapid growth of project management in private and public organizations through training courses and specialized software, project management is not yet widely recognized as a formal or established academic discipline as are subjects such as marketing, finance, and operations research (Turner, 2006). While a vast literature stream exists on various aspects of project management, only rarely are attempts made to build theory (Shenhar & Dvir, 2007; Snider & Nissen, 2003; Belout, 1998; Pittman, 1994). In this context, establishing project management as a well-recognized field depends first on critically assessing the current state of project management research.

Many research studies in project management suffer from three major drawbacks. First, the project management literature is fragmented into many studies that focus too narrowly on a certain aspect of project management at the expense of other considerations. For example, quantitative studies may emphasize the technical dimensions of the project management process, but overlook its social properties or vice versa. Lacking a precise, holistic view of the project management process can result in oversimplifying the entire process, and in some cases, can generate sub-optimal project or research results.

Second, although project management as an activity is well recognized, some researchers have asserted that project management theories remain somewhat underdeveloped (Shenhar & Dvir, 2007; Winter et al., 2006). Indeed, Packendorff (1995) asserted that research literature on managing projects has failed to establish theoretical explanations for problems such as deviating from plans, cost overruns, and conflicts within or between projects. In addition, much of the project management literature features inconclusive conceptual models and conflicting empirical results. This could well be the result of absent theoretical explanations.

The third weakness is the abundance of "inward-looking" perspectives when analyzing different aspects of project management (Packendorff, 1995; Winter, Andersen, Elvin, & Levene, 2006). Researchers often build their work on previous studies in the field and ignore potential contributions from other disciplines (Shenhar & Dvir, 2007). Furthermore, a significant number of theories and research with potential value for project management fall outside the field itself, but should be examined and integrated. In this context, Cunningham (2001) asserted:

> It is noteworthy that most literature references describe general trends, accepted practices, and conventional explanations. The continuing reliance on the literature and experts amounts to reshuffling old ideas already in the field. This, by definition, is limited by however we might be able to recombine these ideas, the result being a new permutation of old ideas, at best. (p. 65)

One promising way to understand project management activities better is to study project management-related interactions from a socio-technical perspective. The socio-technical approach examines interactions among people, tasks, and technologies simultaneously (Bostrom & Heinen, 1977; Griffith & Dougherty, 2002; Pasmore & Sherwood, 1978; Shani, Grant, Krishnan, & Thompson, 1992). Socio-technical interactions are central to studying project management, yet only a few serious studies have tried to capture these complex interactions. It appears that the socio-technical approach is not adopted widely in the project management field because many of its related concepts (e.g., joint optimization) are underdeveloped and lack well-developed methods to capture and analyze complex interactions successfully.

To date, very little research (if any) has examined project management-related interactions from a qualitative perspective. The basic objective of this study, therefore, is to develop an in-depth understanding of project management-related interactions and what governs such interactions. To this end, this study encompasses three primary objectives. First, this study presents a dynamic theory of task-related interactions within complex social networks of interdependent organizational roles. This study's theoretical development draws from the cybernetics theory – specifically Ashby's Law of Requisite Variety – to explore the conditions under which nodes may relate both positively and negatively to other interdependent nodes. Second, this study presents a specific methodology that reflects the degree of coordination on patterns of interactions between any two nodes in a task-related social network. This methodology draws from the original work of Bavelas (1942). Third, this study presents relevant quantitative and qualitative results from a field study in which the proposed theoretical framework is used. The data for this study was extracted from a multinational pharmaceutical company (hereafter referred to as MPC) in the context of developing new pharmaceutical products (e.g., manufacturing, testing, distributing, and marketing).

This dissertation is structured as follows. Chapter 2 reviews the existing literature on different approaches to project management to understand how socio-technical analysis might contribute to the field. Chapter 3 discusses the study's theoretical background based on the cybernetics theory. Chapter 4 presents a method based on the "Echo" method that Bavelas (1942) developed to measure the degree of coordination on patterns of interactions between any two nodes in a task-related social network. Chapter 5 explores an in-depth case study in which the theoretical framework is used. Chapter 6 presents the results of a follow-up survey in which the seven formal research hypotheses are tested. Chapter 7 synthesizes and discusses the results of the qualitative and quantitative studies to extract coherent meaning from the results. Finally, Chapter 8 presents this study’s major conclusions. In addition, limitations of the current study are discussed along with recommendations for future research.

Chapter 2
Literature Review

This chapter investigates different research approaches to uncover assumptions and fundamental questions related to the project management field. The project management field suffers from scanty literature review studies that examine the field's trends in detail (see e.g., Baker & Wilemon, 1977; Crawford, Pollack, & England, 2006; Kioppenborg & Opfer, 2002; Pollack, 2007). In addition, none of the literature review studies has developed a method to analyze and evaluate the paradigms, trends, and approaches that characterize the project management field as a whole. To aid the analysis, we divide the field of project management into five approaches: 1) technical, 2) social, 3) cookbook, 4) critical success factor, and 5) socio-technical. These categories may not be mutually exclusive; however, they do provide a broad conceptual foundation to help understand how researchers with different backgrounds approach project management, often using multiple and sometimes incompatible methodologies. The objective of organizing the literature by approaches rather than traditional taxonomies (e.g., size, type, industry) is to gain greater clarity on what is happening in the field as a whole. In the following sections, we describe and evaluate each approach.

2.1 Project Management Research Streams

2.1.1 Technical Approach

The first stream of research describes project management as a set of models and techniques derived from the operation research and applied mathematics concepts (Packendorff, 1995; Pinto, 1998; Söderlund, 2004). Project management is viewed as a set of tools used to plan, organize, monitor, control, and report projects. Oisen (1971) provides an example of the technical definitions of project management when he refers to project management as "the application of a collection of tools and techniques (such as the CPM and matrix organization) to direct the use of diverse resources toward the accomplishment of a unique, complex, one-time task within time, cost, and quality constraints" (quoted in Atkinson, 1999, p. 337). Similarly, Page (1989) defines project management as "a set of formal analytical procedures that are useful in project planning and implementation" (p. 494), and Turner (1993) defines project management as "a body of knowledge of tools and techniques" (p. 10). These definitions all share the view that the main purpose of project management is to apply quantitative techniques to achieve desired outcomes.

This approach is based on the assumption that better planning and controlling techniques will improve project management performance. In other words, the solution to project management problems is in the development of more efficient algorithms (Sculli & Wong, 1985; Woodworth, 1989). The literature is replete with proposed project management techniques, so it may be difficult to identify the core techniques that best represent project management. However, many researchers argue that only the most basic techniques are used in the field, including Work Breakdown Structure (WBS), Gantt Charts, PERT/CPM networks, Project Crashing Analysis, and Trade-off Analysis (Packendorff, 1995; Page, 1989).

Many researchers assert that project management research is biased towards technical, quantitative, and hard-system approaches (Baker & Wilemon, 1977; Belout, 1998; Turner, 2003). The dominance of the technical approach to project management may be explained by the heavy influence of the construction field (Crawford et al., 2006).

Both scholars and practitioners have long recognized the shortcomings of traditional project management tools and techniques (Pittman, 1994). Many researchers question the assumptions of traditional project management techniques. Some assert that research in project management tends to view projects and organizations as mechanistic systems and that the machine metaphor dominates project management literature (Pollack, 2007; Sauer & Reich, 2007). This mechanistic view of project management assumes that machines are more efficient and rational than humans, and thus humans should act as machines (Kendall & Kendall, 1993; Packendorff, 1995). The historical roots of this view can be traced to the beginning of management theory, and especially to Taylor's Scientific Management approach in which the time and motion study is replaced with linear programming or PERT, and the stopwatch is replaced with a computer (Leavitt, 1965). Ultimately, techniques that employ machine-like behavior tend to focus on technical aspects of the system to the exclusion of its social properties (Ackoff, 1981a; Griffith & Dougherty, 2002).

The mechanistic approach is predicated on the notion that the project manager's role is to develop and strictly adhere to a perfect plan (Dvir, Raz, & Shenhar, 2003). Pollack (2007) argues that the mechanistic view of project management assumes a strong causal connection between management actions and organizational outcomes. Thus, perfect predictions are now possible based on deterministic casual laws (Ackoff, 1979; Jaafari, 2003). For example, Kerzner (2006) states that, "If project planning is performed correctly, then it is conceivable that the project manager will work himself out of a job because the project can run itself" (p. 17). This view implicitly considers plans to be developed and executed in a "vacuum," and what may be useful for analytical purposes cannot be applied to real projects because it oversimplifies the organizational situation (Ayas, 1996; Gabriel, 1984; Jensen, Johannson, & Lofstrom, 2006). Strengthening this conclusion, Pollack (2007) points out that empirical evidence supports the notion that it is impossible to maintain a complete and fully up-to-date plan. Furthermore, Mintzberg, Quinn, & Voyer (1995) stress that organizations deal with dynamic situations in which realized (final) plans are not originally intended (initial) plans, but rather a mix of emergent and intended plans. In this way, it is not surprising that "inadequate planning" is the first reason for project failures in at least 36 studies (Nikander & Eloranta, 1997). By the same token, risk-management techniques fail to anticipate real future threats because risk analysis is a static, one-time procedure undertaken at the beginning of the project (Nikander & Eloranta, 2001).

This may explain why risk-management tools are not often used in practice (White & Fortune, 2002). It follows that traditions and assumptions in project planning should be reevaluated since it is insufficient "to prepare perfectly for an imperfectly-predicted future" (Ackoff, 1979, p. 100).

A further step that could be taken in comprehending the evolving nature of projects is to develop adaptive plans that will improve project managers' flexibility to handle their dynamic environments (Ackoff, 1981b; Kenny, 2003; McKay & Wiers, 2004; McKay, Safayeni, & Buzacott, 1988; McKay, Safayeni, & Buzacott, 1995a; McKay, Safayeni, & Buzacott, 1995b; Mintzberg, 1973). It is worth noting that between 1999 and 2003 keywords such as "complexity" and "emergent" appeared frequently in project management journals (e.g. International Journal of Project Management) (Crawford et al., 2006). A better understanding of the emergent nature of project management will lead to improved strategies for managing projects, and will be particularly useful for projects with ambiguous requirements (Duimering, Ran, Derbentseva, & Poile, 2006; Khurana & Rosenthal, 1997; Pollack, 2007).

Most traditional project management techniques are "deviation management" oriented, tasking the project manager with detecting and correcting any significant deviations between planned and actual situations. However, "deviation management" has resulted in actions that are more reactive than proactive (Thamhain, 1987). In many cases, it may be too late to correct problems by the time they are detected. Also, deviations from the plan may not provide adequate information for identifying the causes of the problem (Kerzner, 2006). Project management techniques are needed that reflect future dynamic situations instead of focusing on historical data (Nikander & Eloranta, 1997; Nikander & Eloranta, 2001).

Another major criticism of most quantitative techniques is that they assume a linear project management process based on the premise that activities can be ordered in the form of sequential interdependencies (Duncan, 1979; Jaafari, 2003; Packendorff, 1995; Sonawane, 2004). In reality, most projects – especially complex ones – are non-linear systems with many reciprocal interdependencies (Duimering et al., 2006). Tasks in a Gantt chart, for example, are assumed to be sequential, meaning that as tasks start, work is assumed to continue until all tasks are completed. Such a representation makes it difficult to represent tasks that need to be "reworked," or to include even the simplest reciprocal task relationships.

Another major problem with most traditional project management techniques is in the close system representation of project management, which overlooks or underestimates the impact of the environment. White & Fortune (2002) consider that 70% of the side effects of traditional project management techniques can be linked to ignorance of the changing environment. In a close system, projects function relatively stably, and the primary goal of the project manager is to develop optimal plans and ensure everything is going according to plan. However, in real projects (i.e. open systems), interactions occur between the project management system and its environment (where raw materials are imported and finished products or services are exported) but with no control over the environment (Augustine, Payne, & Sencindiver, 2005; Lawler, 1976; Pasmore & Sherwood, 1978). All organizations function in a continually changing environment (Bavelas, MacGregor, & Safayeni, 1983). These continuous changes can manifest in rapid and discontinuous changes in demand, competition, and incomplete information (Belout, 1998; McCray, Purvis, & McCray, 2002; Pinto & Slevin, 1987). For organizations to survive, then, a relationship must exist with the larger systems of which they are a part (Scott, 1987), and it must be recognized that any changes in the environment will directly affect project performance (Pasmore & Sherwood, 1978). Moreover, the effects of environmental factors on projects are often nonlinear, further complicating the process of managing projects (Milosevic & Patanakul, 2005).

The continuous increase in project complexity appears to be a major driving force in the continuous development of tools and techniques designed to help managers plan, make decisions, and control project tasks. In general, traditional project management techniques handle complexity through the hierarchical decomposition of tasks (i.e. WBS) into smaller, simpler, and controllable sequences of actions (De Wit & Herroelen, 1990; Duimering et al., 2006; Hegazy, 2002; Plasket, 1986; Project Management Institute [PMI], 2004; Pinto, 1998). These decomposed chunks of tasks are later reconstructed and integrated to represent the whole project. The decomposition process is based on the assumption that even though the overall project may be unique, many of its subtasks have been experienced before (Sonawane, 2004). From this perspective, the better the parts are structured, the better the whole (Packendorff, 1995). However, this view fails to consider that even though partial tasks may be predicted accurately, reintegrating interrelated and interdependent subtasks may produce different estimates when compared to the sum of the parts. As Kurt Lewin stated: "Dynamic wholes have properties which are different from the properties of either parts or the sum of their parts" (quoted in Cunningham, 2001, p. 91). Ackoff, (1979) concurs, asserting that systems are wholes that lose their essential properties when taken apart. Tasks should be explained in terms of their functions in the system, not as independent parts. Ackoff (1979) further argues that optimal plans in dynamic environments cannot be extracted from decomposition processes since these plans depend on how subtasks interact with each other and not on how subtasks act independently. Consequently, the decomposition process can result in abstractions that are loosely related to reality (Ackoff, 1979; Ackoff, 1981a).

A considerable amount of project management research proposes various models and techniques designed to develop optimal plans (e.g. Gerk & Qassim, 2008; Gong, 1997; Rao, Kestur, & Pradhan, 2008; Yang, 2007; Zhang, Li, & Tam, 2006). Such ostensibly optimal plans developed by traditional techniques may not, in fact, be optimal solutions since their underlying models are imperfect representations of the project situation (Ackoff, 1979; Pinto & Slevin, 1987; Posner, 1987). Thus, optimal solutions from such models are seldom adaptive to changes and therefore their optimality is generally short-lived (if it exists at all) (Ackoff, 1979; McKay et al., 1988). Furthermore, WBS can fall apart when used to plan ambiguous projects (e.g. new product development, R&D, organizational restructuring projects) since it assumes tasks and goals are clear and well defined in advance (Duimering et al., 2006; Dvir et al., 2003; Kenny, 2003; Packendorff, 1995; Pich, Loch, & Meyer, 2002; Turner & Cochrane, 1993).

The decomposition process in project management assumes that more detailed plans allow more control (Pollack, 2007; Clarke, 1999). For example, Pinto (1998) states that project plans are a bureaucratic step in the project management process to ensure full control over the project. An overly detailed WBS, however, suffers from two problems. First, updating too many subtasks is time-consuming and can drown project managers in a sea of details (Clarke, 1999). Mintzberg (1973) states that “one can imagine the analyst working in a large war room surrounded by walls covered with PERT or Gantt Charts. Under this system, the manager continues to supervise his projects, but he is relieved from the difficult job of keeping track of their progress” (p. 159). Second, WBS as a tight control system, may result in dysfunctional behaviors by project members (Lawler, 1976). These behaviors can occur when people act in ways that will help them appear good on the control system (e.g. WBS) even though those behaviors do not help achieve project goals.

An alternative view of the decomposition process can be found in the concepts of System Dynamics, which is based on the premise that better understanding of interrelationships within complex dynamic systems can be achieved by first capturing the system’s underlying characteristics and influences and then modeling, simulating, and quantifying them to better design policies (Rodrigues & Bowers, 1996a; Schwaninger & Rios, 2008). Furthermore, to better understand interrelationships between different subsystems, all subsystems should be examined at a holistic level and all feedback loops should be incorporated (Rodrigues & Bowers, 1996b).

The System Dynamics approach to project management offers generic and high aggregation-level views of the whole management process but lacks strong concrete and operational support to specific situations (Rodrigues & Williams, 1998). In other words, it might be difficult to incorporate and translate such generic strategies into immediate actions at an operational level since they ignore the detailed logic of the work structure (Williams, 1999). Some researchers assert that the System Dynamics approach does not offer a complete methodology to design task structures that include the division and distribution of tasks and functions (Schwaninger & Rios, 2008).

In short, traditional project management techniques are threatening to become increasingly irrelevant, unless newer models are developed to handle project complexity (Jaafari, 2003). Cunningham (2001) argues that the focus on rational methods as a means of solving problems may explain why many studies lack insightful discoveries. Other researchers assert that many project management techniques are applied in fashionable and superficial ways with too little connection to real practice (Crawford et al., 2006). In the worst cases, "all [project management] models are wrong, but some are useful" (quoted in Winter, Smith et al., 2006, p. 643). A more optimistic view would be that traditional project management tools and techniques might offer partial solutions to project problems instead of solving problems in their entirety. That is, traditional project management techniques are useful in managing relatively well-defined projects in relatively stable environments (Pollack, 2007), but there is a need for new methods to handle "real projects that are more complex, unpredictable, and multidimensional than the rational, deterministic model which dominates the literature" (Winter, Smith et al., 2006, p. 644). Researchers should adjust techniques to fit real problems instead of searching for problems that fit the techniques (Mintzberg, 1973).

2.1.1.1 Project Management Software

Project management software can be seen as a subset of the technical approach since almost all traditional techniques are incorporated in software packages (e.g. Primavera, Microsoft Project).

Many researchers believe the dynamic and heterogeneous nature of project management elements, the interdependence of various participating entities, the complexity of projects, the need for flexibility, and the high degree of coordination required suggest information technology has great potential for managing projects (Doloi & Jaafari, 2002; Fox & Spence, 2005; Fox, 2000; Hegazy, 2002; Hegazy & El-Zamzamy, 1998; Matthews, 1987; Thamhain, 1987). The use of project management software is growing in all industries (Liberatore, Pollack-Johnson, & Smith, 2001), and many project managers use such software for planning (95%) and controlling (80%) projects (Liberatore & Pollack-Johnson, 2003). The dependency on project management software increases as the size and complexity of projects increase (Allnoch, 1997; Liberatore & Pollack-Johnson, 2003; Pollack-Johnson & Liberatore, 1998). Page (1989) concludes that project management software packages are of great value since they force users to develop detailed plans in the early stages of the project. In addition, the software may be used as a communication tool among project team members. Moreover, tracking project progress is easier through the software since it can automatically recalculate the whole plan whenever a change is made to one part of the plan.

The development and use of project management software packages emerged as a trend in the 1970s (Kioppenborg & Opfer, 2002). Research to date has focused on increasing the level of flexibility and improving ease of use, but it has paid little attention to the conceptual models embedded in the software (Liberatore et al., 2001). In general, while project management software packages may differ in some advanced features, they generally share the same underlying concepts (Bobrowski, 1989; Davis & Martin, 1985; Liberatore et al., 2001). Although project management software packages facilitated the use of traditional project management techniques, they have not led to conceptual breakthroughs (Page, 1989). Therefore, more investigation should be conducted to explore the nature of project management software packages and how they help and/or hinder project management (Metcalfe, 1997; Pollack-Johnson & Liberatore, 1998). For example, adopting automated systems (e.g. project management software) may result in a reduction in the quantity and quality of social interactions in the management process (Safayeni, MacGregor, Lee, & Bavelas, 1987). Since the conceptual models of project management software discussed in the technical section form the basics of any project management software, the rest of this section will discuss software-related issues.

Most literature about project management software is descriptive, with over-enthusiastic and unrealistically optimistic evaluations (De Wit & Herroelen, 1990; Kidd, 1990; Liberatore & Pollack-Johnson, 2003). The literature concentrates on technical reviews and comparisons of specific packages and fails to offer any critical examinations of the impact of such software on the project management process. In addition, the software selection process is usually feature-driven and based on advertisements instead of being business driven and based on project management requirements (Bienkowski, 1988; Hegazy & El-Zamzamy, 1998; Metcalfe, 1997; Wasil & Assad, 1988). Huge investments continue to be made in project management software packages, but there is a significant divide between the promises some software developers offer and the outcomes delivered. Too often project managers make the mistake of believing that mastering project management software will result in the successful planning and controlling of projects (Allnoch, 1997; Fawcette, 1984; Fox, 2000; Gruber, 1991; Plasket, 1986). Similarly, some project managers feel confident about budgets and schedules advanced software packages produce, even though some estimates such software provides have proven to be inaccurate (Woodworth, 1989).

On an abstract level, project management software can be defined as a set of predefined assumptions and preconditions about what projects are and how they should function (Matthews, 1987). Mintzberg (1973) defines complex computer programs as “a set of closed routines tied together by an executive program” (p. 136). Beer (1981) defines computers as machines with programmed algorithms. He further defines an algorithm as “a technique or a mechanism which prescribes how to reach a fully specified goal" (p. 52). Beer (1967) argues that software is often an automated replacement of the organization's existing procedures.

In this context, project management software will not be presented as a series of computer programs but as a set of predefined assumptions about the project management process. Hughes (1986) asserts that the objective of software is to model reality in a way that will help managers handle the project. However, some managers deal with the modeled project in the software as a true representation of reality, accepting data from the software at face value. This can lead some managers to become "software managers," coping with a static system instead of handling dynamic situations. Some researchers have shown that managers using such software will be distracted from monitoring real problems to focus on derivatives of real problems (Thamhain, 1987). In the most extreme cases, the project representation in the software becomes the goal instead of the means (Clarke, 1999). In these cases, the tool may be used to justify and legitimize poor performances as they appear in the software instead of correcting real problems (Woodworth, 1989). As formal communication tool (Matthews, 1987), the software may be used to construct positive images of project performance (Gasser, 1986; Thamhain, 1987). Language ambiguity can allow for reporting events in ways that will maintain a positive image of the project even though it may be failing in reality (Duimering, 1998; Duimering & Safayeni, 1998). For example, managers may input false feedback in the software to show that the unit has met a plan, where, in reality, they missed it (Mintzberg, 1979).

One may argue that project management software packages are flexible tools that can cope with unexpected changes in the project management situation. However, the flexibility of any technology is limited to the predefined range of possibilities programmed in them (Duimering, Safayeni, & Purdy, 1993). This is why some researchers view project management software as a static tool adopted to shoot moving targets (Thamhain, 1987). Consequently, users may feel the need to "work around" such "bureaucratic" software to overcome its inflexibility (Hamilton, 1998). Workaround practices use software in ways for which it was not designed to overcome the software misfit (Gasser, 1986). Nevertheless, careful attention should be given to workaround practices since some managers perceive them as "irrational" actions that contradict formal organization practice (Gasser, 1986). Part of workaround practice may be explained by the fact that project management software packages are information-hungry tools that require users to quantify all tasks, schedules, and costs at early stages (Rushinek & Rushinek, 1991). This may explain why some project managers rely more on their own intuition to generate "best guesstimates" instead of relying on the output of quantitative models (Hughes, 1986; McCray et al., 2002). However, since project management software may be perceived as a rigid tool that acts as a constraint, some researchers suggest that their contribution to the project management field may continue to be limited (Matthews, 1987).

These limitations in project management software may explain why project managers rank such software as the tool with the most drawbacks, especially when applied to complex projects (White & Fortune, 2002). Overall, project management software supports a structured, analytical, and systematic approach to project problems (Fox & Spence, 2005). Thus, its applicability is most useful for structured tasks where decisions can be set in advance with minimal environmental impact on the project. Furthermore, the limitations of the project management software become more apparent as project complexity and uncertainty increases (Kidd, 1990). Thus, the software is most useful for stable situations that behave like the programmed models in the software. However, a structured and systematic tool lacks the ability to handle unpredictable and dynamic situations that are commonplace in reality.

2.1.2 Social Approach

As the previous section illustrates, the technical approach to project management is the dominant perspective in the field. However, individual and organizational behavioral dimensions of project management processes are increasingly attracting more attention. Many researches assert that the primary problems of project management are not merely technical, but also human (Belout & Gauvreau, 2004; Hegazy, 2002; Packendorff, 1995; Posner, 1987). Despite this view of social aspects of project management, some researchers argue that human issues are still overlooked (Belout, 1998; Laplante, 2003; Metcalfe, 1997). This shift towards a more social approach to project management is based on the premise that project outcomes can be enhanced by first changing the behaviors of those involved in the process. The main areas of interest are organizational culture, organizational support, organizational commitment, learning, leadership, decision making, team building, knowledge building, conflict management, and communication skills (e.g. Bresnen, Edelman, Newell, Scarbrough, & Swan, 2003; Brookes, Morton, Dainty, & Burns, 2006; Jackson & Klobas, 2008; Johns, 1999; Nordqvist, Hovmark, & Zika-Viktorsson, 2004; Wang & Armstrong, 2004; Wong & Cheung, 2008). However, many human side studies have fallen short of their potential since they lack an accurate representation of real project management situations.

Project managers are frequently the focal point of social approach studies, but many of these have overestimated the project manager's role where he/she is considered the central project management contributor to the project management process (e.g. Globerson & Zwikael, 2002; Styhre, 2006; White, 2006; Wright, 1997). For example, Kerzner (2006) states that, "if the project manager performs well, the project will be successful" (p. 19). Blackburn (2002) offers a succinct review of how more optimistic literature views the project manager as a "hero by whose skills and actions the successful project is delivered" (p. 199). Dinsmore (1984) offers an instructive reminder that "the stereotyped character called the project manager in the literature may not exist at all … the project manager as cited in professional publications is perhaps only a model or a prototype against which individuals in project management positions can compare themselves" (p. 119).

A better understanding of project reality shows that projects are managed by networks of effective interactions involving all related groups and individuals, not merely project managers. Thus, the solution to project management problems is not in increasing the authority of project managers as some authors propose (e.g. Dinsmore, 1984), but by ensuring that each member in the project management network functions effectively and his/her interactions are coordinated properly to achieve desired project outcomes. This holistic view of project management processes will lead to a deeper understanding of project reality instead of the "one-man show" fallacy many social studies promulgate.

As previously mentioned, the "technical" approach to project management suffers from a myopic focus on technical components of the project system, with little consideration for the social context. In the same way, many social studies of project management often lack a clear specification of the larger technical task contexts of a project, which may either constrain or facilitate both role behavior and social relations among project participants. For example, "coordination" between project management members is considered a key factor to the success of any project (Jha & Iyer, 2007), but is discussed in the literature with little reference to the important technical aspects of coordination. Neil (1993) defines coordination as "unifying, harmonizing and integrating different agencies involved in any industry with multiple objectives" (quoted in Jha & Iyer, 2006, p. 314). However, if an individual or group in the coordination process does not have the capacity to carry out the task, coordination cannot succeed. Capacity, in this context, is a technical component of the process since it requires technical knowledge, skills, or resources. Seen in this light, coordination is not only "harmony integration," but also the technical ability to perform a required task.

Conflict management is another popular topic since projects consist of heterogeneous groups acting within time, budget, and resource constraints. Cheung & Chuah (1999) posit that cultural and traditional values play an important role in project managers' choice of conflict- resolution strategies. For example, Chinese project managers are predicted to adopt a "withdrawal" approach to conflicts, because Chinese culture values relationships with others and "being a friend rather than an opponent"

(Cheung & Chuah, 1999, p. 398). Ma (2007), however, argues that studies on conflict management styles across cultures suffer from two flaws. The first is that most studies are inconsistent in the terms they use to classify conflict-management styles. The second flaw is that most studies lack actionable knowledge. In other words, these studies fail to answer simple questions such as 'so what?'. Ultimately, conflict resolution should be examined in the context of organizational situations instead of focusing only on managers' values.

Psychological variables such as trust have been considered as a major influence in many social studies of project management. Some researchers believe higher levels of trust among team members will lead to better project performance and facilitate project success (Kadefors, 2004; Munns, 1995; Shek-Pui Wong & Cheung, 2004). In the context of project management, "trust" is "a decision to become dependent on another in return for the possibility of a shared positive outcome" (Munns, 1995, p. 19). The tension here is that projects have time constraints while trust requires a relatively long period to build up and share. Munns (1995) argues that initial opinions among team members in the early stages of a project will shape the project's outcomes. However, this social discussion of project management, like that of many other social studies, lacks a clear technical context that constrains and facilitates social relationships among project participants. In the same way, "trust" concepts in project management may be challenged by the question "in relation to what?" For example, a project manager may trust a functional manager's technical knowledge, but not his/her estimates about the budget for a specific task.

To conclude, the main focus of research on the human side of project management should be the way people *actually* manage projects, as opposed to how people *should* manage projects (Packendorff, 1995). With no clear understanding of actual project management, little can be safely prescribed to project managers and teams. There is a need to answer the basic question: what do managers do? (Mintzberg, 1997) By focusing on projects' realities, managers can solve real project problems rather than imagined ones within ideal situations (McKay, Safayeni, & Buzacott, 1995a).

2.1.3 The Cookbook Approach

The thrust of most project management "cookbooks" is to provide practitioners with a more user-friendly reference of project management with less technical jargon. A fair amount of project management books, which are considered "cookbooks" in this study, approach project management concepts based on non-technical discussions, personal experiences, and 'dos and don'ts' lists. Some researchers argue that this approach is important since project managers do not have the luxury of thinking about the philosophical backgrounds of project management (Turner, 2003). Many "cookbook" authors claim that most academic research develops concepts about managing projects that might be theoretically attractive but are dramatically inconsistent with real project management situations. For example, Kyle (1998) argues that most academic books are "dry textbooks" that do not fit project managers' needs in the field, and tend to complicate simple subjects. Seen in this light, academic studies are difficult to utilize and are sometimes irrelevant. Clearly there is a gap between theory and practice in project management, but the question of whether or not these books have any real value for dealing with actual project management situations remains.

The primary weakness of many cookbooks, from an academic perspective, is their lack of academic creditability. It is common to read a whole book with not one conceptual framework or reference (e.g. Heerkens, 2005; Kemp, 2006; Kyle, 1998; Mingus, 2003; Portny, 2006). Most "cookbooks" have failed to explain how suggested rules and guidelines were developed, and there are rarely any supporting references to empirical studies. Many of the written "rules" may be considered subjective. For instance, Newell & Grashina (2004) assert that in the process of constructing a WBS, all elements of the WBS should be relatively the same size (i.e. if a task is broken into four subtasks at one level, all other tasks at the same level should be broken into four subtasks). But it is unclear what empirical evidence was used to arrive at this conclusion. Similarly, it is common to read that the minimum time allocated to the planning of any project should be five percent of the project's duration (Cook, 2005) without any reference to how such a rule was derived. With no clear conceptual frameworks, some guidelines are difficult to follow. For example, Heerkens (2005) states that, "as a project manager, one of your jobs is to form the team into a unified, single-minded unit with a focused project objective" (p. 32). The extent to which such advice is practical or even realistic raises a different set of drawbacks altogether.

The cookbook approach oversimplifies project management processes. Filled with universal rules, "magic formulas," and "one-size-fits-all" methods to project management, these books show the basic premise: "no matter how simple or complex the project, however, the process is the same" (Portny, 2006, p. 14). A fair number of cookbooks tend to be over-optimistic in describing project management processes and related techniques (e.g. Kemp, 2006; Kliem, 2002; Murray, 2002; Portny, 2006). For example, Portny (2006) claims that "most complex analytical techniques take less than ten minutes to master" (p. 2); while Kemp (2006) notes that "estimating is easy, but most people think they'll never get it right" (p. 63); and Newell & Grashina (2004) state that "doing a work breakdown structure is one of the simplest things that you will do as a project manager" (p. 32).

In this context, oversimplification pervades the entire project management field. McGhee & McAliney (2007) assert that project management is an easy journey since "we'll take you through the basic steps in order, like an easy-to-follow recipe" (p. 1). In the introduction to Painless Project Management, McGhee & McAliney (2007) state how "easy" and "simple" project management is. "Painless Project Management makes it simple by cutting through the jargon, formulas, and needless complexity with an easy, step–based approach for managing virtually any project, big or small, from beginning to end". Kyle (1998) writes that his book "is a demonstration of how simple [project management] really is," while Tedesco (2006) explains that as a project manager "you will learn new concepts that are easy to adapt to your current management process because they don't really change the way you do business now; they simply add to it or simplify what you do."

Clearly, the most influential drivers in cookbooks studies are simplicity and ease, and it follows that many cookbook authors claim that anyone can master project management simply by reading their book. This argument implies that project management can be reduced to a purely cognitive skill, but the reality is that awareness of such concepts – assuming they are accurate – is not enough to help project managers and teams deal with real project management situations. Management should be taught through practice and feedback (Mintzberg, 1997).

Perhaps one of the most alarming facts here is that many, if not all, "cookbooks" depend on personal observations devoid of theoretical foundations. Most studies are situation driven, causing the reader to focus on isolated parts of project management processes instead of focusing on the overall process. Many "cookbook" authors cite their years of experience as evidence of their credibility, but such experience is rarely used to offer justifications for their straight answers to project management problems (Packendorff, 1995). In short, cookbooks may be of some use in describing project situations, but are ultimately weak at drawing correct conclusions about these situations. Seen in this light, cookbooks could bring substantial advantages to the project management field if they reported actual project management events instead of proposing "quick and dirty" solutions that contribute little knowledge.

2.1.4 Critical Success Factors Approach

The project management literature is abundant with lists of critical success factors (CSFs) (e.g. Belout, 1998; Belout & Gauvreau, 2004; Cooke-Davies, 2002; Diallo & Thuillier, 2004; Westerveld, 2003). However, many CSF studies fail to define "success" rigorously (Fortune & White, 2006; Pinto & Slevin, 1988; Wateridge, 1998), leading to multiple and often contradictory meanings, interpretations, and concepts for different people. For example, a project may be perceived as a success for a project manager, yet as a failure by clients and vice versa (Belassi & Tukel, 1996; Freeman & Beale, 1992; Wright, 1997).

In the literature, the dominant criterion for success is completing a project within the constraints of time, cost, and performance (Belout & Gauvreau, 2004; Bobrowski, 1989; Cooke-Davies, 2002; Dvir, Lipovetsky, Shenhar, & Tishler, 2003; Globerson & Zwikael, 2002; Jang & Lee, 1998; Kerzner, 2006; Milosevic & Patanakul, 2005). Many researchers consider these triple constraints (i.e. time, cost, and performance) as an objective indicator, in contrast to other subjective factors in the field (Wateridge, 1998). The widespread acceptance of this definition of success may be attributed to the fact that the triple constraint is the easiest to quantify (Pinto & Slevin, 1988).

However, based on this definition of success, Gardiner & Stewart (2000) claim that almost all projects should be considered failures since they seldom finish on time and within budget. Moreover, adopting the triple constraint for measuring success may be problematic because it results in a local and “operational mindset” instead of a global, organizational view of success (Dvir, Sadeh, & Malach-Pines, 2006).

Can a project that fails to meet an unrealistic rigid budget and schedule be considered a failure? If a project manager overestimates project time and cost, enabling the project to finish ‘perfectly’ based on such poor estimates can the project be considered successful? Arguably, since each project is unique, how can perfectly accurate initial cost and time estimates even be developed? More to the point, how can rough initial estimates and premature plans be the dominant success factors in evaluating projects? Looking only at time, cost, and performance will not identify whether a project was managed correctly or not. It is possible to complete a project on time and within budget but with poor project-management practices (or vice versa) (Munns & Bjeirmi, 1996; Shenhar & Dvir, 2007). To be a useful criterion, success should be linked to both project management processes and outputs

(Atkinson, 1999). In short, success should be viewed as a dynamic concept that depends on the project situation and not on fixed measurements based on the triple constraint. This definition of success is influenced by project outcomes rather than the dynamic processes responsible for the outcomes. Thus, the triple constraint is not the right criterion, or at least not the sole criterion for success.

Some project management researchers define project success in terms of financial returns (Diallo & Thuillier, 2004). Others describe project success in terms of users' satisfaction levels (Lim & Mohamed, 1999; Pinto & Slevin, 1988). From this perspective, including customers in the success model is important because it adds an external dimension to success instead of focusing on internal measurements. Some definitions of project success are difficult to quantify or measure (Belout, 1998; Diallo & Thuillier, 2004). For example, some researchers define a project as successful if it is completed without changing the corporate culture or routines (Kerzner, 2006; Munns & Bjeirmi, 1996). In this respect, success can be considered subjective since it is based on individual judgments (Dvir et al., 2003; Hughes, 1986; Jha & Iyer, 2007; Jha & Iyer, 2006). With these multiple definitions of project success, future studies should redefine "success" by considering the uniqueness of a given project management context. Unless an agreed upon definition is developed, project success studies will continue to have limited influence on project management practice (Pinto & Slevin, 1988).

The premise of this approach is that successful projects behave in the same way and have common characteristics (Diallo & Thuillier, 2004; Dvir et al., 2003; Milosevic & Patanakul, 2005). Research in this area provides checklists of key project success factors project managers and members generate; each list varies in its objective and scope.

Pinto & Slevin (1987) describe the project success model as follows:

$S= f(x_1, x_2, \ldots, x_n)$

Where

S is project success, and

x_i is critical success factor i.

Pinto & Slevin (1987) argue that the project success model is based on two assumptions. First, each critical success factor is an independent variable. Second, each critical success factor positively relates to project success, but with no measurement of the strength of its relationship with project success. These assumptions will be discussed in later parts of this section.

It is worth noting that the confusion about CSFs in project management is widely reported in the literature, which is replete with project success factors (Pinto & Slevin, 1987). There is no consensus among researchers on what factors result in project success (Dvir et al., 2003; Fortune & White, 2006; Jha & Iyer, 2007; Jha & Iyer, 2006). Pinto & Slevin (1988) state that "there are few topics in the field of project management that are so frequently discussed and yet so rarely agreed upon as that of the notion of project success" (p. 67). Variance in CSF lists may be explained by the fact that many CSF studies are influenced by the research approach. On the one hand, if the research adopts a technical approach, success factors will be biased towards the project's quantitative measures. On the other hand, if the researcher is primarily concerned with social issues, success factors will relate more to the project's human elements.

Undoubtedly, every project team aims for success but, unfortunately, success is easier said than done. CSF studies provide little advice on how success factors can be applied and utilized (Clarke, 1999). These CSF studies answer the question: "What to do?" but provide no clear answer to the hard question: "How to do it?" (Pinto & Slevin, 1987; Wateridge, 1995). It seems the main objective of CSF studies is to identify success factors. However, awareness of success factors is not sufficient to enhance project performance. Some researchers argue that CSF studies provide comprehensive descriptions with superficial analysis (Packendorff, 1995). For example, a success factor such as "good communication" (Wateridge, 1995) includes nearly every transmission of information (e.g. e-mail, memo, face to face, telephone etc.) with no information regarding the attributes of “good” as they apply to each method of communication. In the same way, success factors such as “to develop realistic cost, schedule, and performance estimates and goals” or “keep changes under control” (Kerzner, 2006, p. 354) do not help project managers develop realistic estimates or even simple control mechanisms. Thus, these lists may be of little practical use to real project situations.

It is important to note that success factors are interrelated and interdependent; therefore, it is insufficient to list them as independent factors leading to project success (Fortune & White, 2006). Interrelated CSFs are even more prevalent in complex projects with more interrelated tasks (Westerveld, 2003). Thus, it is difficult in the context of complex projects to validate the presumption that a success factor is the true reason behind project success. Strengthening this conclusion is the fact that most CSF lists are often anecdotal and based on single-case studies with little empirical evidence (Pinto & Slevin, 1987; Wateridge, 1995). The project management field seems to abound with stereotyped success factors that are accepted at face value. Given the limitation in empirical validation, it is difficult to confidently conclude that some factors are definitely related to project success.

To conclude, the CSF approach contradicts basic project properties. Since projects are composed of “unique” tasks, how can we assume that success factors are transferable and applicable to many projects of different types and in varying contexts? (Belassi & Tukel, 1996; Dvir et al., 2006; Jha & Iyer, 2007; Westerveld, 2003). CSF studies should focus on constructing success theories instead of generating more factors (Glass, 1999). These factors need to be re-evaluated by scholars and practitioners to determine what is and what is not relevant to project success. Until then, the question of what critical factors really lead to project success remains open.

2.1.5 Socio-Technical Approach

The previous discussion reveals that one of the major shortcomings of most project management studies is the tendency to discuss the technical and social aspects of projects independently. This mode of thinking frames the issue as human elements versus technical components. The literature is filled with such statements. For example, Armour (2002) notes, “as an industry, we’ve spent an awful lot of time in the mechanism [technical] area. Maybe it’s time for a bit of the organism [human]” (p. 20). Neglecting the interactions between technical and social elements of project management, however, and simply examining each element as its own entity often results in sub-optimal project performance (Turner, 2003). Therefore, a better understanding of the interrelated and interdependent interactions of the technical and social variables of project management is needed. In this respect, the socio-technical approach to project management is promising because it simultaneously examines the interactions among people, tasks, and technologies (Bostrom & Heinen, 1977; Griffith & Dougherty, 2002; Pasmore & Sherwood, 1978; Shani et al., 1992).

The socio-technical approach can be traced to Trist & Bamforth’s (1951) classic study on coal-mining methods. This study’s primary objective was to show how technical system outcomes cannot be understood in isolation, but must include their related social context. Traditional mining was based on small groups of miners who worked together closely. Each group was required to work on different tasks; control over the work was handled internally (i.e., within each group). This social setting, however, was disrupted because a traditional manual method of cutting coal was replaced by a new mechanical coal cutter. This new method required employees to perform routine, standardized, undemanding, and isolated jobs. This technological disruption to the mining social system reduced productivity and increased absenteeism. The study’s main conclusion is that the effectiveness of any technical system depends on how well its social system actually copes with the system’s requirements.

In general, “socio-technical” has become a buzzword that is widely used without clear definition or methodology (Griffith & Dougherty, 2002; Majchrzak & Borys, 2001). Accordingly, researchers do not yet agree on the exact definition of socio-technical systems. In this respect, clarifying the basic definition of a socio-technical system may be essential to using this concept in the field of project management. At a basic level, it can be argued that whenever human and technical elements are implemented, socio-technical interactions will occur, whether intended or not (Herrmann, Hoffmann, Kunau, & Loser, 2004). The technical system can be defined as task requirements and formal procedures that include the technologies needed to achieve desired results. Social systems can be defined as task dependencies that require coordination and can lead to developing group social norms for task performance (Palvia, Sharma, & Conrath, 2001). In this context, social relationships are specified in terms of task requirements and task interdependencies (DeGreene, 1973).

The socio-technical approach helps analyze complex and dynamic relationships among people, tasks, and technologies because it addresses organizational settings in which people are required to perform tasks to produce desired outputs (Bostrom & Heinen, 1977; Griffith & Dougherty, 2002; Pasmore & Sherwood, 1978; Shani et al., 1992). Thus, to accomplish a project, the interdependent social and technical systems should be optimized jointly, as some researchers have previously proposed (Cherns, 1976; Pasmore & Sherwood, 1978; Scott, 1987). Other researchers have further asserted that the joint optimization process between the technical and the social system is complex because each system tends to be individually dissimilar (Scott, 1987). Social systems require flexibility and diversity, while technical systems require efficiency and control. This thus creates two difficult sets of tasks that are difficult to combine (Mumford, 2000). Both social and technical requirements, however, should be given equal weight because the means are as important as the ends and output cannot be achieved by either the technical system or the social system working alone (Mumford, 2000).

Some researchers have argued that joint optimization is a dynamic process that continues even after a solution is found. This facilitates a fit between an organization's social and the technical elements and includes the "fit between the resulting socio-technical structure and the human characteristics of people who enter it" (Katz & Kahn, 1978, p 701). As noted, many studies in project management focus on the technical components at the expense of related social systems, with only rare attempts to optimize both systems. That is, project tasks are designed based on the technical systems' requirements, and humans are expected to fit their social system to these technical specifications (Emery & Marek, 1962). The result is a reduced ability of the whole system to handle unpredictable events (Scott, 1987).

Many studies in project management do not explicitly apply a socio-technical approach; however, socio-technical results can be found in the literature (in substance, although not necessarily by name). Project management research with socio-technical results is mainly micro-level perspectives focusing on human-machine systems. Their main objective appears to be an examination of how computers affect people and how to design computers effectively. Examples of related areas with a similar objective include human-computer interaction (Weir & Alty, 1991); ecological design (Van der Ryn & Cowan, 2007); participatory design (Schuler & Namioka, 1993); contextual design (Beyer & Holtzblatt, 1998); situated cognition (Clancey, 1997); and cognitive work analysis (Vicente, 1999) to name few. It is worth noting that most socio-technical studies focus on designing better tools and techniques for human use and are related to project management software. For example, many authors have asserted that the technical features of project management software should be improved without losing "ease of use" and "user friendliness" (De Wit & Herroelen, 1990; Liberatore et al., 2001; Wasil & Assad, 1988). Similarly, Fox & Spence (2005) examined how differences in cognitive decision style influence how project management software is used. The study showed that project managers with a directive or an analytical approach to decision making performed better in terms of time and accuracy in developing plans through project management software than managers with a more conceptual or behavioral approach. On the negative side, White & Fortune (2002) found that many project management tools and techniques poorly modeled "real-world" problems. Gutierrez & Kouvelis (1991) suggested that managers should examine behavioral issues to understand how using critical path models will affect the time needed to complete a project. In the same way, Duimering et al. (2006) showed that overestimating time and budget parameters (i.e., padding) is common in project management. Both functional and project managers may add time to a project to cope with unexpected events resulting from project uncertainty (Duimering et al., 2006).

Other micro-level studies have focused on finding the point where tasks and those performing them align. For example, Posner (1986) found that as uncertainty increases in task performance, more face-to-face meetings (as opposed to impersonal communication) were needed to solve the problem. In the same way, Williams (1999) argued that increased project complexity resulted in more internal conflict within the project. Finally, when Hoegl & Gemuenden (2001) examined how different levels of task uncertainty and complexity impact teamwork quality and task performance, they concluded that as tasks become more routine, teamwork quality will have less influence on task performance, and vice versa.

The existing literature on socio-technical systems offers several relevant insights into the field of project management, but major shortcomings remain. There are insufficient studies of socio-technical interactions from a group/organizational perspective. The socio-technical approach can, however, yield significant utility to project management by using its underlying concepts to conceptualize project management. In this light, project management can be viewed as interacting subsystems in which projects are delivered by establishing a fit among various groups with different, and possibly competing, expectations and goals. However, it appears that the socio-technical approach is not widely adopted in the project management field because many of its related concepts (e.g., joint optimization) are underdeveloped and lack well-developed methods to capture and analyze complex interactions successfully.

2.2 Summary

Project management approaches are increasingly diverse, but only rarely are any attempts made to build theory. In general, researchers have approached project management from either a social or technical viewpoint and do not integrate these two interdependent components into a single theory of project management. One way to understand the activities of project management better is to study project management-related interactions from a socio-technical perspective. The socio-technical approach simultaneously examines the interactions among people, tasks, and technologies. Unfortunately, the concept is underdeveloped and presents no clear methodology on how to capture and analyze complex interactions successfully. Additional research is needed to refine the concept of socio-technical systems, as the concept applies to project management.

Table 2.1 summarizes the main properties—as well as shortcomings—of the five project-management approaches.

Research Approach	Main Properties	Main Shortcomings
Technical Approach	• Applies operation research and applied mathematics concepts • Relies on rational and deterministic models • Is used to plan, organize, monitor, control, and report projects • Assumes solutions to project management problems exist through the development of more efficient algorithms	• Has a myopic focus on technical, quantitative, and hard system components • Tends to promote a mechanistic view with many linear assumptions • Relies on closed-system representation • Most applicable for structured tasks, in which decisions can be set in advance with minimal disturbance from the environment
Social Approach	• Focuses on behavioral components—namely, the influence of cognitive, psychological, social, and organizational variables on project management • Assumes solutions to project management problems emerge from people's improved behavior	• Suffers from a narrow focus on social components • Lacks a clear specification of larger technical task contexts • Overestimates the project manager's role
Cookbook Approach	• Is based on non-technical discussions, less technical jargon, personal experiences, and 'dos and don'ts' lists	• Lacks academic credibility • Oversimplifies and is overly optimistic in describing project management processes • Fails to provide explanations on how suggested rules and guidelines are developed or can be implemented
Critical Success Factors Approach	• Examines factors that are highly correlated with project success • Provides indicators in evaluating project performance • Offers suggestions for improving project management	• Fails to define "success" rigorously • Lacks agreement regarding which factors result in project success • Relies on the presumption that a success factor is the true reason behind project success, which is difficult to validate • Offers little advice on how success factors can be applied and utilized • Is often anecdotal and based on single-case studies, with little empirical evidence
Socio-Technical Approach	• Examines interactions among people, tasks, and technologies simultaneously • Views project management as interacting subsystems in which projects are delivered by creating a fit among various related groups • Offers one promising and potential solution to the fragmented project management literature by studying project management from a socio-technical perspective	• Is based on an underdeveloped and poorly defined concept • Lacks clear methodology for capturing and analyzing complex interactions successfully

Table 2.1: Five Project Management Approaches: Main properties and shortcomings

Chapter 3
Theoretical Background

This chapter develops a theoretical approach to modeling project management effectiveness based on the cybernetics theory, specifically Ashby's Law of Requisite Variety. This model views the social and technical components of project management as a task-related social network within an organizational context. Project management is examined first at the organizational level to show how project management systems interact with the environment in dynamic ways. Following this discussion, the project management-related task structure network is examined. Finally, the human properties of the task structure are integrated into the context of project management.

3.1 Project Management: The Organizational Context

Many studies treat project management as independent systems that exist in a vacuum, rather than as subsystems of larger systems. This view of project management focuses on internal processes with no controls for external disturbances (White, 2006). An abstract model of organizations is introduced in order to construct a conceptual model of project management and to illustrate the impact of organizations on project management. This organizational view of project management is particularly important because the literature lacks empirical research on the interactions of project management systems at the organizational level (Milosevic & Patanakul, 2005). In this context, organizations are viewed as complex systems of many interrelated subsystems. Leavitt (1965) asserted that organizations are composed of at least four interacting variables: task, technology, structure, and people. The organization itself is part of a larger system; that is, its environment, on which the organization depends to survive. Figure 3.1 illustrates this concept (Leavitt, 1965; Scott, 1987).

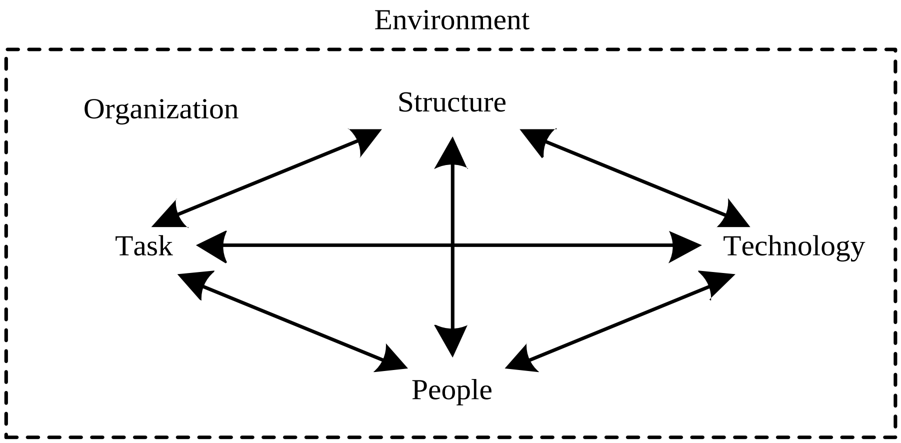

Figure 3.1: The Leavitt model

The *task* variable in Leavitt's (1965) model is a collection of subtasks that produce a good or service. The *people* variable refers to the actors who contribute to the organization. *Technology* is the machines used to solve problems. Finally, *structure* refers to the systems of communication, authority, and workflow. Without considering these basic elements of organizations, important aspects of project management can be misunderstood or overlooked. In addition, these variables are highly interrelated and interdependent, such that any change in one or more variable results in intended or unintended changes to other variables. This view of organizations is holistic because "the component on which one may temporarily focus is understandable only in relation to other components and the total systems' functions or operations" (Berrien, 1976, p. 61). More importantly, this organizational view of project management suggests that the source of local difficulties in managing projects may not only be due to the uniqueness or uncertainty of the task itself, but also because of a change in the organizational context (e.g., technological, structural).

The Leavitt (1965) model of organizations reveals three important aspects of project management: (1) projects are initiated in dynamic organizations that have ongoing tasks and routines; (2) project management systems directly affect and are affected by the organization; (3) project management cannot be understood isolated from its environment.

3.2 Project Management: The Task Structure Network

Many researchers have supported project management as a representation of the task structure network, which is composed of interrelated and interdependent heterogeneous actors (Bailetti, Callahan, & DiPietro, 1994; Blackburn, 2002). This task structure network is, in part, a product of complex interactions among people, tasks, and technologies. In this context, project management is examined through the flow of information in the task structure network.

A task structure network is composed of nodes that represent tasks and links that connect nodes to communicate and coordinate the tasks that produce desired outcomes. Each node is a subsystem that performs subtasks essential to accomplishing the larger task. For example, developing a new drug may include R&D, production, marketing, and project management subtasks. Figure 3.2 illustrates an example of this project task structure network.

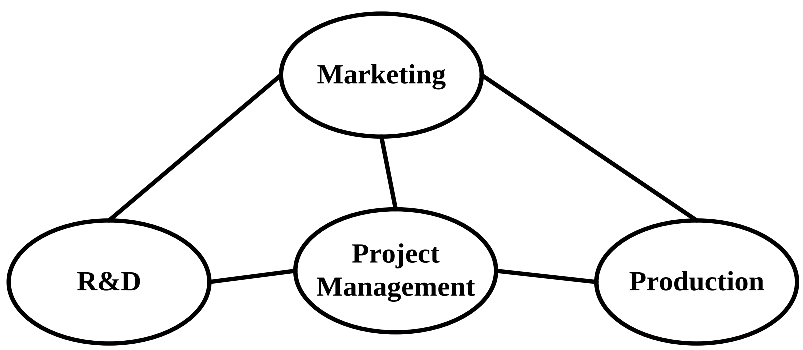

Figure 3.2: A basic task structure

Links among the nodes in the network can vary significantly based on different flows of authority, work material, information, and decision processes (Mintzberg, 1979). Furthermore, all nodes in the network are assumed to be interdependent. Because completing the entire project is beyond the capacity and ability of any single node, the performance of one node in the task structure directly affects other interconnected network nodes.

Project management systems function in an organizational context; therefore, the task structure network can be extended to include nodes within and across organizational boundaries. For example, both upper management and the organization's environment might be included. Furthermore, all nodes in the task structure are treated the same whether they are inside or outside the organizational boundary. An example of an extended task structure network based on Figure 3.2 is presented in Figure 3.3.

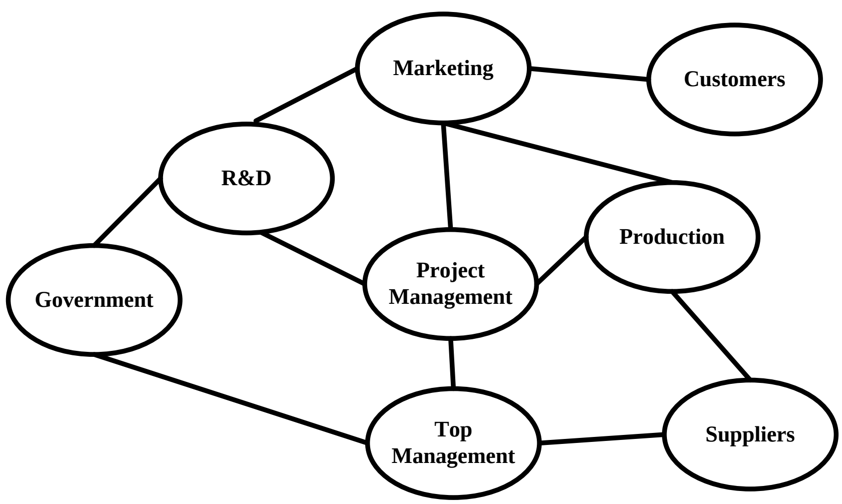

Figure 3.3: An extended task structure network

In Figure 3.3's task structure, the overall effectiveness of project management depends on the effectiveness of all the interactions among the interdependent nodes.

The following sections introduce cybernetics theory and its related concepts as a means to examine effective interactions among the nodes in a task structure network.

3.2.1 The Cybernetics Theory

Wiener (1948) originally defined cybernetics as “the science of control and communication, in the animal and the machine” (p. 19). In other words, to achieve a goal, actions should be controlled, and the progress of actions should be communicated continuously through feedback loops to ensure system stability (Trask, 1971). Beer (1974) defined cybernetics as “the science of effective organization” (p. 13) and asserted that the central theme of cybernetics is to seek a general theory of control (Beer, 1967). Control in this context, then, refers to the ability to seek and achieve a desired goal, while maintaining the system’s viability (Trask, 1971). Any system can be viewed as a “goal-directed” system because the system’s behavior depends on to what degree it has deviated from the goal state (Scott, 1987). Cybernetics has been applied to areas such as flexible manufacturing systems (see e.g., Scala, 1995; Scala, Purdy, & Safayeni, 2006); just-in-time manufacturing systems (see e.g., Duimering, 1991; Tucker, 1992); and organizational effectiveness (see e.g., Head, 2001).

3.2.1.1 Variety

Variety, the measure of complexity in a system, is defined as the number of different possible states the system can assume and their relative probabilities of occurring (Ashby, 1956; Beer, 1967; Beer, 1974; Duimering, 1991). For example, in the process of sending a message, the focus is not on what is said, but on what could be said (Guilbaud, 1959). In this way, variety and uncertainty are the same and reducing variety equates to removing uncertainty (Scala et al., 2006).

Packendorff (1995) suggested that projects can range from being well-defined and predictable to being ambiguous and unpredictable, while Leavitt (1965) pointed out that projects can range from sets of programmed and repetitive tasks to sets of novel and badly structured tasks. An example of a project with a low level of uncertainty is a linear project composed of repetitive tasks such as a highway or a pipeline (Hegazy, 2002).

To examine variety at a basic level, consider the task of sorting a standard deck of 52 playing cards by color. In this case, there are two sets of possible outcomes—black and red. It follows that the variety the person doing the sorting must handle is limited to two categories. Task variety increases to four if the task is changed to sorting the playing cards based on suit (clubs, spades, hearts, and diamonds) and will increase even more if the task is changed to sorting the cards based on their 13 face values or ranks (Ace, King, Queen, and so on). In this way, the task of sorting playing cards based on color, where the task variety is two, is less complicated than sorting the same cards by suit, where the task variety is four, or rank, where the task variety is 13.

The purpose of focusing on variety is to uncover potential patterns in project management and to understand how complex systems maintain stability. As a measure of complexity, variety indicates how much complexity a system can handle; that is, Ashby's Law of Requisite Variety.

3.2.1.2 Ashby's Law of Requisite Variety

Ashby's Law of Requisite Variety states, "Only variety can destroy variety" (Ashby, 1956, p. 207). Beer (1981) explained Requisite Variety as possible "only if the variety of the controller is at least as great as the variety of the situation to be controlled" (p. 41). In other words, variety can be reduced or destroyed by an equivalent variety handling capability from the system. Thus, for a system to maintain a stable state of output, it must be able to respond to potential input variety with equivalent variety handling capability (Ashby, 1956). Duimering (1991) summarized Ashby's Law as follows:

> In order to remain viable, a system must be capable of generating at least as much variety as the amount of internal and external variety affecting the system. This variety generated by the system is referred to as requisite variety, in that it is variety which is required by the system to match or cope with the internal and external sources of variety affecting the system. When a system possesses enough requisite variety to destroy, or cope with, all possible forms of

> internal and external variety, it will remain viable and perform in a stable manner. When a system does not have enough requisite variety to cope with all internal and external sources of variety affecting it, it will become unstable, and no longer survive. (p. 17)

To understand project management in the context of Ashby's Law of Requisite Variety, it is necessary to examine both input variety and a system's variety handling capability. In general, input variety can pose a threat to the system's stability; indeed, each node in the task structure network can face input variety from either external or internal sources (MacGregor, Lee, & Safayeni, 1996; Safayeni et al., 1987). External variety stems from the node's environment, such as a supplier's delay in delivering raw materials. Internal variety means that the node itself is generating variety that affects its own performance, such as machinery breakdowns and human error. Input variety may mean that additional work and time are required to handle the task.

Variety handling mechanisms are the sets of actions available to handle variety (MacGregor et al., 1996) and may involve one or several nodes (Safayeni et al., 1987). In other words, variety handling mechanisms can be distributed across groups in the task structure network. A failure to handle variety may result in inefficiencies in the system (MacGregor et al., 1996).

How can a system regain control when input variety and variety handling capabilities are mismatched? Beer (1974) suggested that either 1) variety can be reduced at the source or 2) the system's variety handling capability can be increased. For example, a manufacturing department suffering from too many late shipments could apply a variety *reducing* mechanism, such as implementing policies to force suppliers to ship parts on time. This would constitute reducing variety at the source. Alternatively, they could implement a variety *handling* mechanism, such as increasing inventory levels as a buffer to handle any future variability in shipment arrivals, a variety handling capability. Increasing variety handling capabilities (e.g. buffering), however, usually results in undesirable variety in terms of additional costs (Bavelas et al., 1983; Duimering et al., 1993; Safayeni & Purdy, 1991).

In addition to buffering, White (2006) described feedforward and feedback variety handling mechanisms. Feedforward variety handling "attempts to eliminate the effect of the disturbance [input variety] before any internal states have been measurably changed using a measure of anticipation" (White, 2006, p. 128). That is, feedforward is "foreseeing and discounting of troubles" (McKay & Wiers, 2004, p. 45). In this context, feedforward information eliminates variety by helping the system become more predictable (Beer, 1967). Feedforward variety handling is a response to expected system performance, not to actual events; therefore, it follows that the tactic offers a preventive and proactive approach to managing projects.

There are two types of unknown project events particularly relevant to the feedforward process (Pinto, 1998): (1) Foreseen but unexpected events that are initially predictable, but were overlooked in the planning phase (i.e., "known unknown" events), and (2) unforeseen events that are difficult to predict because they are associated with very low probabilities of occurring (i.e., "unknown unknown" events). Considering potential unforeseen events is particularly important because people are limited to their rationality boundaries, making it difficult, if not impossible, to consider all possible outcomes in a given situation (Gasser, 1986).

Feedback variety handling, in contrast, is a response to actual system performance (i.e., deviations) rather than to expected performance (Wiener, 1968). Feedback variety handling can be either negative or positive. Negative feedback reduces deviations, while positive feedback amplifies a measured deviation (Beer, 1967; Berrien, 1976; Katz & Kahn, 1978; Trask, 1971). Negative feedback is highly visible in the project management literature because managers frequently apply negative feedback controls to projects in order to reduce time and cost deviations from the project plans. Positive feedback, however is rarely discussed in the project management literature, but may also be a mechanism to handle variety. For example, the condition of "financial/resource escalation of failing projects," a well-known problem in the literature, is a positive feedback variety handling practice in which decision makers become overcommitted to previous decisions and invest more resources in a failing project (Keil, 1995; Keil & Robey, 2001). In other words, the greater the deviations in project cost and time, the more funds/resources are injected into the project.

The project management task structure network can be seen as a variety handling system (Bavelas et al., 1983; Safayeni et al., 1987) in which project variety introduced into the task structure network is met with equal variety handling capability to achieve desired outcomes. Increased input variety to a task structure may result in more unforeseen events to some nodes, but this increased variety may have an uneven effect on nodes in the task structure. In other words, some nodes may face more input variety, while other nodes may be affected only minimally by the increased variety because the excess variety may be reduced by other interconnected nodes. This discussion leads to this study's first hypothesis:

> ***H1:*** *The degree of the mismatch between input variety and variety handling capability in some nodes is greater in complex projects than in simple projects.*

3.3 Project Management: The Task Structure Network as a System of Roles

Bavelas et al. (1983) and Scott (1987) asserted that task dependencies result in associated social structures because social and task structures are interrelated. The social structure may redesign the formal task structure into the structure the organization actually uses; likewise, the formal task structure may impose constraints on the social structure. Thus, different task structures result in different levels of interdependencies (Safayeni et al., 1987). Roethlisberger (1956) suggested that behaviors at work cannot be understood without examining the social structure of the task-related groups. In this context, social structure refers to “the actual patterns of interaction existing within and between employee groups” (Roethlisberger, 1956, p. 566).

Unlike machines, humans act in different ways in different situations. For example, a person may have the ability to handle a task, but does not do so because the task is not part of his/her job. People’s expectations about the task must be considered in order to capture the behavior patterns in the social-structure (Packendorff, 1995; Roethlisberger, 1956). It follows that people’s actions are not automatic or constant, but are based on expectations and assumptions that exist between nodes.

Katz and Khan’s (1978) role model illustrates the impact of expectations between nodes in the task structure network. The role model is “the recurring actions of an individual appropriately interrelated with the repetitive activities of others so as to yield a predictable outcome. The set of interdependent behaviors comprise a social system or subsystems, a stable collective pattern in which people play their parts” (Katz & Kahn, 1978, p. 189). The role model views people in organizations as sets of expected behaviors and aggregating these sets of expectations results in expected roles.

With project management, people are assigned specific roles, and expectations exist about what others on the project should and should not do. These expectations are communicated from the role sender to the role receiver. Thereafter, the role receiver interprets and evaluates the expectation in relation to his/her own expectations and generates a behavior that is fed back to the role sender. Based on the alignment between the receiver’s behavior and the sender’s initial expectation, the role sender adjusts his/her expectations. This alignment process may influence future expectations.

Formal job descriptions only partially determine a person’s expectations of others in the process of managing projects; the remaining expectations are derived from the role system that determines what should and should not be done on the job. Furthermore, the role receiver’s behavior is derived in part from the sender’s expectations, while the remainder is derived from the receiver’s own perception of the job. Over time, repetitive tasks and a common understanding of the project management process can lead people to develop standards, norms, and assumptions that others are expected to follow. In this sense, the role model is a dynamic system of cycles in which adjustments are ongoing until stability is reached. This model explains how expectations of one node may influence the behavior of another node in a situational, interdependent, and reciprocal process within an organizational context (Figure 3.4).

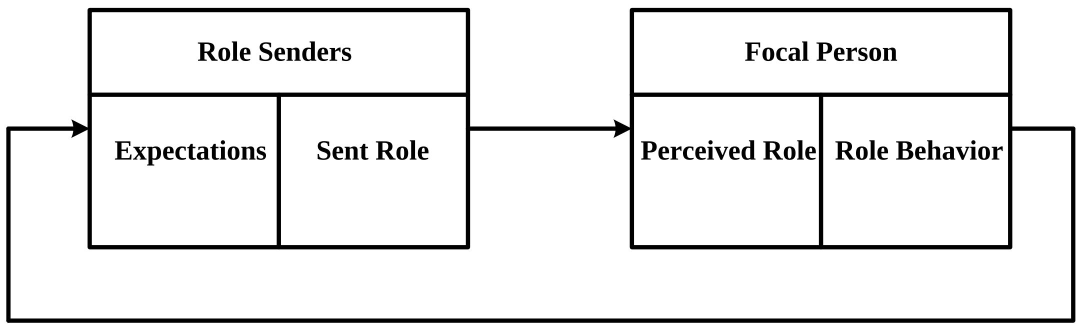

Figure 3.4: Katz and Khan's simplified role model

Every role handles parts and pieces of the total project variety. The network representation described in relation to the task structure (Section 3.2) represents associated roles, with the only difference being that nodes represent roles or perceptions associated with tasks, rather than representing pure tasks. In managing a project, the role sender may send an output that he/she expects the role receiver to handle, and the role receiver then evaluates this expectation based on his/her own range of expected variety and generates a behavior. In general, the role sender may send an expectation that the receiver may perceive to be within or outside his/her expected range of variety, resulting in three types of expectations. Within the expected range of variety are "normal" situations in which the role receiver perceives to be an expectation as part of his/her job. Expectations that are beyond the expected range of variety can be one of two types: an expectation that increases or reduces variety for the role receiver.

To understand the three types of expectations, consider the simple task in which one person sorts a stack of papers and another person staples them. If the sender (the paper-sorter) submits a well-sorted stack of papers to the receiver (the stapler), the output falls within the range of expected variety. If the sender does not sort the papers correctly, however, the output is outside the range of expected variety because it requires the receiver to perform additional tasks that he/she may perceive as beyond his/her role (e.g., re-sorting the papers). In a more positive example of output beyond the range of expected variety, the sender may reduce the task variety on the receiver's side, perhaps by sorting the papers in a way that will make it easier for the receiver to staple them.

In the context of project management, mismatched expectations between nodes can be inherent in the organization's task structure design. For example, in developing a new product, units such as Marketing and Requirement Engineering frequently conflict because mismatched expectations between the two units are pre-designed (Safayeni et al., 2008). On one hand, the marketing unit may assume that other units should expect its outputs to be ambiguous because uncertainty about the new product requirements is high in the early stages of the project life cycle. On the other hand, requirement engineering may expect the marketing unit's outputs to be detailed and specific in order to prepare documentation. Both units must adjust their range of expectations continuously based on cycles of communications until the problem is at least partially solved.

Further, each member of the role system may have a positive or negative history with other members that may affect their relationships (Dvir, 2005). Cunningham (2001) asserted:

> In any setting, people have expectations of what should happen and how others should behave. They have likes and dislikes, as well as keen interests and pet peeves. They can be frustrated and disappointed or satisfied and happy. If we understand these nuances, we are much more likely to develop useful ideas for solving complex problems (p. 5).

The quality of interpersonal relationships between the role sender and the role receiver plays a major role in influencing the sender's expectations and the receiver's behavior. In this light, a role's variety handling capability is flexible and dynamic and may expand or shrink based on working relationships. For instance, a recipient node may perceive a required task to be beyond his/her role; however, he/she may still be willing to "go that extra mile" and "stretch things," because the close interpersonal relationship with the variety sender influences variety handling capabilities in a positive way. In this sense, close relationships in task situations are a prerequisite for effective cooperation (Roethlisberger, 1956).

Negative relationships between the role sender and role receiver, however, may reduce the receiver's variety handling capability to "minimum requirements." For example, imagine a role sender sends an incomplete form that the receiver rejects without explanation. This action delays completing the project because more cycles of communications and task rework are needed. This discussion leads to this study's next set of hypotheses:

> ***H2:*** *Positive working relationships between nodes result in higher levels of variety handling capability than do negative working relationships.*
>
> ***H3:*** *If the relationship between nodes is negative, a node is less likely to handle increased variety that is perceived to be beyond the node's role, even if it is within the variety handling capability of the node.*

Mismatched expectations in the role system may result in three negative consequences to nodes in the task structure network (Katz & Kahn, 1978). The first mismatch problem is "role overload," where a role receiver is required to handle many expectations from a role sender or multiple role senders to a degree that exceeds his/her capacity. "Capacity," in this context refers to "how much work a system can do” within a specific time (Mackey, 1996, p. 28). Expressed in cybernetic terms, capacity is a node’s potential for handling variety (Scala et al., 2006).

The second mismatch problem is “role conflict,” where “forces acting on the person are opposite in direction and about equal in strength” (Lewin, 1951, p. 260; Lewin, 1935, p. 88). For example, a functional manager and a project manager may demand that a role receiver perform two contradictory tasks at the same time. In other cases, a role conflict may occur between the role sender and the receiver’s expectations as to what should and should not be done on the job. For example, a project manager asks a functional manager to take minutes in a meeting, which the role receiver perceives as beyond his/her role, resulting in “role conflict.” In general, conflict situations are associated with anxiety, tension, and reduced effectiveness (Katz & Kahn, 1978). Little can be said, however, about the occurrence of both role overload and role conflict in projects with different levels of complexity because a project may be of high or low complexity and still have problems of overload and conflict.

The focus in this study is on the third mismatch problem, “role ambiguity,” because hypotheses regarding this mismatch problem can be formulated within the proposed conceptual framework. Role ambiguity occurs when a role receiver is uncertain about how or what should be done on the task. In these situations, many possible states of the project may be difficult to predict because the role receiver lacks relevant information. Accordingly, Katz and Kahn (1978) asserted that role ambiguity may result in diminished performance. Role ambiguity is inevitable in project management because projects are unique by definition. It is of interest, therefore, to discuss the decision-making mechanisms that can be applied by nodes in the task structure to handle ambiguous tasks.

A decision is “a commitment to action” (Mintzberg, 1979, p. 58) and can be conceptually categorized as routine (i.e., programmed) or ad hoc (i.e., unprogrammed) (Mintzberg, 1979; Strank, 1983). Routine decisions are repetitive actions with some sort of predetermined procedures and rules, expressed as “if a, do x; if b, do y.” Ad hoc decisions, on the other hand, are unstructured actions with no explicitly predefined methods for action or resolving problems. Because ad hoc decisions lack predefined rules and procedures to handle input variety, variety handling mechanisms are also developed ad hoc; that is, ad hoc decisions are developed dynamically and implemented to solve immediate and pressing non-routine problems (Dinsmore, 1984; Gasser, 1986; Jaafari, 2003; Strank, 1983). For example, if a role receiver is asked to sort a deck of cards by color, red and black, and he/she encounters a green card, the receiver may not know what to do because the expected variety is two: black or red. One possible action by the receiver may be to ask the sender for more information about the green card, resulting in cycles of communication until the problem is solved. Alternatively, the receiver may simply develop a new rule to handle similar types of variety by placing any unknown card into a new pile.

In general, nodes in project management work with a certain level of predefined procedures to handle routine and repetitive tasks (Jang & Lee, 1998), leading to variety handling mechanisms being applied frequently. In complex projects with more unpredictable tasks, however, ad hoc variety handling mechanisms are more likely to be used because many nodes lack knowledge about the tasks or the means to achieve the objectives. This discussion leads to the next three hypotheses:

> ***H4:*** *Role ambiguity in the network is more frequent in complex projects than simple projects.*
>
> ***H5:*** *Ad hoc decisions are used as a means of handling variety more often in complex projects than simple projects.*
>
> ***H6:*** *Applying existing rules and procedures as means of handling variety is applied in simple projects more often than in complex projects.*

Some nodes in the task structure may want to map project uncertainty to the certainty inherent in current rules and procedures. For example, a project manager may force a new product development project to comply with existing project management software, routines, and procedures used to manage previous projects. This may result in negative perceptions about such procedures such as barriers, narrow-mindedness, and inapplicable rules (Dinsmore, 1984). Furthermore, using such rules and procedures may discourage problem solving in individual cases (Thomas, 1976) and generate undesirable variety that may lead to work-around practices. As discussed in the literature review, project management software may be seen as a low-variety handler that is more useful when applied to structured tasks for which decisions can be set in advance with minimal disruption to the project from the environment. Many studies have surveyed available project management software packages (e.g., Hegazy & El-Zamzamy, 1998; Liberatore & Pollack-Johnson, 2003; Liberatore et al., 2001), but rarely offer in-depth case studies that show the software's actual impact on the project management process. The current study examines the effectiveness of project management software and its impact on the project management process in several settings, leading to the next hypothesis:

> ***H7:*** *Project team members perceive management software as a less effective tool in complex projects than it is in simple projects.*

3.4 Summary

This study's proposed framework has the following basic characteristics:

1. Task-related social networks are created based on the division of work and formal task structures.
2. The basic unit of analysis is the interaction between two or more interrelated nodes.
3. The main property of interaction is the variety or number of possible states that one node generates for a recipient node.
4. Variety, or the possible states that can affect each node, can be internal or external to organizations, such that task-related social interactions should not be limited to internal nodes.
5. The degree of coordination is the extent to which a recipient node is capable of handling variety or the possible states generated by another interrelated node. Effectively managing projects may

depend on an adequately distributed requisite variety in each recipient node within the task-related social network.

6. Handling input variety between any two nodes in the network will be improved through positive social relationship and hindered through negative social relationship.
7. All nodes undergo a continuous process of informal adjustment to ensure projects are coordinated effectively.
8. Over time, the pattern of interactions among nodes tends to stabilize and modify the formal task structure into the one that is actually used.

Chapter 4
Methodology

4.1 Study Background

This study was conducted in a leading multinational pharmaceutical company (MPC) in the Middle East. The MPC designs, manufactures, and supplies more than 300 products in several therapeutic drug classes including antibiotics, analgesics, antirheumatics, cough and cold preparations, vitamins, and antidepressants. The MPC manufactures products in several pharmaceutical dosage forms, such as capsules, tablets, ampoules, syrups, ointments and creams, vials, suppositories, and eye and nasal drops.

The MPC uses a functional organizational structure in which employees with similar sets of specialized tasks are grouped into departments such as Marketing, Sales, and Production. The MPC is divided into two main physical sites: the Head Office and the Plant. The Head Office is responsible for managing product development, including the departments of Business Development, Marketing, Sales, Regulatory Affairs, and Distribution. In general, Head Office activities include monitoring the market for new product ideas, conducting feasibility studies, registering new products with governmental agencies, and marketing, selling, and distributing finished products to customers.

The Plant, on the other hand, is responsible for the technical side of product development and includes a Pharmaceutical Development Center, Quality Services, Production, Inventory Control & Production Planning, Procurement, and Production Engineering. In general, the Plant activities include conducting technical assessments for new products to ensure the company can manufacture them and developing both lab-scale samples and scaled-up batches of new products, which involves stability, formulation, packaging, procurement, quality services, and production. In addition to the Head Office and the Plant, the MPC has many branches serving the European, Asian, and African markets.

4.1.1 New Product Development Process in the MPC

Figure 4.1 presents a simplified view of the MPC's new product development process. To begin the process, the Business Development and Marketing departments provide the Pharmaceutical Development Center with new product requests (a list of new products) and identify the status of product development/registration as:

- know-how sourcing;
- in-house development;
- under license; or
- outsource and contract manufacturing.

The Medical Department provides the Pharmaceutical Development Center with reference product samples so that it can conduct development trials for new products. If the product is a licensor product, Business Development provides a technical dossier to the Pharmaceutical Development Center. The Procurement department procures the raw material and packaging that the Pharmaceutical Development Center requests based on their evaluation of the reference sample or technical dossier. If needed, the Pharmaceutical Development Center requests new tooling for new product development from Production Engineering.

Marketing provides the brand name for the new product. Thereafter, the Pharmaceutical Development Center begins preparing the registration file for the new product, including the artwork and packaging designs. Next, the Medical Department conducts the bioequivalency study for the new product, if required. After completing the registration file, the Pharmaceutical Development Center sends the file to the Ministry of Health through Regulatory Affairs. Regulatory Affairs informs the Pharmaceutical Development Center about the Ministry of Health's requirements, queries, and comments on the registration files and follows up with the Ministry of Health Central Lab on the status of the new product.

After obtaining approval of the new product from the Ministry of Health Sub-committee, Marketing prepares the forecast and launch plan for the new product. The Procurement department starts procuring all approved packaging components, raw materials, tooling, and so on. Inventory Control & Production Planning, the Pharmaceutical Development Center, and Production start scale-up/manufacturing activities for the new product based on a confirmed plan from Marketing. Quality Services reviews the batch record to approve the finished product. Finally, Marketing and Sales launch the new product to the market.

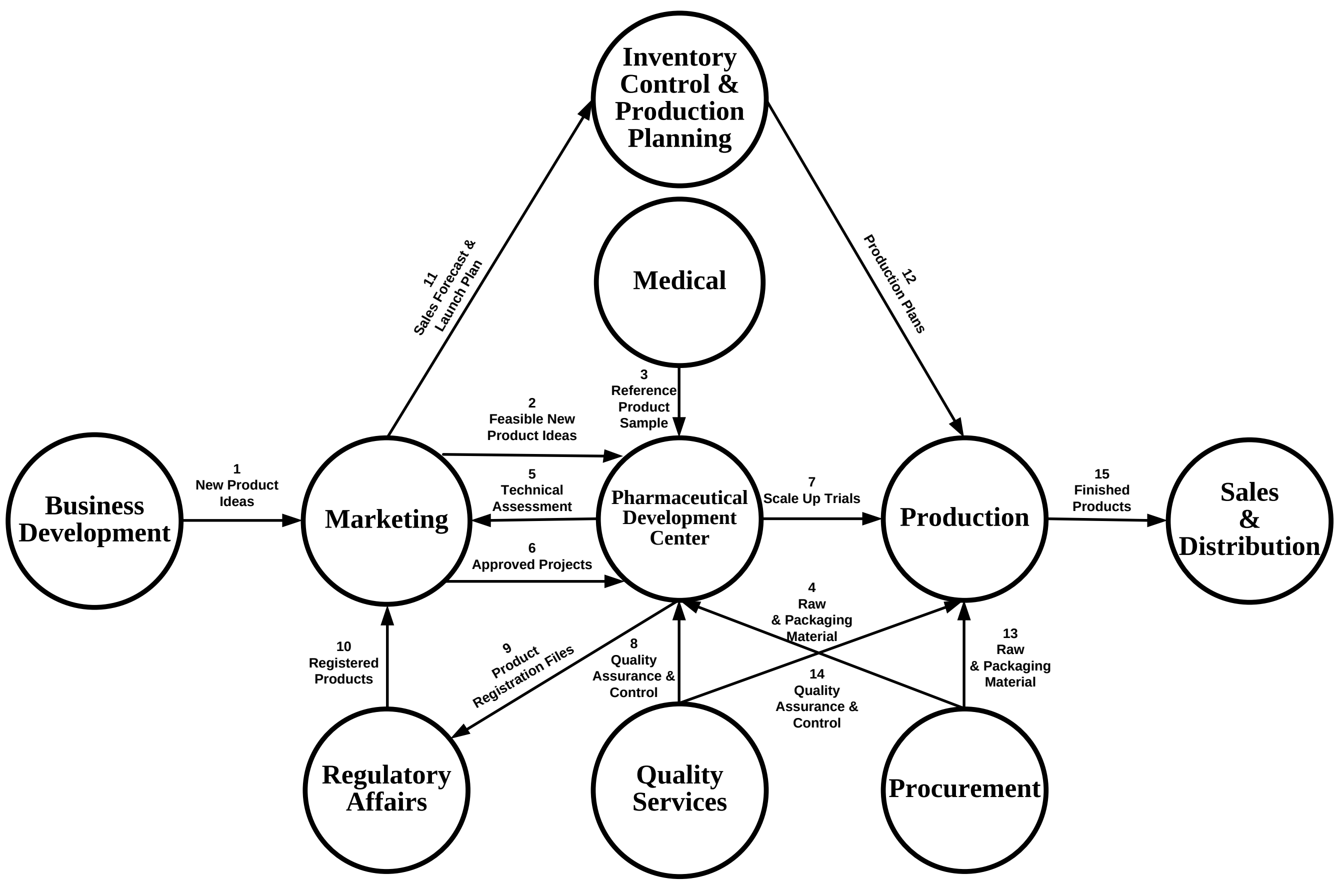

Figure 4.1: The MPC's simplified new product development process

4.2 Participants

Data for this study were collected via one-on-one interviews, each lasting approximately two hours. The entire data collection process lasted three months. All interviews were tape-recorded, and transcripts of the audio recordings were used in the final data analysis. Thirty-three managers from different departments in the MPC and with various hierarchal ranks constituted the sample frame of this study (see Table 4.1). Years of experience on the job ranged from 1 to 20 years, with a mean of 11.3 years (*SD* = 4.5).

Departments	**Number of Participants**	**Managerial Ranks**		
		Number of Directors	Number of Managers	Number of Supervisors
Marketing	5 (15.2%)	1 (3%)	3 (9.1%)	1 (3%)
Sales	2 (6.1%)	2 (6.1%)	-	-
Business Development	2 (6.1%)	1 (3%)	1 (3%)	-
Pharmaceutical Development Center	8 (24.2%)	-	-	8 (24.2%)
Quality Services	5 (15.2%)	-	3 (9.1%)	2 (6.1%)
Inventory Control & Production Planning	4 (12.1%)	-	1 (3%)	3 (9.1%)
Procurements	1 (3%)	-	1 (3%)	-
Production	5 (15.2%)	-	2 (6.1%)	3 (9.1%)
Medical Advisor	1 (3%)	-	-	1 (3%)
Total	**33 (100%)**	**4 (12.1%)**	**11 (33.3%)**	**18 (54.5%)**

Table 4.1: Interview Participants by Department and Managerial Rank (N = 33)

Because Arabic is the most widely spoken language in the Middle East, an Arabic version of the interview questions was developed from the original English questions using back-translation (Brislin, 1970). Two bilingual, independent researchers—both with knowledge of the local culture and the study's topic—were involved in the translation processes. One translated the questions from

English to Arabic, while the second blindly translated the questions from Arabic to English. Thereafter, the same two independent researchers helped the researcher examine and correct the original English questions, the Arabic translation, and the back-translated version for errors that might lead to different meanings. Finally, the Arabic version was pre-tested with some participants in the MPC to ensure that the interview questions were workable within the context of drug development projects. It is worth mentioning that the data was analyzed in Arabic to ensure that the respondents' meanings were not lost in the process of translation and that the initial codes were translated to English.

4.3 Method

This section presents this study's method, which is based on the "Echo" method originally developed by Bavelas (1942). Cunningham (2001) defined the Echo approach as "a way of observing, quantifying, and describing what people value and believe. It is a way to describe the patterns of value and influence that are felt, verbally expressed, and often acted upon in groups or organizations" (p. 4). The Echo method allows for a detailed analysis of task-related social interactions. In particular, the Echo based method is used to measure the degree of coordination within each link in a network (see e.g., Safayeni et al., 2008). This includes a series of interviews to describe participants' views and behaviors as an "echo" of their own role, allowing them to express their unique perspectives and insights about task situations using their own language (Cunningham, 2001; Cunningham & MacGregor, 2006). The advantage of the Echo method is that it captures real task situations with minimal researcher intervention. That is, the Echo method provides context-specific information about participants' task situations as they perceive it. The Echo method has been applied widely in numerous organizational studies (see e.g., Cunningham, 2001; Cunningham & MacGregor, 2006;

Duimering, 1991; Duimering et al., 2006; MacGregor et al., 1996; Safayeni et al., 2008; Scala et al., 2006; Schaefer, Bavelas, & Bavelas, 1980).

Each interview began by gathering background information about the participant, such as the interviewee's formal job description and how long they have worked on the job. Participants were then asked an aggregate-level question to identify their specific task interactions. Participants were asked to name any group or technology with which they interact to accomplish their tasks. By repeating this process with all related nodes in the project management process, an overall picture of the participant's immediate task-related social network can be developed (see Figure 4.2).

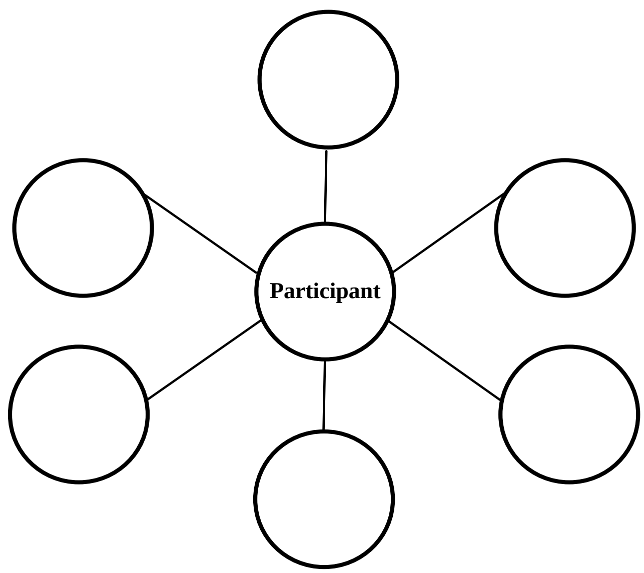

Figure 4.2: Blank social network diagram

After the participant's task-specific social network of significant interactions is identified, he/she is asked to describe how other nodes affect his/her tasks in both positive ("helpful" behaviors) and negative ("not so helpful" behaviors) ways (Cunningham, 2001); how the participant handles each type of negative behavior; and how the organizational context influences interactions. Duimering et al. (2006) described the process of interview questions based on the Echo method as follows:

> ‘Echo questions’ are then used to examine interactions between the subject and each of the identified nodes. The subject is asked to provide concrete examples of behaviors performed by other nodes that are helpful from the subject’s point of view, and examples of behaviors that are not so helpful. By asking for specific examples of positive and negative behaviors, subjects are encouraged to provide descriptive information about actual events experienced on the job rather than ungrounded opinions or stereotypes about the behavior of others. By conducting interviews with people in each of the identified nodes, multiple perspectives on a given situation can be obtained. (p. 241)

Specifically, participants were asked the following questions: “In the process of managing this project, what does Node A do that is helpful in accomplishing your task? Please give me as many examples as you can.” In addition, the opposite question was asked: “In the process of managing this project, what does Node A do that is not so helpful in accomplishing your task? Please give me as many examples as you can.” Using this method encouraged participants to provide concrete examples that resulted in an “in-depth description of real issues, rather than a person’s opinions and interpretations” (Cunningham, 2001, p. 68). Appendix A presents the interview questions used in this study.

Conceptually, helpful behaviors are good indicators of variety handling mechanisms, because helpful behaviors from one node reduce variety on the part of the recipient node. On the other hand, not so helpful behaviors increase variety to the recipient node (Scala et al., 2006). The use of “helpful” and “not so helpful” behaviors is a practical way of representing the concept of “variety” to participants.

Furthermore, participants were asked to indicate the impact of both “helpful” and “not so helpful” behaviors on their work. This “impact” element was used as a secondary representation of variety for project team members. In addition, participants were asked about any corrective actions they took toward each “not so helpful” behavior. Specifically, participants were asked: “What do you do when this not so helpful behavior happens?” The corrective actions available at the recipient node were used to indicate variety handling mechanisms used in project management.

Participants were also asked to indicate the link with which they have the most positive working relationship and another link with which they have the least positive working relationship. Participants were then asked to provide concrete examples about the helpful and not so helpful behaviors that they provide to both links (reverse Echo). Finally, participants were asked to rank all interdependent nodes based on their relative importance and performance when working on a specific project.

Chapter 5
Case Study Results

This chapter presents the results of the interviews based on the “Echo” method. Specifically, the qualitative data is examined on two levels: quantitative analysis and categorical analysis (Miles, 1994). In this context, both numbers and words are used to obtain both macro- and micro-levels of understanding the complex interactions of project management. It is worth noting that all major results will be discussed thoroughly within the proposed theoretical framework in Chapter 7.

The research hypotheses were initially designed to compare a complex and a simple project; however, it was found the first few interviewees had difficulties associating concrete examples to specific projects. This difficulty was traced to MPC’s organizational structure and the way in which projects are assigned and delivered. In functional organization structures, employees doing specialized jobs are already clustered into departments according to their roles. In turn, projects are designed to shuffle around to different departments, with each department ensuring that their parts of the project are completed. In this case, project management-related coordination and communication activities are coordinated by essentially the same members, resulting in difficulties distinguishing and mapping specific examples to particular projects. Thus, the later interviews focused on asking participants to describe how each unit in the process of managing projects both positively and negatively affects other interrelated units with respect to a typical project. A follow-up survey was designed and conducted to overcome this limitation and test the formal research hypotheses (Chapter 6).

5.1 Quantitative Analysis of the Qualitative Data

This section describes eight analytical activities: (1) coding the qualitative data for further in-depth analysis; (2) calculating the organizational interaction effectiveness (IE) average ratio; (3) analyzing the network from an organizational level; (4) analyzing the network from a departmental level; (5) analyzing the symmetrical/asymmetrical relationships; (6) analyzing the variability of interactions; (7) testing the ability of the helpful and not so helpful examples participants mentioned to discern differences among the links between nodes in terms of their relative importance and performance; and (8) analyzing the differences between the most and least positive working relationship links.

5.1.1 Data Coding

After transcribing all interviews, the text was coded systematically into seven categories following the structure of the interview questions: Helpful, Not So Helpful, Helpful Impact, Unhelpful Impact, Variety Handling Mechanisms, Helpful to Others, Not So Helpful to Others. Summarizing in this way is essential to preparing the data for analysis and extracting meaning. Using QSR NVIVO 7 software, the data were coded for analysis. The coding process was iterative and the data were reported primarily using the participants' own words. Table 5.1 summarizes the number of distinct examples provided within each category and a typical example for each of them. Appendix B presents the entire set of examples all participants provided.

Category	**# of Examples**	**Typical Example**
Helpful	386	Advance notifications about potential problems
Not So Helpful	378	Frequently changing plans without informing us
Helpful Impact	218	Reduce task reworks
Unhelpful Impact	293	Caused delays
Variety Handling Mechanisms	335	Conduct follow ups
Helpful to Others	125	Handling their urgent requests as a priority
Not So Helpful to Others	82	Pressuring them with many urgent requests
Total	**1817**	

Table 5.1: Frequencies of Examples per Qualitative Categories

5.1.2 Organizational Interaction Effectiveness (IE) Average Ratio

This study used quantitative measures to examine participants' comments regarding their task-related social interactions; specifically the ratio of helpful to not so helpful behaviors. This ratio indicates the relative effectiveness of the link between nodes in the task-related social network when compared between links or to the organizational average ratio. Safayeni et al. (2008) referred to this ratio as the link's interaction effectiveness (IE). In the case of the MPC, the organizational interaction effectiveness average ratio was estimated as 1.03. This ratio was calculated by dividing the total number of helpful behaviors identified (387) by the total number of not so helpful behaviors identified (377) for all nodes. The ratio of 1.03 means there was approximately one helpful behavior for every one not so helpful behavior.

5.1.3 Organization Level Analysis

We begin by analyzing the MPC from an organizational level of analysis, treating all departments in the Head Office as a single entity and all departments in the Plant as an interdependent single entity. At this general organizational level of analysis, the IE ratio was calculated as 0.4 for the Plant and 1.62 for the Head Office. The direction of each arrow in Figure 5.1 indicates a flow of behaviors from the sender node to the recipient node. Ratios of more than 1.03 are shown as solid lines, indicating that effectiveness is above the organizational average, while ratios less than 1.03 are shown as dashed lines, indicating effectiveness is below the organizational average.

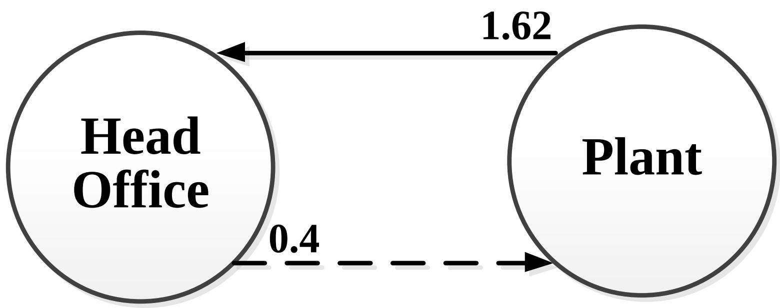

Figure 5.1: Interaction effectiveness ratio between the MPC's Head Office and Plant locations

This discrepancy in perceived IE ratios suggests that the Head Office perceives that the Plant as a variety handler (i.e., decreases variety in the system), while the Plant perceives the Head Office as a variety generator (i.e., increases variety in the system).

5.1.4 Departmental Level Analysis

The network is composed of nodes that represent tasks and links that connect nodes to communicate and coordinate tasks that produce desired outcomes. Because of space constraints, only those nodes with a two-way relationship are addressed in this study. Figure 5.3 illustrates the MPC's task-related social network diagram for all nodes with two-way relationships, along with relative IE ratios.

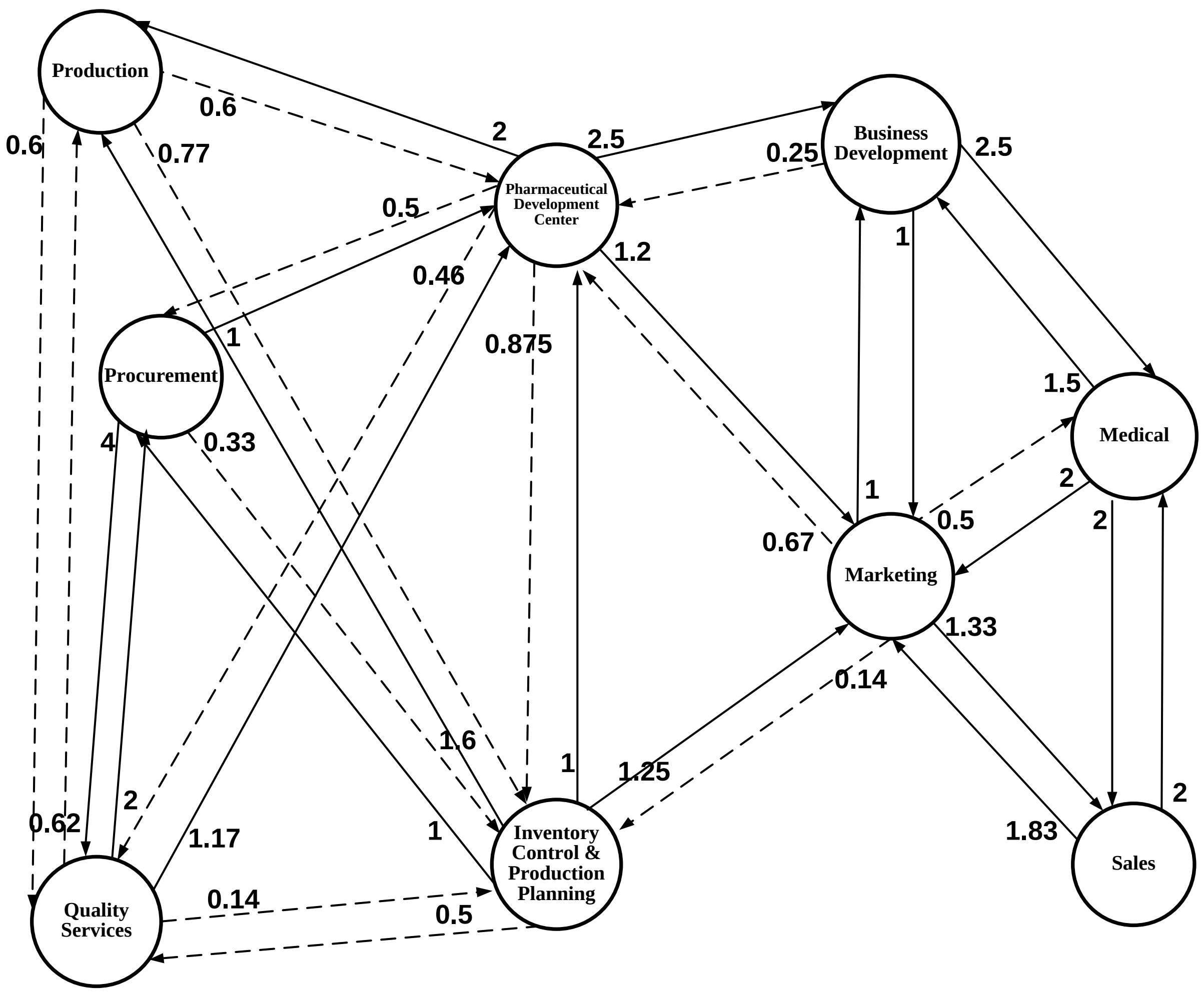

Figure 5.2: The MPC's task-related social network diagram for all nodes with two-way relationships indicating relative IE ratios

5.1.5 Symmetrical/Asymmetrical Relationships

Symmetry is defined in relation to the quality of interactions, not in terms of mutual dependence (i.e., directionality). There are many types of symmetrical/ asymmetrical relationships. A symmetrical relationship can mean that both nodes are either helpful or not so helpful to one another to the same relative degree. Asymmetrical relationships, on the other hand, can mean that there is a significant difference between IE ratios, reflecting a discrepancy in the relationship. There are three types of asymmetrical relationships: (1) a node is helpful to its interrelated node, but the recipient node is very helpful; (2) a node is not so helpful to its interrelated node and the recipient node is extensively not so helpful to its interrelated node; and (3) one node is helpful to another interdependent node and the recipient node is not so helpful (see Table 5.2).

	Helpful (H)	**Not So Helpful (NH)**
Symmetrical	$H_A/NH_A \approx H_B/NH_B$; $H_{AB}/NH_{AB} > 0$	$H_A/NH_A \approx H_B/NH_B$; $H_{AB}/NH_{AB} < 0$
Asymmetrical	$H_A/NH_A \neq H_B/NH_B$; $H_A/NH_A > H_B/NH_B > 0$	$H_A/NH_A \neq H_B/NH_B$; $H_A/NH_A < H_B/NH_B < 0$
	$H_A/NH_A \neq H_B/NH_B$; $H_A/H_A > 0$ & $H_B/NH_B < 0$	

Table 5.2: Symmetrical and Asymmetrical Relationships

In the MPC's case, Figure 5.2 indicates that all relationships are asymmetrical, ranging from 0.14 to 4.0, except for four relationships: (1) Marketing's relationship with Business Development; (2) Sales' relationship with Medical; (3) the Pharmaceutical Development Center's relationship with Inventory Control & Production Planning; and (4) Quality Services' relationship with Production. To account for a margin of error, only those relationships with a discrepancy of more than 25% were considered asymmetrical.

5.1.6 Variability of Interactions

Figure 5.2 indicates that some nodes, while interacting with other interdependent nodes, have a wide range of IE ratios compared to others. That is, some nodes have consistent interactions with their interdependent nodes, while others do not (see Table 5.3).

Departments	IE Average Ratio	Standard Deviation
Marketing	1.45	0.46
Sales	1.67	0.12
Business Development	1.67	1.15
Pharmaceutical Development Center	0.78	1.28
Quality Services	0.89	0.80
Inventory Control & Production Planning	0.45	0.40
Procurements	1.83	1.50
Production	1.41	0.10
Medical	1.67	0.29
Average	1.31	**0.68**

Table 5.3: Variability in IE Ratios

In this context, having a high standard deviation indicates a high level of variability in the degree of helpfulness (i.e., inconsistency) compared to nodes with a low standard deviation. For example, a node may be extremely helpful to some interdependent nodes in the network and not so helpful to others. Consistent interactions do not imply that the relationship is positive, however, because some nodes may be consistently not so helpful to other interdependent nodes.

5.1.7 Assessing the Volume and Effectiveness of Interactions

As discussed in Chapter 4, participants were asked to name the departments with which they interact on projects and provide examples of helpful (H) and not so helpful (NH) behaviors of the other units while they work on the project. Two metrics, therefore, were created:

1. The total of helpful and not so helpful examples: H + NH
2. The relative effectiveness of interactions (IE ratio): H/NH.

Participants were also asked to rank departments based on how *important* they are and their perceived *performance* on the job. These two variables are ranked from 1 to the total number of departments with which the department interacts, where 1 means the *most* important or the *best* performance.

The importance rankings were used to test the ability of the calculated total of helpful and not so helpful examples to discern differences between the quality of the links based on the volume of interactions. In addition, the node performance rankings were used to test the ability of the ratio of helpful to not so helpful examples (i.e., the IE ratio) to predict the link's effectiveness.

Table 5.4 shows a significantly high and positive correlation (0.378) between the ranking of importance and performance, meaning that the more important the department is, the higher the perception of performance. The data in Table 5.4 also reveals an interesting result related to the association between the total of helpful and not so helpful examples and the IE ratio with both; that is, the importance and performance ranking. While the association between the total of helpful and not so helpful examples is significantly higher with the importance ranking and lower with the performance ranking, the relationship between IE ratio and performance is stronger than the relationship between IE ratio and importance. Effectiveness, therefore, is statistically more associated with performance than to importance.

		Ranking of Importance	Ranking of Performance	Total of Helpful and Not So Helpful Examples	IE Ratio	Number of Helpful Examples	Number of Not So Helpful Examples
Ranking of Importance	Pearson Correlation	1					
	Sig. (2-tailed)						
	Count	188					
Ranking of Performance	Pearson Correlation	.378**	1				
	Sig. (2-tailed)	.000					
	Count	188	188				
Total of Helpful and Not So Helpful	Pearson Correlation	-.495**	-.168*	1			
	Sig. (2-tailed)	.000	.021				
	Count	188	188	188			
IE Ratio	Pearson Correlation	-.149*	-.539**	.221**	1		
	Sig. (2-tailed)	.042	.000	.002			
	Count	188	188	188	188		
Number of Helpful Examples	Pearson Correlation	-.430**	-.445**	.785**	.688**	1	
	Sig. (2-tailed)	.000	.000	.000	.000		
	Count	188	188	188	188	188	
Number of Not So Helpful Examples	Pearson Correlation	-.289**	.248**	.722**	-.415**	.148*	1
	Sig. (2-tailed)	.000	.001	.000	.000	.043	
	Count	188	188	188	188	188	188

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 5.4: Correlation Analysis

The data in Table 5.4 shows that the number of helpful examples is significantly highly correlated with the ranking of importance and performance, meaning that the closer to 1 the rankings, the higher the number of helpful examples. This situation changes when comparing not so helpful examples and the ranking of performance, as the coefficient of correlation (0.248) indicates that the higher the number of not so helpful examples, the poorer the perceived performance. It can be concluded, therefore, that the participants' ranking of the importance of the nodes is more closely associated with the number of examples, regardless of the type of example (helpful or not so helpful). In contrast, the ranking of performance is more closely associated with the type of examples: helpful examples are more associated with high performance and not so helpful examples are more associated with low performance.

These results can be confirmed using a multiple regression analysis, with importance and performance rakings as independent variables, with the total helpful and not so helpful examples and IE ratio as dependent variables. Table 5.5 shows that when the dependent variable is the total of helpful and not so helpful examples, the p-value corresponding to performance ranking (0.746) indicates that the dependent variable is not statistically significant in explaining the total of helpful and not so helpful examples. The standardize beta coefficient corresponding to the ranking of importance, however, is statistically significant at the 5% level. This means that for each decrease in the importance of the department (the closer to 1), the total of helpful and not so helpful examples increases by 0.503.

	Unstandardized Coefficients		Standardized Coefficients		
	B	SE	Beta	t	Sig.
(Constant)	5.850	.316		18.505	.000
Ranking of Importance	-.529	.073	-.503	-7.297	.000
Ranking of Performance	.024	.074	.022	.324	.746

Table 5.5: Summary of Multiple Regression Analysis for Variables Predicting Total of Helpful and Not So Helpful

The opposite situation occurs when the dependent variable is IE ratio because the performance ranking is the only variable statistically significant in explaining the IE ratio. In this case, the standardize beta coefficient corresponding to the ranking of performance means that for each decrease in the performance of departments (closer to 1), the IE ratio increases by 0.563 (Table 5.6).

	Unstandardized Coefficients		Standardized Coefficients		
	B	SE	Beta	t	Sig.
(Constant)	2.331	.163		14.308	.000
Ranking of Importance	.036	.037	.064	.965	.336
Ranking of Performance	-.320	.038	-.563	-8.441	.000

Table 5.6: Summary of Multiple Regression Analysis for Variables Predicting IE Ratio

5.1.8 Working Relationships

Participants were found to have almost double the IE ratio with links to their most positive working relationships compared to links with their least positive working relationships. For the most positive links, the ratio of 2.03 means that approximately one not so helpful behavior exists for every two helpful behaviors. For the least positive links, the ratio of 1.09 means that approximately one not so helpful behavior exists for every one helpful behavior. It is worth noting that both ratios were calculated by dividing the total number of “helpful to others” behaviors by the total number of “not so helpful to others” behaviors for each type of link (i.e., positive and negative working relationship). The IE ratio for working relationship is clearly different from the previously used IE ratio calculated by dividing the total number of “helpful” behaviors by the total number of “not so helpful” behaviors for all nodes.

Overall, this discrepancy in IE ratios between positive and negative links suggests that people tend to generate more helpful behaviors and fewer not so helpful behaviors toward others with whom they have positive working relationship and will do the opposite when they have negative working relationships. Table 5.7 shows the distribution of all helpful to others and not so helpful to others examples and their relative IE ratios.

	# of Helpful to Others Examples	# of Not So Helpful to Others Examples	IE
Most Positive Link	77	38	2.03
Least Positive Link	48	44	1.09

Table 5.7: Distribution of all Helpful to Others and Not So Helpful to Others Examples and their Relative IE Ratios

5.2 Categorical Analysis of the Qualitative Data

In this section, data is analyzed at different levels of aggregation in a sort of “ladder of abstraction” (Miles, 1994). The analysis begins with an organizational level analysis, followed by similar analyses on location levels (Head Office and Plant) and departmental levels for commonly occurring patterns. Finally, working relationships are discussed at a more individual level. It is worth noting that only results with major differences (>10%) between categories or within categories are reported.

5.2.1 Data Categories

Analyzing qualitative data requires making sense of data and capturing emergent patterns. This research avoids the use of predefined and generic categories because they may be insufficient to characterize and understand the ways in which tasks are coordinated and integrated on projects. Instead, this study relies on emergent categories that were developed by six independent researchers. It is worth noting that segmenting the data is a demanding task. Each of the six researchers, therefore, was given 50 random examples per category (two researchers per category), asked to cluster examples based on similarity, and then label each cluster with a reasonable name.

During this segmenting process, all developed subcategories were reviewed repeatedly to arrive at agreed upon categories to ensure that the unstructured interview data were summarized in a reasonable and unbiased manner. Thereafter, a thorough discussion determined whether new categories were still needed or current categories needed to be reduced or modified by merging similar categories. The entire group of researchers made the final decision regarding what categories should be used for further analysis. Table 5.8 presents the result of the segmenting process, including subcategories labels, the property of an example to be included in a specific category, and a typical example for each subcategory.

Qualitative Category	Properties of Messages	Typical Example
Helpful Category Labels		
Competency	Messages reference an important special capability or expertise ("Good at doing their work")	Very competent legal advisors
Communication	Messages relate to transferring information from one unit to another	Updating us with actual production progress
Cooperation	Messages relate a degree of willingness to help	Very cooperative in changing schedules based on our requests
Basic Job Performance	Messages relate to a person carrying out his/her work properly ("Doing what they are suppose to do")	Evaluating suppliers
Not So Helpful Category Labels		
Incompetency	Messages reference lacking normally expected degree of ability ("Not doing a good job or not doing what they are suppose to do")	Not following quality control procedures
Miscommunication	Messages relate to cases in which information was not transformed as desired	Sending incomplete forms
Noncooperation	Messages relate to a degree of unwillingness to help	Lack of initiative to solve even minor problems
Unreasonable Expectations	Messages reference a request that does not correspond to approved rules or norms	Pressuring us with many requests to accelerate product development
Helpful Impact Category Labels		
Save Time	Messages relate to case resulting in an act before planned or required time	Saved time
Less Work	Messages relate to the need of reduced amount of effort to complete the task	Reduce task reworks
Psychological	Messages reference mental or emotional effects	Increased motivation toward work
Quality/Resources	Messages relate to appropriateness and reliability of human, machines, and materials	Resulted in fewer defects
Unhelpful Impact Category Labels		
Delay	Messages relate to a case resulting in an act later than planned or required	Caused delays
Additional Work	Messages relate to the need of extra effort to complete the task	More communications cycles

Psychological	Messages reference mental or emotional effects	Became frustrated
Quality/Resources	Messages relate to inappropriateness and unreliability of human, machines, and materials	Wasted resources
Variety Handling Category Labels		
Following up/Pressuring	Messages relate to reminding the sender to handle the problem	Pressure them with many follow-ups
Discussing	Messages relate to joint problem solving	Call for a one-time meeting to negotiate with them
Escalating	Messages related to involving third party to help resolving the problem	Ask our manager to intervene
Suggesting	Messages relate to proposing way(s) for recipient to handle the problem	Ask them to increase their number of analysts
Accepting	Messages relate to problems beyond the control of the recipient node (forced to handle the problem)	Nothing because it is beyond our control
Fixing	Messages relate to problems in which the recipient node handles the problem yet has the option not to do	Reorder new raw materials

Table 5.8: Subcategories for each Qualitative Category and Related Content Property

The categorization process revealed that some categories are symmetrical while others are not. For example, the “communication” and “cooperation” categories are symmetrical with the “miscommunication” and “noncooperation” categories, respectively. The not so helpful category of “incompetency,” however, is not exactly symmetrical with the helpful category of “competency,” because incompetency extends to include examples of people not doing their job (i.e., “basic job performance”). Interestingly, “unreasonable expectations” does not appear on the helpful side because it appears that people do not report examples of others asking for “reasonable” requests.

It is worth noting that the proposed subcategories are not mutually exclusive, meaning that examples can be placed in more than one category. Appendix B presents the entire set of examples for each developed subcategory. Examples followed by an asterisk (*) mean that the same example appears in one or more category. This overlap reflects the real nature of the examples in that some are pure and others are not. Allowing comments to appear in more than one category, however, resulted in more complexity to the categorization process.

5.2.2 Reliability Check-Coding

To check the researchers' categorization reliability for segmenting all examples within the developed subcategories, ten novices (two for each category) were asked to sort 50 random examples into related subcategories. The aim of this checking process was to ensure the clarity of the developed subcategories and their reliability. The reliability scores were calculated based on the following formula, which considers the number of agreements/disagreements between each two sorters as a measure of the reliability of the category to adequately represent examples (Miles, 1994):

$$Reliability = \frac{Number\ of\ Agreements}{Total\ Number\ of\ Agreements + Disagreements}$$

All categories were within the acceptable range of reliability, with scores ranging from 86% to 94%. Table 5.9 presents the reliability scores for each of the main five categories.

Category	**Reliability**
Helpful	90%
Not So Helpful	92%
Helpful Impact	94%
Unhelpful Impact	92%
Variety Handling Mechanisms	86%

Table 5.9: Reliability Score for each Category

5.2.3 Organizational Level Analysis

Aggregating the qualitative data at an organizational level shows how all units view the organization on average, both positively and negatively. The objective here is to determine the most dominant issues encountered in project management at an organizational unit of analysis.

5.2.3.1 Helpful Examples

As a proportion of total helpful behavior examples, "competency" (30.02%) received the highest number of favorable comments, followed by "communication" (25.51%), and "basic job performance" (24.83%). "Cooperation" (19.64%) received the fewest examples. Table 5.10 shows the distribution of all helpful examples as perceived by all units.

Helpful Categories	**%**
Competency	30.02%
Communication	25.51%
Basic Job Performance	24.83%
Cooperation	19.64%

Table 5.10: Distribution of Examples of Helpful Categories

5.2.3.2 Not So Helpful Examples

"Incompetency" is the largest not so helpful category, with almost half of all examples related to others either not being competent or not doing their basic job properly. On the other hand, "noncooperation" (9.57%) received the fewest examples. Table 5.11 presents the distribution of all not so helpful examples as perceived by all units.

Not So Helpful Categories	**%**
Incompetency	49.28%
Miscommunication	23.44%
Unreasonable Expectations	17.7%
Noncooperation	9.57%

Table 5.11: Distribution of Examples of Not So Helpful Categories

5.2.3.3 Helpful Impact/Unhelpful Impact Examples

As discussed, each participant was asked about the impact of helpful and not so helpful behaviors, if any, on the project. The highest proportion of helpful impact examples fall into the category of "save time" (68.14%). "Psychological" impact (4.42%) received the lowest proportion of examples. Table 5.12 presents the distribution of all helpful impact examples as perceived by all units.

Helpful Impact Categories	**%**
Save Time	68.14%
Less Work	16.37%
Quality/Resources	11.06%
Psychological	4.42%

Table 5.12: Distribution of Examples for Helpful Impact Categories

Similarly, Table 5.13 shows that a high level (68.87%) of unhelpful impacts is related to delaying the project, while the lowest proportion of examples related to "psychological" impacts (4.64%).

Unhelpful Impact Categories	**%**
Delay	68.87%
Additional Work	15.56%
Quality/Resources	10.93%
Psychological	4.64%

Table 5.13: Distribution of Examples per Unhelpful Impact Categories

Overall, both helpful impact examples (M = 25, SD = 0.29) and unhelpful impact examples (M= 25, SD=0.29) follow a similar pattern.

5.2.3.4 Variety Handling Mechanism Examples

Each participant was asked about the ways they handle not so helpful behaviors, if any. As a proportion of total variety handling mechanisms examples, "suggesting" (22.06%), "fixing" (20.92%), and "following up/pressuring" (20.63%) received the highest number of comments, followed by “accepting” (17.19%). One the other hand, the lowest proportions, 10.6% and 8.6%, of variety handling mechanisms examples fall into the categories of “discussing” and “escalating,” respectively. Table 5.14 presents the distribution of all variety handling mechanisms examples as perceived by all units.

Variety Handling Mechanisms Categories	**%**
Suggesting	22.06%
Fixing	20.92%
Following up/Pressuring	20.63%
Accepting	17.19%
Discussing	10.6%
Escalating	8.6%

Table 5.14: Distribution of Examples of Variety Handling Mechanisms Categories

5.2.4 Head Office and Plant Relationship

As discussed, MPC is divided into two main physical sites: the Head Office and Plant. The Head Office involves managerial departments (e.g., Marketing, Sales, Business Development, Human Resources, Legal, and Regulatory Affairs), whereas Plant includes departments with more technical roles (e.g., Production, Quality Services, Pharmaceutical Development Center, Production Engineering, and Inventory Control, and Production Planning). This distinct difference between Head Office and Plant presents useful insights because the locations are both geographically and functionally separate.

The objective here is to understand the organizational context of projects within systems of communication, authority, and workflow. This holistic view of the process is of great importance because it will be apparent from the analysis that the function of Head Office is understood only in relation to the Plant’s operations and vice versa.

As discussed in Section 5.1.3., the discrepancy in perceived IE ratios implies that the Head Office perceives that the Plant as a variety handler (1.62), while the Plant perceives the Head Office as a variety generator (0.4). It is of interest to examine the properties of both variety generators and handlers in relation to their distributions of examples across different qualitative categories.

5.2.4.1 Helpful Examples

One of the largest differences between the results from the Head Office and the Plant occur in the category of "competency", meaning that the Head Office perceives the Plant to be highly competent in doing its work. For Head Office, the highest proportion of helpful examples falls into the category of "competency" (35.9%). Both "basic job performance" (20.51%) and "cooperation" (15.38%) received the fewest helpful examples as perceived by Head Office units. For Plant units, on the other hand, examples are spread more evenly across all categories (M = 25, SD = 0.05), meaning that all types of helpful behaviors are important for the Plant to accomplish their tasks. Table 5.15 presents the distribution of all helpful examples as perceived by Head Office and the Plant units.

Location	**Helpful Categories**			
	Competency	Communication	Cooperation	Basic Job Performance
Head Office	**35.9%**	28.21%	15.38%	20.51%
Plant	**25%**	31.25%	18.75%	25%

Table 5.15: Distribution of Examples of Helpful Categories for Head Office and Plant

5.2.4.2 Not So Helpful Examples

Overall, participants at both Head Office (M = 25, SD = 0.21) and Plant (M = 25, SD = 0.19) gave about the same proportion of examples in all not so helpful categories with no major differences. For both Head Office and Plant, "incompetency" is the largest not so helpful category, with around half of all examples. “Noncooperation” received the lowest proportion of not so helpful examples for both Head Office and Plant. Table 5.16 presents the distribution of all not so helpful examples as perceived by the Head Office and the Plant units.

Location	**Not So Helpful Categories**			
	Incompetency	Miscommunication	Noncooperatio n	Unreasonable Expectations
Head Office	52.38%	28.57%	4.76%	14.29%
Plant	50%	30%	7.5%	12.5%

Table 5.16: Distribution of Examples of Not So Helpful Categories for Head Office and Plant

5.2.4.3 Helpful Impact/Unhelpful Impact Examples

Overall, both the Head Office (*M* = 25, *SD* = 0.26) and Plant (*M* = 25, *SD* = 0.30) share a similar view of the distribution of helpful impact comments. In addition, for both Head Office and Plant, “save time” is the largest helpful impact. On the other hand, “psychological” impacts received the fewest helpful impact examples for both Head Office and Plant. Table 5.17 presents the distribution of all helpful impact examples as perceived by both the Head Office and the Plant.

Location	**Helpful Impact Categories**			
	Save Time	Less Work	Psychological	Quality/Resources
Head Office	62.5%	20.83%	4.17%	12.5%
Plant	68.81%	15.84%	4.46%	10.89%

Table 5.17: Distribution of Examples of Helpful Impact Categories for Head Office and Plant

One of the largest differences within the unhelpful impact examples between Head Office and Plant occur in the category of “delay,” meaning that Plant is more sensitive about project delays than Head Office. “Psychological” impacts received the smallest proportion of unhelpful impact examples from both the Head Office and the Plant. Table 5.18 presents the distribution of all unhelpful impact examples as perceived by the Head Office and the Plant.

Location	Unhelpful Impact Categories			
	Delay	Additional Work	Psychological	Quality/Resources
Head Office	**60.34%**	20.69%	6.9%	12.07%
Plant	**70.9%**	14.34%	4.1%	10.66%

Table 5.18: Distribution of Examples of Unhelpful Impact Categories for Head Office and Plant

5.2.4.4 Variety Handling Mechanisms

One apparent difference between the Head Office and the Plant occurs in the "suggesting" category. Here, 32.22% of Head Office examples fall into the category of "suggesting," compared to only 18.53% of Plant examples. No major differences were found in other variety handling mechanism categories between Head Office and Plant. Table 5.19 presents the distribution of all variety handling mechanisms examples as perceived by the Head Office and the Plant.

Location	Variety Handling Mechanism Categories					
	Following up/Pressuring	Discussing	Escalating	Suggesting	Accepting	Fixing
Head Office	16.67%	11.11%	4.44%	**32.22%**	20%	15.56%
Plant	22.01%	10.42%	10.04%	**18.53%**	16.22%	22.78%

Table 5.19: Distribution of Examples of Variety Handling Mechanisms Categories for Head Office and Plant

5.2.5 Departmental Level Analysis

Examining the qualitative data at the departmental level has two objectives. First, this analysis shows how each node represents a subsystem that performs subtasks, which are essential for the larger task. In this view, tasks are explained in terms of their unidirectional and cyclical relationships in the system and not as independent parts. Second, this level of analysis explains how a node may influence the behavior of other interrelated nodes in a situational, interdependent, and reciprocal process within an organizational context. In other words, project management can be seen as a system of cyclical influences among nodes among different functional areas.

The departmental level of analysis provides contextual information that leads to a better understanding of how each node is affected by helpful and not so helpful behaviors; how they handle the not so helpful behaviors, and what the impact is of the helpful and not so helpful behaviors on projects in an organizational context.

Note again that only units with two-way relationships are reported due to limitations in space. In addition, only units in which four or more people were interviewed are reported in order to avoid single and anecdotal views.

5.2.5.1 Helpful Examples

Looking at differences *between* departments, one major difference in the helpful category of "competency" occurred between Inventory Control & Production Planning (34.38%) and Marketing (21.82%) departments. "Communication" received the highest proportion of examples by Marketing (30.91%) and the lowest by Quality Services (15.38%). One major difference in the helpful category of "cooperation" occurred between Quality Services (15.38%) and Marketing (9.09%). Finally, 'basic job performance" received the highest proportion of examples by Marketing (38.18%) and the lowest proportion by Inventory Control & Production Planning (18.75%).

When looking at differences *within* departments, the highest proportion of helpful examples by Marketing falls into the category of "basic job performance" (38.18%). On the other hand, Marketing placed the least proportion of helpful examples in the category of "cooperation" (9.09%). According to the Pharmaceutical Development Center, helpful examples are spread more evenly across all categories (M = 25, SD = 0.04). The highest proportion of helpful examples for by Quality Services falls into the category of "cooperation" (30.77%) and the lowest in the category of "communication" (15.38%). According to Inventory Control & Production Planning, the highest proportion of helpful examples fall into the category of "competency" (34.38%), while the lowest fall in the category of "basic job performance" (18.75%). Finally, Production placed the highest proportion of helpful examples in the categories of "competency" (29.31%) and "basic job performance" (29.31%) and the fewest in the category of "cooperation" (18.97%). Table 5.20 shows the distribution of all helpful examples across different departments.

Departments	**Helpful Categories**			
	Competency	Communication	Cooperation	Basic Job Performance
Marketing	**21.82%**	**30.91%**	**9.09%**	**38.18%**
Pharmaceutical Development Center	29.78%	26.97%	22.47%	20.79%
Quality Services	26.92%	**15.38%**	**30.77%**	26.92%
Inventory Control & Production Planning	**34.38%**	25%	21.88%	**18.75%**
Production	29.31%	22.41%	18.97%	29.31%

Table 5.20: Distribution of Examples of Helpful Categories for Departments

5.2.5.2 Not So Helpful Examples

Looking at differences again *between* departments, one major difference in the not so helpful category of "incompetency" occurred between Inventory Control & Production Planning (58.33%) and the Pharmaceutical Development Center (41.89%). "Miscommunication" received the highest proportion of examples by Inventory Control & Production Planning (31.25%) and the lowest proportion of examples by Production (9.8%). One major difference in the not so helpful category of "noncooperation" occurred between Quality Services (12.16%) and Inventory Control & Production

Planning (2.08%). Finally, "unreasonable expectations" received the highest proportion of examples by Production (21.57%) and Pharmaceutical Development Center (20.95%) and the lowest proportion by Inventory Control & Production Planning (8.33%).

When looking at differences *within* each department, the highest proportion of not so helpful examples by all departments fall into the category of "incompetency," meaning that all departments face problems from others because a normally expected degree of ability on the job is lacking. In addition, the lowest proportion of not so helpful examples by all departments (except for Production), fall into the category of "noncooperation." Production indicates that "miscommunication" (9.8%) to be the not so helpful category with the fewest examples. Table 5.21 shows the distribution of all not so helpful examples across different departments.

Departments	**Not So Helpful Categories**			
	Incompetency	Miscommunication	Noncooperation	Unreasonable Expectations
Marketing	54.35%	28.26%	6.52%	10.87%
Pharmaceutical Development Center	**41.89%**	25.68%	11.49%	20.95%
Quality Services	48.65%	20.27%	**12.16%**	18.92%
Inventory Control & Production Planning	**58.33%**	**31.25%**	**2.08%**	**8.33%**
Production	56.86%	**9.8%**	11.76%	**21.57%**

Table 5.21: Distribution of Examples of Not So Helpful Categories by Departments

5.2.5.3 Helpful/Unhelpful Impact Examples

Looking now at differences *between* departments, one major difference in the helpful impact category of "save time" occurred between Inventory Control & Production Planning (78.57%) and Quality Services (57.89%). "Less work" received the highest proportion of examples by Inventory Control & Production Planning (21.43%) and Quality Services (21.05%) and the lowest proportion by

Production (6.98%). No major differences were found between departments in the helpful impact category of “psychological.” Finally, “quality/resources” received the highest proportion of examples by Quality Services (15.79%) and Marketing (15.00%) and the lowest by Inventory Control & Production Planning (0.00%).

When looking at differences *within* each department, the highest proportion of helpful impact examples all departments noted falls into the category of “save time,” meaning that all departments associate helpful behaviors by others with more time saved on the project. In addition, the lowest proportion of helpful impact examples by all departments falls into the category of “psychological.” Table 5.22 shows the distribution of all helpful impact examples across different departments.

Departments	**Helpful Impact Categories**			
	Save Time	Less Work	Psychological	Quality/Resources
Marketing	70.00%	15.00%	0.00%	15.00%
Pharmaceutical Development Center	66.67%	17.46%	4.76%	11.11%
Quality Services	**57.89%**	21.05%	5.26%	**15.79%**
Inventory Control & Production Planning	**78.57%**	**21.43%**	0.00%	**0.00%**
Production	76.74%	**6.98%**	4.65%	11.63%

Table 5.22: Distribution of Examples of Helpful Impact Categories by Department

Looking at differences *between* departments for the unhelpful impact categories, “delay” received the highest proportion of examples by Production (92.86%) and the lowest by Inventory Control & Production Planning (65.12%), the Pharmaceutical Development Center (66.12%), and Quality Services (67.65%). “Additional work” received the highest proportion of examples from Marketing (20.00%) and the Pharmaceutical Development Center (19.83%) and the lowest proportion of examples from Production (2.38%). No major differences were found between departments in the unhelpful impact category of “psychological.” Finally, “quality/resources” received the highest proportion of examples from Inventory Control & Production Planning (25.58%) and the lowest from Production (4.76%).

When looking at differences *within* each department, the highest proportion of unhelpful impact examples all departments noted falls into the category of "delay," meaning that all departments consider that not so helpful behaviors by others equates to more delays in the project timetable. In addition, the lowest proportion of unhelpful impact examples all departments noted falls into the category of "psychological." Table 5.23 shows the distribution of all unhelpful impact examples across different departments.

Departments	**Unhelpful Impact Categories**			
	Delay	Additional Work	Psychological	Quality/Resources
Marketing	70.00%	**20.00%**	0.00%	10.00%
Pharmaceutical Development Center	66.12%	19.83%	5.79%	8.26%
Quality Services	67.65%	17.65%	5.88%	8.82%
Inventory Control & Production Planning	**65.12%**	6.98%	2.33%	**25.58%**
Production	**92.86%**	**2.38%**	0.00%	**4.76%**

Table 5.23: Distribution of Examples of Unhelpful Impact Categories by Department

5.2.5.4 Variety Handling Mechanisms

Looking at differences *between* departments, "following up/pressuring" received the highest proportion of examples from Inventory Control & Production Planning (30.00%) and the lowest from Marketing (8.89%). "Discussing" received the highest proportion of examples from Production (21.05%) and the lowest from Inventory Control & Production Planning (2.00%). No major differences were found between departments in the variety handling mechanism categories of "escalating" and "accepting." One major difference in the variety handling mechanism category of “suggesting” occurred between Marketing (40.00%) and Production (10.53%). Finally, “fixing” received the highest proportion of examples from Quality Services (28.57%) and the lowest proportion of examples from Marketing (15.56%).

When looking at differences *within* each department, the highest proportion of variety handling mechanism examples from Marketing falls into the category of “suggesting” (40.00%) and the lowest in the category of “following up/pressuring”(8.89%). According to the Pharmaceutical Development Center, the highest proportion of variety handling mechanism examples fall into the category of “suggesting” (24.04%), while the lowest are in the category of “escalating” (7.69%). The highest proportion of variety handling mechanism examples noted by Quality Services falls into the category of “fixing” (28.57%) and the lowest proportion of examples fall into the category of “discussing” (7.14%). According to Inventory Control & Production Planning, the highest proportion of variety handling mechanism examples falls into the category of “following up/pressuring” (30.00%) and the lowest in the category of “discussing” (2.00%). Finally, Production placed the highest proportion of variety handling mechanism examples in the category of “fixing” (23.68%) and the least proportion of examples in the category of “escalating” (5.26%). Table 5.24 shows the distribution of all variety handling mechanism examples across different departments.

Departments	Variety Handling Mechanism Categories					
	Following up/Pressuring	Discussing	Escalating	Suggesting	Accepting	Fixing
Marketing	**8.89%**	13.33%	8.89%	**40.00%**	13.33%	**15.56%**
Pharmaceutical Development Center	21.15%	11.54%	7.69%	24.04%	17.31%	18.27%
Quality Services	17.86%	7.14%	14.29%	19.64%	12.50%	**28.57%**
Inventory Control & Production Planning	**30.00%**	**2.00%**	14.00%	12.00%	16.00%	26.00%
Production	18.42%	**21.05%**	5.26%	**10.53%**	21.05%	23.68%

Table 5.24: Distribution of Examples of Variety Handling Mechanism Categories by Department

5.2.6 Working Relationships

As discussed in Chapter 4, participants were asked to indicate the link with which they have the most positive working relationship and another link with which they have the least positive working relationship. Participants were then asked to provide concrete examples about the helpful and not so helpful behaviors that they provide to both links (reverse Echo). In this section, data are first analyzed in general, regardless of the quality of the working relationship. A comparative analysis will then present the significant differences between the most positive and least positive working relationship links in terms of the kind of helpful and not so helpful examples.

5.2.6.1 Helpful to Others Examples

Overall, participants indicate the highest proportion of their helpful to others examples fall in the categories of “basic job performance” (30.14%) and “communication” (29.45%), followed by “cooperation” (26.03%). On the other hand, the least proportion of helpful to others examples fall in the category of “competency” (14.38%). Table 5.25 shows the distribution of all helpful to others examples for all participants.

Helpful to Others Categories	%
Basic Job Performance	30.14%
Communication	29.45%
Cooperation	26.03%
Competency	14.38%

Table 5.25: Distribution of Examples of Helpful to Others Categories for all Participants

5.2.6.2 Not So Helpful to Others Examples

The highest proportion of not so helpful to others examples falls into the category of "unreasonable expectations" (40%), while the lowest proportion falls in the category of "noncooperation" (5.56%). Table 5.26 shows the distribution of all not so helpful to others examples for all participants.

Not So Helpful to Others Categories	%
Unreasonable Expectations	40%
Incompetency	35.56%
Miscommunication	18.89%
Noncooperation	5.56%

Table 5.26: Distribution of Examples of Not So Helpful to Others Categories for all Participants

5.2.6.3 Helpful to Others Examples: Most Positive vs. Least Positive Working Relationships

In looking at differences *between* positive and negative working relationships, one difference occurred in the "communication" category. Here, 36.56% of the examples participants reported with positive working relationships fall into the category of "communication," compared to only 16.98% of participants' examples regarding negative working relationships. Major differences also were found in the category of "cooperation," in which participants' examples regarding positive working relationships were 32.26%, with only 15.09% for participants with negative working relationships. In addition, almost half of the examples participants reported regarding negative working relationships fall in the category of "basic job performance" (49.06%), whereas only 19.35% of the examples for participants with positive working relationships fall in this same category. No major differences were found between the positive and negative working relationships for the category of "competency."

Looking at differences *within* each type of working relationship, the majority of helpful to others examples for people with positive working relationships fall in the categories of "communication" and "cooperation," with a total of 68.82%. The lowest proportion of the helpful to others examples fall into the category of "competency" (11.83%). On the other hand, almost half of the helpful to others examples regarding participants' least positive relationships fall in the category of "basic job performance," while the fewest examples fall in the category of "cooperation" (15.09%). Table 5.27 shows the distribution of all helpful to others examples for both the most positive and least positive links.

Working Relationships	**Helpful to Others Categories**			
	Competency	Communication	Cooperation	Basic Job Performance
Most Positive Links	11.83%	**36.56%**	**32.26%**	**19.35%**
Least Positive Links	18.87%	**16.98%**	**15.09%**	**49.06%**

Table 5.27: Distribution of Examples of Helpful to Others Categories for Most and Least Positive Links

5.2.6.4 Not So Helpful to Others: Most Positive vs. Least Positive Working Relationships

Overall, participants with positive working relationships (M = 25, SD = 0.18) and negative working relationships (M = 25, SD = 0.15) gave approximately the same proportion of examples in all not so helpful to others categories. In addition, for both working relationship types, "incompetency" is the largest not so helpful to others category, with about 40% of all examples falling in this category. "Noncooperation" received the lowest proportion of not so helpful examples for both positive and negative working relationships. Table 5.28 presents the distribution of all not so helpful to others examples for both the most positive and least positive links.

Working Relationships	**Not So Helpful to Others Categories**			
	Incompetency	Miscommunication	Noncooperation	Unreasonable Expectations
Most Positive Links	37.5%	15%	5%	42.5%
Least Positive Links	34%	22%	6%	38%

Table 5.28: Distribution of Examples of Not So Helpful to Others Categories for Most and Least Positive Links

5.3 Summary

This chapter presented the results of interviews based on the “Echo” method. Specifically, the qualitative data was examined at two levels: quantitative and categorical analysis. This study used quantitative measures to examine participants’ comments regarding their task-related social interactions, specifically, the ratio of helpful to not so helpful behaviors (IE ratio). This ratio was used as an indication of the relative link effectiveness between nodes in the task-related social network, when compared between links or to the organizational average ratio. The IE ratio was also used to examine the structural properties of the task-related social network (i.e. symmetrical/asymmetrical relationships and variability of interactions) as means of understanding interactions. In addition, the quantitative results suggest that helpful and not so helpful examples are reliable indicators of the perceived importance and performance of particular nodes on the project.

The categorical analysis of the interviews involved segmenting, summarizing, separating, and sorting all helpful, not so helpful, variety handling mechanisms, helpful impact, unhelpful impact, helpful to others, and not so helpful to others examples into subcategories. Relative frequencies were then associated with each subcategory to examine the most and least important examples that affect interdependent nodes during the process of managing projects. All major results will be discussed thoroughly within the proposed theoretical framework in Chapter 7.

Chapter 6
Follow-Up Survey

As discussed in Chapter 5, the research hypotheses were developed to examine variety-related concepts with respect to different degrees of project complexity (i.e., complex vs. simple). The qualitative study results, however, were limited to typical projects in which participants were not required to map specific events and concrete examples to either complex or simple projects. Hence, it seemed fitting to carry out a follow-up survey in MPC to test the research hypotheses. This chapter begins by discussing the methodology used to conduct the survey, followed by testing the seven formal research hypotheses. Additional major findings from the survey results are then presented.

6.1 Method

To address the research objectives, the final survey questions were developed based on modified survey questions derived from several instruments; namely, project complexity items (Lee, 2003); role ambiguity items (Kahn, 1964; Rizzo, House, & Lirtzman, 1970); positive/negative working relationship behavior items (Keup, 2001); and project management software items (Fox, 1998). In addition, some central items from the qualitative study were included in the final survey. Specifically, to design survey questions based on the qualitative data applicable to diverse roles/functions, specific behaviors from the qualitative data were restated in more abstract and generic terms. For example, "Not So Helpful" behaviors such as "Not providing us with specific answers to our inquires," "Not providing us with complete information (scenarios) about their new ideas," and "A lack of updated information about their activities" were classified as miscommunication problems and were restated in the survey as "Most people are not likely to get all the information needed to carry out their job on the project." Survey respondents were asked to indicate the extent to which they experience this problem when working on a typical complex or simple project.

The follow-up survey involved seven main parts: (1) project complexity; (2) the degree of mismatch between variety and variety handling capability; (3) the impact of working relationships; (4) role ambiguity; (5) the role of adhocracy variety handling mechanisms; (6) the role of procedural variety handling mechanisms; and (7) the degree of project management software effectiveness. All questions except for working relationship behavior items were designed using Likert scales ranging from 1 (not very complex projects) to 7 (very complex projects). The questions for working relationship behavior items were designed using Likert scales ranging from 1 (not very positive relationship) to 7 (very positive relationship).

The questions served three main purposes. The first part included a set of statements designed to measure perceived project complexity to examine whether participants share a common understanding of how project complexity is defined. This part is of great importance because the remainder of the questionnaire was built on comparing different degrees of project complexity. The second part of the survey focused directly on testing the seven formal research hypotheses presented in Chapter 3. At the end of the survey, participants were asked to provide various job-related demographic information such as job title, years of experience in their current job position, years working in the company, and their level of experience using project management software. The questionnaire consisted of 54 questions (see Appendix C).

To understand the different factors involved in managing projects better, several constructs were created using different questions. Table 6.1 presents the constructs and their related items. In this way, the number of variables involved in the analysis was reduced, using constructs to explain similar information.

Construct	Items
Project Complexity	Q1-Q9, Q18
Mismatches of Variety/Variety Handling Capability	Q11-Q16
Role Ambiguity	Q17, Q19-Q21, Q24
Adhocracy mechanisms	Q22, Q25, Q28
Procedural mechanisms	Q23, Q26, Q27
Positive Working Relationship Behaviors	Q29, Q31, Q32, Q34, Q37, Q39
Negative Working Relationship Behaviors	Q30, Q33, Q35, Q36, Q38

Table 6.1: Constructs and their Related Items

6.2 Sample

The setting for this study was MPC, which has a population of approximately 1,000 employees. The study sample was selected randomly from within each department in MPC. The questionnaires were distributed in both of MPC's locations (i.e., the Head Office and the Plant) using the drop-off/pick-up method (Zikmund, 1994). A total of 122 employees from 17 different departments completed a questionnaire, resulting in a reasonably good response rate of 12.2%. The sample demographics collected from the survey included job title, length of time on the same job, and length of time in the company. Demographically, years of experience on the job ranged from 6 months to 20 years, with a mean of 6.6 years (*SD* = 4.9). Years working in the company ranged from 1 year to 23 years, with a mean of 10.1 years (*SD* = 5.5).

6.3 Results

The survey findings are divided into three parts. First, the reliability of the research factors is described. Second, the results of a Confirmatory Factor Analysis (CFA) test are presented to verify the factor structure of the observed variables. Third, the results of a one sample *t*-test are presented, through which the research hypotheses are tested.

6.3.1 Reliability Test

To determine the reliability of the instrument used in this study, Cronbach's alpha was calculated for each construct. The closer to 1 the reliability, the higher the level of precision for each variable to measure the determined construct. The overall reliability for each construct is given in Table 6.2.

Construct	Cronbach's Alpha
Project Complexity	0.53
Mismatches of Variety/Variety Handling Capability	0.39
Role Ambiguity	0.67
Adhocracy Mechanisms	0.60
Procedural Mechanisms	0.65
Positive Working Relationship Behaviors	0.66
Negative Working Relationship Behaviors	0.74

Table 6.2: Overall Reliability for Each Construct

As Table 6.2 indicates, certain factors have a reliability of less than 0.6, which indicates poor accuracy of the corresponding items in explaining their theoretical factor. In the following section, items with no significant impact on the corresponding factors will be removed to improve the reliability scores.

6.3.2 Confirmatory Factorial Analysis (CFA)

The primary objective of a CFA is to determine the ability of a predefined factor model to fit an observed set of data. To provide statistical proof of creating the theoretical factors, therefore, a CFA was applied to test whether a relationship between the observed variables and their underlying latent construct(s) exists or not. Table 6.3 presents standard estimates of each variable within each latent variable, along with the corresponding *p*-value.

Construct	Item	*p*-value	Standard Estimate
Project Complexity	Q1	0.00	0.78
	Q2	< 0.001	0.82
	Q3	0.71	-0.04
	Q4	0.01	0.18
	Q5	0.00	0.36
	Q6	0.00	0.20
	Q7	0.00	0.24
	Q8	0.57	0.60
	Q9	0.00	0.22
	Q18	0.18	0.14
Mismatches of Variety/Variety Handling Capability	Q11	0.00	0.36
	Q12	< 0.001	0.71
	Q13	0.46	-0.02
	Q14	0.02	0.83
	Q15	0.14	-0.32
	Q16	0.00	0.21
Role Ambiguity	Q17	< 0.001	0.44
	Q19	< 0.001	0.40
	Q20	0.00	0.72
	Q21	< 0.001	0.64
	Q24	< 0.001	0.53
Adhocracy Mechanisms	Q22	0.00	0.83
	Q25	0.00	0.63
	Q28	0.01	0.35
Procedural Mechanisms	Q23	0.00	0.75
	Q26	< 0.001	0.45
	Q27	0.00	0.62
Positive Working Relationship Behaviors	Q29	0.00	0.38
	Q31	0.05	0.23
	Q32	< 0.001	0.62
	Q34	< 0.001	0.58
	Q37	< 0.001	0.61
	Q39	< 0.001	0.62
Negative Working Relationship Behaviors	Q30	0.00	0.63
	Q33	< 0.001	0.49
	Q35	< 0.001	0.59
	Q36	< 0.001	0.57

	Q38	< 0.001	0.71

Table 6.3: Standardized Estimate of each Item

As observed in Table 6.3, certain items (i.e., Q3, Q8, Q13, Q15, and Q18) have no significant impact on the corresponding factors. This lack of explanation affects the reliability index. In an attempt to improve these indexes, therefore, items that did not significantly contribute to explain the factors were removed. The new reliability indexes are provided in Table 6.4.

Construct	**Cronbach's Alpha**
Project Complexity	0.62
Mismatches of Variety/Variety Handling Capability	0.63
Role Ambiguity	0.67
Adhocracy Mechanisms	0.60
Procedural Mechanisms	0.65
Positive Working Relationship Behaviors	0.66
Negative Working Relationship Behaviors	0.74

Table 6.4: Overall Reliability for each Construct

As expected, reliability indexes improved and the Cronbach's alpha indicates acceptable internal consistency of the items in the scale.

6.3.3 Test of Hypotheses

For testing purposes, a new item was created using the mean of all items corresponding to each construct/hypothesis. A one sample *t*-test compared the average of each new item versus 4, the scale representing "no difference." Table 6.5 shows the *t*-test estimate, degrees of freedom, *p*-value, and mean difference (with respect to 4).

Construct	**t**	**df**	***p*-value**	**Mean Difference**
Project Complexity	19.490	121	.000	.99754
Mismatches of Variety/Variety Handling Capability	11.732	121	.000	.70628
Role Ambiguity	12.835	121	.000	1.06885
Adhocracy Mechanisms	14.085	121	.000	1.17486
Procedural Mechanisms	-12.410	121	.000	-.93443
Positive Working Relationship Behaviors	17.719	121	.000	1.19672
Negative Working Relationship Behaviors	-18.727	121	.000	-1.37377
Project Management Software	6.351	121	.000	1.00000

Table 6.5: Results from One Sample t-test for Each Construct

As observed in Table 6.5, a one sample *t*-test determined that the overall mean score for project complexity (*M* = 4.99, *SD* = 0.56) was significantly greater than an average rating of 4 (*t* = 19.490; df = 121; *p* = .000). It appears, therefore, that participants share a common understanding of project complexity. In addition, according to Table 6.5, all hypotheses (H1-H6) are supported with strong statistical evidence at the 5% level of significance except for Hypothesis 7. Specifically, no statistical evidence at the 5% level of significance shows that "Project team members perceive management software as a less effective tool in complex projects than it is in simple projects." This is because the *p*-value corresponding to project management software is less than 5%; however, the mean difference is positive. In other words, the one sample *t*-test indicated that the overall mean score for project management software (*M* = 5.00, *SD* = 1.73) is significantly greater than an average rating of 4 (*t* = 6.351; df = 121; *p*= .000). This implies that participants perceive project management software to be more effective for complex projects, which opposes the initial hypothesis. Thus, Hypothesis 7 is not supported. Nonetheless, further analysis is conducted in the following section to explore possible explanations for this result; the consequences of this finding will be discussed in Chapter 7.

To test the hypotheses for each individual item, a *t*-test was applied for each item, taking as a reference the middle value of 4. Table 6.6 shows the one sample *t*-test results for each item.

Construct	**Item**	**t**	**df**	***p*-value**	**Mean Difference**
Project Complexity	Q1	-12.667	121	.000	1.369
	Q2	-15.287	121	.000	1.434
	Q3	3.357	121	.001	.525
	Q4	21.524	121	.000	1.852
	Q5	.414	121	.679	-.066
	Q6	20.369	121	.000	1.656
	Q7	4.625	121	.000	.803
	Q8	1.207	121	.230	-.213
	Q9	17.871	121	.000	1.582
	Q18	7.610	121	.000	1.033
Mismatches of Variety/Variety Handling Capability	Q11	15.297	121	.000	1.459
	Q12	2.797	121	.006	.492
	Q13	-2.859	121	.005	.402
	Q14	16.439	121	.000	1.402
	Q15	1.408	121	.162	-.180
	Q16	5.631	121	.000	.664
Role Ambiguity	Q17	10.634	121	.000	1.246
	Q19	9.902	121	.000	1.189
	Q20	-7.417	121	.000	1.041
	Q21	-5.264	121	.000	.713
	Q24	-9.928	121	.000	1.156
Adhocracy Mechanisms	Q22	14.735	121	.000	1.467
	Q25	9.558	121	.000	1.082
	Q28	6.495	121	.000	.975
Procedural Mechanisms	Q23	-14.994	121	.000	-1.451
	Q26	-12.898	121	.000	-1.287
	Q27	-.409	121	.683	-.066
Positive Working Relationship Behaviors	Q29	14.582	121	.000	1.492
	Q31	.668	121	.505	.107
	Q32	15.016	121	.000	1.393
	Q34	14.242	121	.000	1.475
	Q37	12.044	121	.000	1.451
	Q39	12.798	121	.000	1.262
Negative Working Relationship Behaviors	Q30	-16.880	121	.000	-1.525
	Q33	-12.192	121	.000	-1.418
	Q35	-7.196	121	.000	-.951
	Q36	-13.922	121	.000	-1.279

	Q38	-17.692	121	.000	-1.697

Table 6.6: One Sample t-test Results for each Item

As Table 6.6 indicates, almost all hypotheses were confirmed by checking the sign of the difference between the mean of each item and the score 4. In only a few items (i.e., Q5, Q8, Q31, Q15, and Q27) was the hypothesis not statistically proven. Overall, the data analysis showed that all hypotheses—except for hypothesis 7—were significantly confirmed ($p < 0.05$).

6.3.4 The Effectiveness of Project Management Software

Regarding the effectiveness of project management software (Hypothesis 7), the initial findings seem conflicting and suggest that participants perceive the software to be more effective for complex projects. In the follow-up survey, participants were asked to answer a yes/no question regarding whether they had any past experience in using project management software. Based on their responses to this question, participants were split into groups defined as "users" and "nonusers." Table 6.7 shows the distribution of respondents based on whether they had used the software previously or not.

Past Experience	**Participants**
Users	46 (37.7%)
Nonusers	76 (62.3%)
Total	**122 (100%)**

Table 6.7: Past Experience with Project Management Tools

One interesting observation to note is the split in the responses to Question 50, which asked "Overall, based on your understanding of the project management software, it is most useful with [options]." The frequency of distribution, according to users and nonusers, of the perceived adequacy of the project management software score is shown in Figure 6.1.

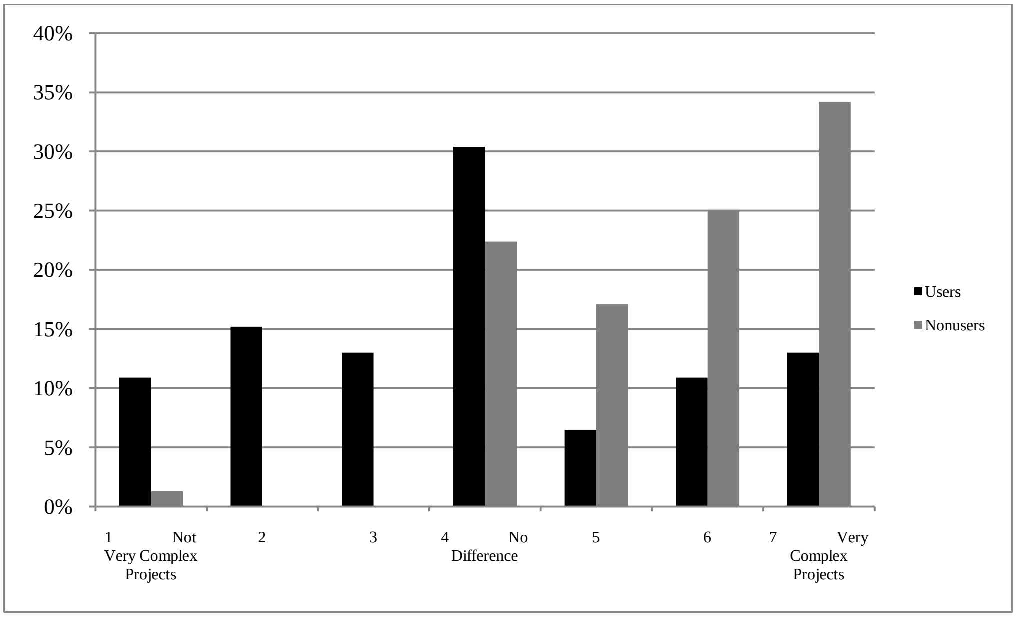

Figure 6.1: Users' and nonusers' perceptions toward project management software

Figure 6.1 indicates that, in general, nonusers perceive the project management tool to be effective for complex projects. On the other hand, it appears that participants with previous experience with the tool have an undecided view regarding its best uses.

Further analyzing the differences between the software users and nonusers yielded an interesting result regarding the differences in their perceptions of the software's role. Table 6.8 shows that users' average understanding of project management software as a useful tool for complex projects is 3.91 whereas nonusers' average is 5.66.

Past Experience	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Users	46	3.91	1.86	.274
Nonusers	76	5.66	1.28	.147

Table 6.8: Descriptive Analysis of Users and Nonusers

It is important to note that people not familiar with project management software (i.e., nonusers) considered the software to be statistically more useful for very complex projects than for less complex projects (average is equal to 5.66) at the 5% level of significance (see Table 6.9).

	t	**df**	***p*-value**	**Mean Difference**
Q50	11.28	75	.000	1.658

Table 6.9: One Sample t-test Results for Nonusers

On the other hand, users with previous experience with the software could not distinguish the adequacy of project management software for less complex projects versus very complex projects, as the average is 3.91. In other words, no agreement exists among software users on the exact types of projects with which the project management software can be used effectively. Results from the *t*-test prove this assumption at a 5% level of significance (see Table 6.10).

	t	**df**	***p*-value**	**Mean Difference**
Q50	-.317	45	.753	-.087

Table 6.10: One Sample t-test Results for Users

To compare means for both users and nonusers, it is necessary to first test the variance of Question 50 for each group, which was done using Levene's test. Levene's test for equality of variances indicated that the variances were significantly different (*p*-value = 0.027). A *t*-test assuming unequal variances resulted in a significant *t* value, thereby confirming this finding. We can conclude, therefore, that a statistical difference exists in the means for Question 50 between project management software users and nonusers at the 5% level of significance. Table 6.11 presents the results of Levene's test and the *t*-test for users and nonusers.

		Levene's Test for Equality of Variances		*t*-test for Equality of Means			
		F	*p*-value	t	df	*p*-value	Mean Difference
Q50	Equal variances assumed	4.996	.027	-6.128	120	.000	-1.745
	Equal variances not assumed			-5.608	71.046	.000	-1.745

Table 6.11: Levene's Test and t-test Results for Users and Nonusers

Appendix D presents the results concerning differences among groups based on demographic variables. Nevertheless, while these results present interesting findings, they do not pertain to the formal research hypotheses of this study. These analyses, however, may generate ideas for future studies.

6.4 Summary

This chapter presented the results of the follow-up survey involving the descriptive statistics of the demographic variables, along with the results of CFA test. Also, the hypotheses testing and their significance were presented using *t*-test analysis. The survey findings suggest that all hypotheses were supported except for the hypothesis regarding project management software (i.e., Hypothesis 7). Furthermore, an important pattern emerged indicating differences between project management users' and nonusers' perceptions of the effectiveness of project management software in handling different degrees of project complexity. The next chapter discusses the results from the qualitative (Chapter 5) and quantitative (Chapter 6) studies.

Chapter 7
Discussion

This chapter synthesizes the qualitative and quantitative data (i.e., triangulation) to make sense of actual situations and extract coherent meaning from the results. Due to the study's specific objectives, only major findings will be discussed thoroughly within the proposed theoretical framework.

7.1 Mismatches of Variety and Variety Handling Capability

The survey results support the notion that as project complexity increases, mismatches between variety and variety handling capability are magnified across all nodes. According to Ashby's Law of Requisite Variety, whenever input variety is greater than variety handling capability, output cannot be controlled, which then creates an unstable system. Understanding the distributed mismatches of variety and variety handling capability in the network can be considered a basic property of learning in organizations. Beer (1974) asserted that learning in organizations should focus on ways to attain stability. In other words, any system that does not recognize the stable state *cannot learn,* because the learning reference point is missing. The following subsections discuss mismatches between variety and variety handling capability.

7.1.1 Effectiveness of Interactions

This study shows that the helpful to not so helpful ratio (the IE ratio) can be used in several ways to assess a node based on its links in the network. One of this study's important finding relates to the estimated organizational IE ratio (1.03), which is based on the total number of helpful and not so helpful behaviors for all nodes. This ratio is used as a baseline to indicate whether a link is working effectively relative to the organizational average. The IE ratio, therefore, which indicates mismatches in variety and variety handling capabilities, can help examine the quality of the distributed interactions within the network.

This IE ratio is very important because it is often difficult to detect and measure the quality of intergroup interactions or to relate this quality of interaction (if detected) to aspects of managing projects. In MPC's case, nodes with an IE ratio below the organizational average of 1.03 are considered ineffective. Such nodes result in ineffectiveness accumulating across the entire process, because, as the saying goes, "the strength of a chain depends on its weakest link." In other words, the overall effectiveness of the system's interactions depends on the least effective nodes.

If MPC is motivated to improve its overall effectiveness, this organizational IE ratio could potentially be increased to 2.00 (i.e., two helpful behaviors for every not so helpful behavior) or even 3.00 (i.e., three helpful behaviors for every not so helpful behavior). A change in the organizational IE ratio will have a direct effect on the relative effectiveness of many links within the network because some of the effective links based on an IE ratio of 1.03 might then appear actually ineffective when the organizational IE ratio is improved.

7.1.1.1 Assessing the Volume and Effectiveness of Interactions

As noted in Chapter 5, participants were asked to rank their interdependent nodes based on relative *importance* and *performance* when working on a typical project. A correlation analysis shows a significantly high and positive correlation (0.378) between the ranking of importance and performance, meaning that the higher the importance of a node, the better the perception of its performance. In this context, it appears that people devote significant effort and energy to sustaining the most important links in their networks—those with a major and direct effect on their work—so that they operate effectively.

The results of the multiple regression analysis support the idea that the total helpful and not so helpful examples increase for a specific node and so will the ranking of nodes' importance. The rationale for using the total number of helpful and not so helpful behaviors to measure nodes' importance is that nodes perceived as significant will produce more incoming variety—both positive and negative—compared to those perceived as less significant in affecting a specific node in the network. The ranking of nodes' importance is of great value because the research on project management network analysis (e.g., Hossain, 2006; Hossain, 2009) assumes that all links in the network are equally important to the recipient node.

In addition, the results of the multiple regression analysis support the notion that the ranking of nodes' performance will increase as the IE ratios increase for a specific node. This significant relationship between node performance rankings and IE ratios reflects the assumption that people associate better performance with nodes that generate less variety and handle more variety. Therefore, the IE ratio, which indicates perceived node performance on the project, provides a way to quantify, measure, monitor, and report a specific node's performance.

These findings show that ranking a node's importance confirms the ability of the calculated total of helpful and not so helpful examples to reveal differences between links based on the volume of interactions. Specifically, the rankings of node importance are closely linked with the number of examples an interrelated node generated, regardless of the type of example (i.e., helpful or not so helpful). The rankings of node performance, on the other hand, confirm the ability of the IE ratio to predict the degree of link effectiveness. Specifically, node performance rankings are associated with the type of examples the participants provided: helpful examples are associated more with high performance, while not so helpful examples indicate low performance.

7.1.2 Symmetrical/Asymmetrical Relationships

As noted, a symmetrical relationship means that both nodes have relatively similar IE ratios. Asymmetrical relationships, on the other hand, indicate a significant difference exists between IE ratios and thus a discrepancy in the relationship. For analysis, the organizational IE ratio of 1.03 is used to assess whether a particular node acts as a variety generator (i.e., increases variety in the system) or a variety handler (i.e., decreases variety in the system) relative to other interrelated nodes. Specifically, an IE ratio below 1.03 indicates that a node is a variety generator, while an IE ratio greater than 1.03 indicates that a node is a variety handler. In this context, the organizational IE ratio serves as a baseline where a score's distance from 1.03 reflects the degree to which a node either generates or handles variety. Interestingly, based on the IE ratios among different nodes, it appears that interacting nodes have a mixed view of one another. In the case of MPC, one striking finding is that most interactions between interrelated nodes appeared asymmetrical (76.5%). This asymmetry in interactions means that not every node handles its part of the input variety, because the network is overflowing with excess variety. Governing asymmetrical relationships may indicate a "dysfunctional equilibrium" state in the system that requires immediate effort to improve organizational interactions.

The following subsection presents two examples of asymmetry to uncover possible reasons why such a discrepancy exists in the node's relationships. The first example involves an organizational level analysis of the Head Office and Plant relationship. The second example involves a departmental level analysis of the Production Department and its interrelated units.

7.1.2.1 Head Office and Plant Relationship

Figure 7.1 illustrates an organizational level analysis of the interactions between the Head Office and the Plant, showing that the Head Office is perceived as a variety generator and the Plant is perceived as a variety handler.

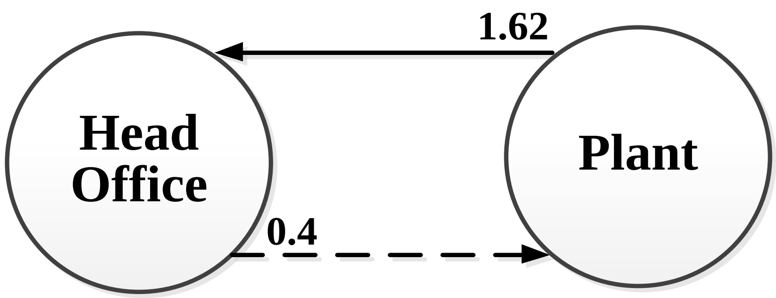

Figure 7.1: IE ratio between MPC's Head Office and Plant locations

The large proportion of undesirable variety the Head Office generates can be traced to the nature of its work. The Head Office mainly makes "requests" to the Plant, thus potentially creating more variety for the Plant to handle. For example, when referring to the Plant, a sales director noted, "Let me put it this way, we [i.e., Head Office] are the brains of the company and the Plant is the muscles. We are the thinkers and they are the doers." The qualitative data shows a huge difference in the type of variety the Head Office generates compared to the Plant (see Table 7.1).

Head Office's Point of View		**Plant's Point of View**	
Helpful	**Not So Helpful**	**Helpful**	**Not So Helpful**
Fast comprehension and implementation of our ideas	Late information about possible production delays	Flexible at adjusting product designs based on our capability	Pressuring us with many requests to accelerate product development
Adjusting to frequent changes of our plans	Delaying our requests	Informally communicating and updating task priority list	Frequent changes to plans
Keeping up with due dates	Unable to handle many of our new idea requests	Effective at handling Ministry of Health's requirements at early stages of product development	Not clearly communicating new product launch dates

Table 7.1: Typical Examples of Helpful and Not So Helpful Behaviors from the Recipient's Viewpoint

Analyzing the helpful categories supports the idea that Head Office is acting as a variety generator and the Plant is acting as a variety handler. For example, the Head Office reported a large proportion of helpful examples in the category of “competency” (35.9%) when describing the Plant’s role. In contrast, the Plant reported relatively fewer examples in the category of “competency” (25%) when describing the role of the Head Office. A medical advisor from Head Office shared a similar view about the competency of the Plant staff at his level, stating:

> The Plant people are overloaded, but very organized. Everything is done in steps. If you ask someone something or even ask his opinion on anything, he will first take a breath. He thinks first, and then answers. These people are qualified for the work. I wish that the way the work is done in the Plant–the system and style–were adopted and transferred and applied here [i.e., Head Office] strictly.

In addition, analysis of variety handling mechanisms showed that the Head Office mainly uses “suggesting” as a variety handling mechanism (32.22%) compared to the Plant (18.53%). This reflects a higher level of authority with which the Head Office sends orders to the Plant. When a Pharmaceutical Development Center manager described his interactions with Head Office, he stated:

> The problem is we consider Head Office our decision makers and this is wrong. For example, they give us a product to work on, and after some time, they tell us we don’t need the product anymore. Okay, so why didn’t they think it through from the beginning? We are supposed to at least question their reasons. What study is the Marketing Department building their conclusions on? We shouldn’t accept their changes to plans without at least asking for justifications.

In addition, the qualitative data shows that different types of dependencies (e.g., sequential versus reciprocal) may influence both helpful and not so helpful behaviors. In sequential dependency, the recipient node's output minimally affects node-generating variety; therefore, the sender may be less helpful to the recipient node. A Pharmaceutical Development Center manager confirmed that sequential dependencies provide fewer opportunities for others to engage in helpful behaviors. He reported, "Actually, I'm in a position to help them more than they can help me…they are taking the output from me." In contrast, having reciprocal dependency means the recipient node's output highly affects the sender node. In turn, the sender might be more helpful to the recipient node by minimizing future variety. For example, a production manager admitted he is willing to help the Pharmaceutical Development Center staff in their trials to ensure a better future position for himself, even though it is not part of his formal job. He stated:

> I'm easing his work, and it will help me too. How? For example, in the technology transfer process, based on our practical experience with the machines, I help him because his work is part of production. I work with him on the lab scale even though, as part of Production, I'm supposed to work only on the Production scale. However, when I work with him in the early stages on the lab scale and pilot batches, it will help me because I'll have fewer problems in the Production scale.

Conceptually, directionality of the relationships between interdependent nodes could significantly contribute to explaining the symmetrical and asymmetrical relationships in networks. It might be premature, however, to establish hypotheses in this study regarding the relative strength of directionality in predicting both symmetrical and asymmetrical relationships in task-related social networks. Still, this study's findings could provide some insight into establishing such hypotheses in future studies.

7.1.2.2 Production Department

A departmental analysis of the interactions between the Production Department and other interrelated units in the network shows that the Production Department was perceived as a variety generator (0.66) compared to interrelated organizational units, which Production perceived as variety handlers (1.13). Figure 7.2 shows the degree of asymmetry between the Production unit and other interrelated units.

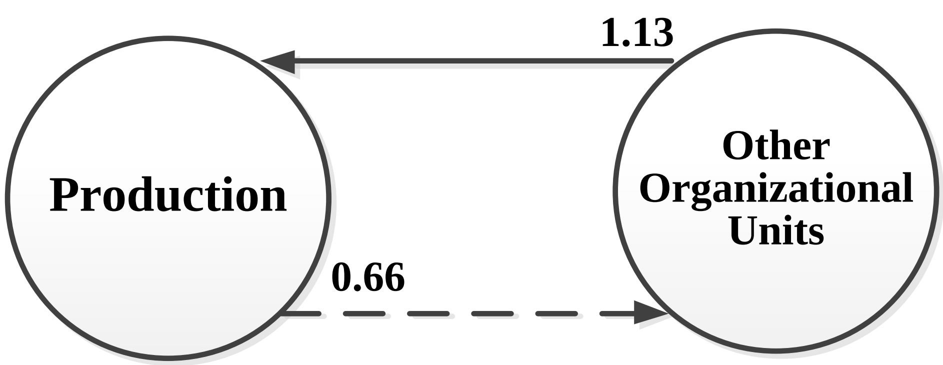

Figure 7.2: IE ratio between Production and Other Organizational Units

This asymmetrical relationship reflects an advantageous position for Production because it is protected against any disturbances in the relative environment. In other words, Production has more opportunities to generate excess variety for others, yet will be served with higher levels of variety handling by other interrelated units in the network. This concept is consistent with Mintzberg's (1979) notion that uncertainty is reduced as units become more internal. Specifically, Mintzberg (1979) stated, "… production departments, [are] best protected from environmental uncertainty…" (p. 272).

Another possible explanation for Production's advantageous position in relation to other departments lies in the consequences of production problems, which are usually visible and have organizational effects. This special treatment has resulted in the quality of providing predictable outputs to all interrelated units. A Production manager articulated this idea clearly when he explained the reasons for reducing disturbances to Production. He said:

> Usually, Production has the advantage of being supervised by top management. For that reason we are served by all departments; any error or delay is under the microscope. There will not be a product to sell. This is why the focus on us is high, but everyone helps us.

A Quality Services manager confirmed this when he said, “Production is usually the first priority in the company. Because they are Production and their output will go to the market, not like the Pharmaceutical Development Center, their job is to develop lab scale products. Their product trials are within the company.”

7.1.3 Variability of Interactions

The present findings show that many nodes in the network exhibit a large range of variability – from 0.10 to 1.28 – in their IE ratios when interacting with different interdependent nodes. This variability indicates that input variety affects different units to different degrees. This uneven distribution of input variety to all units may be a result of unbalanced workloads, as some units face more input variety than others. This idea is consistent with Mintzberg’s (1979) who suggested that “A further source of inefficiency in the Adhocracy is the unbalanced workloads…” (p. 464).

One possible explanation for this wide range of IE ratios may be linked to the organizational design of tasks within projects, such as “linear” tasks, which means that tasks are designed as a sequential flow of relationships. It appears, however, that this linear process of developing new products does not reflect reduced variety throughout the nodes. The actual process of managing projects can be seen as a “linearizing mess,” in which different units are required to handle just portions of the project variety based on their role. Thus, in the process of reducing tasks into linear parts, some units may generate undesirable variety for other interrelated units.

In addition, variability practiced across all nodes to different degrees implies that no universal or absolute behavior exists. That is, behaviors within the task-related social networks are situational and depend on many factors, both personal and structural. In the following subsection, the Quality Services Department and two of its interconnected nodes are used to illustrate *variability* in IE ratios.

7.1.3.1 Quality Services: A Bureaucratic Unit in a Dynamic System

The Quality Services Department is responsible for critically monitoring and reviewing all product samples, raw materials, and finished products for approval based on predefined rules and regulations. The tasks Quality Services undertakes includes internal quality investigations and audits to ensure that all products, raw materials, and processes meet pharmaceutical industry standards. Within Quality Services, however, job processes may result in unintended difficulties to interrelated nodes. A Quality Services manager affirmed:

> This is a reality we are living here. Throughout the world, there is a lack of agreement between Quality Services and all departments, especially Production. People do not like giving them instructions. All the time, this is a subject of argument, but it's nothing personal; it's all business.

Analyzing the qualitative data shows that Quality Services has a bureaucratic relationship with others, because it is responsible for enforcing rules and procedures on others. For example, a Quality Services manager affirmed that rules and procedures should help alleviate problems. He explained:

> You see, in any system, it is not the machine, the paper, or the building that creates problems – it's the humans. I always say that humans are the most problematic element in any business. They are very difficult to control because everybody is thinking in his own way. We as Quality Services are doing our best, based on our expertise and training and extensive documentation, to force people to do the right thing because we cannot afford mistakes.

Mintzberg (1979) agreed, stating, "The more stable and repetitive the work, the more programmed it is and the more bureaucratic that part of the organization that contains it" (p. 91). The existence of Quality Services as a bureaucratic unit in the network is thus consistent with Mintzberg's (1979) notion of Professional Bureaucracy organizations in which "… professionalism and bureaucracy can coexist in the same structure" (p. 103).

In this context, Quality Services is seen as a bottleneck in the process in which its inherent role is to double-check things, thus slowing down projects' progress. For example, a Production manager commented that Quality Services imposed many constraints on Production's progress, thereby delaying work. He stated:

> The routine work of Quality Services results in many problems because their requirements slow down the work pace. For example, all approvals should be in written form. Sometimes we already have the approval, but we need the signature of the departments concerned at the time and cannot start production until all approvals are collected, which results in problems, unfortunately. Those who work with machinery and equipment, after a certain time, become obsessed with numbers – how many I produced and how much I should produce. While the Quality Service people look at the product from a quality dimension, they make sure all products conform with the specifications and standards, but ultimately you are delaying my work.

Another Production manager shared a similar view about Quality Services' way of resolving problems. He stated:

> If they suspect a problem with one of the machines, even if it's only 1%, they will perform a full inspection of all of them. This inspection can take a full day to process. Of course, their action may be right, but actions should be reasonable. For example, if the printing of some manufacturing and expiration dates is unclear though still legible, they will go and put the whole batch on hold to inspect each and every piece.

Interestingly, a Quality Services supervisor admitted he sometimes intentionally delays production to reinforce others' appreciation of the importance of quality. He emphasized:

> Whenever I feel Production is rushing things and not paying attention to quality issues, I directly stop the line. When I stop them, they will be affected, and I'm sure they will realize the size of their mistake and may be convinced in future that rushing things is a problem.

On the one hand, Quality Services' overwhelming priority for improved product quality leads to increased time to market. On the other hand, departments such Inventory Control & Production Planning frequently cut corners to meet deadlines at the expense of product quality, which may be one source of frequent conflict with Quality Services. In the next section, a detailed analyses examines how the Inventory Control & Production Planning and Procurement departments interact with Quality Services in such a dynamic environment. All analyses will be presented and discussed in light of helpful and not so helpful comments.

The IE ratios for Quality Services was 0.14 and 0.5 for Inventory Control & Production Planning, respectively. This discrepancy in perceived IE ratios implies that both Quality Services and Inventory Control & Production Planning perceive the other as variety generators (see Figure 7.3).

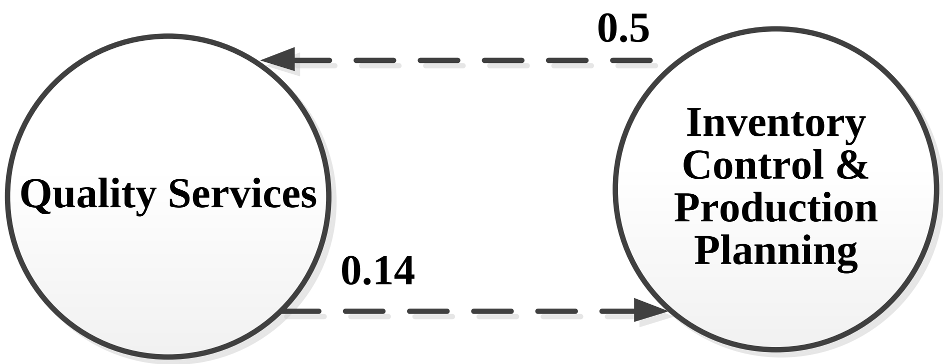

Figure 7.3: IE ratio between Quality Services and Inventory Control & Production Planning

The qualitative data shows that Quality Services gains control over the behavior of other interrelated units in two ways. First, Quality Services enforces rules and standards as a way to coordinate work. For example, when referring to rules and standards, a Quality Services manager commented, “the ultimate rule in the company is that everything should go according to rules and standards; you know, procedures are the law here.” Another Quality Services manager explained:

> Sometimes, other departments may have more experience than ours, but we have the power of rules. . .all departments should know that we have our own way of seeing things and we will focus on this way and enforce it for the benefit of the company. To be honest, I regard them with full suspicion and they should trust that I will make sure at the end of the day that things are safe.

Second, Quality Services relies on formal systems (e.g., SAP) to communicate and report work. For example, a Quality Services manager reported:

> Of course, we face problems when people are hiding problems and not reporting them in the right way. We have a clear system. Anyone who speaks outside the system, I personally

> consider it a violation. In my opinion, people who speak off the record are not honest. But at the end of the day, this is an expected thing because if people did not do wrong things, then we would not have been established as a department from the beginning.

Further analysis of the helpful category of "basic job performance" indicates that Quality Services is more concerned about others "following rules and procedures," which represents 50% of their "basic job performance" comments. On the other hand, analyzing the not so helpful category of "incompetency" shows many comments about others "not following rules and procedures," represent 33.3% of all "incompetency" comments. A Quality Services manager acknowledged this when he said, "There are always some hiccups coming from people who tend to go for a shortcut. They think they are not going to jeopardize product quality because it is only in the beginning of the product development stage." He elaborated:

> Sometimes people make smart moves and then they make these mistakes. You know most of the mistakes happen when people do not follow procedures in a given situation. So, we encourage people . . .we always tell people that even if it takes 30 minutes extra to do it, saving five minutes may jeopardize the overall quality and necessitate a retrospective inspection. We tell them all the time in this business – just stick to the written and approved procedures.

Quality Services is thus reducing external variety by reducing the variability of its requirements (e.g., standardizing process). Quality Services has attempted to establish routines and stabilize work by establishing and enforcing standard forms for the formal output of other units. In this way, Quality Services is trying to deal with interrelated units on a routine and predictable basis.

This tendency to enforce rules and procedures over others is meant to ensure stability. It appears, however, that Quality Services is obsessed with having everything under control. That is, Quality Services wants to control its relative environment to ensure internal efficiency. This idea is consistent with Mintzberg's (1979) notion that "… organizations formalize behavior to reduce variability, ultimately to predict and control it" (p. 83). Broadly speaking, for Quality Services, rules and procedures can be seen as an end, while for other units, rules and procedures are a means to another end. For example, a Marketing manager illustrated, "Our ultimate objective is not to follow the system. Our ultimate objective is to get things done with the support of the system. We should think about ways to survive within the system. You use the system to reach something. We should not follow rules blindly."

Prior research shows that rules and procedures provide the preferred way to handle tasks, but do not specify all possible ways that a task can be handled (Mckay et al., 1999). Specifically, as uncertainty increases, rules and procedures (as a variety handling mechanism) cannot meet every contingency in the project. This leads to frequent conflicts. For example, Inventory Control & Production Planning made many comments about standard rules and procedures, labeling them as "red tape," "inconsistent," and "nonproductive." Specific examples of such rigidity include filling out unnecessary paperwork and requiring a long time to approve decisions. For example, when dealing with Quality Services requirements, a Production manger stated:

> Also, one of the things that causes difficulties is the documents. Quality Services sometimes makes strange decisions. For example, we prepare the documents and then just because there is a formulation of a sentence that the manager personally dislikes, the document is returned for correction, and I need to change the sentence and have it signed again by my manager. All this headache is because of his style of writing things up. One time, the document went back

> and forth for corrections six or seven times. If it was a critical issue, I wouldn't mind, but all their comments are about minor things in the document, and this is bad.

In contrast, a Quality Services manager in discussing his perspective explained:

> I might be picky on minor mistakes when I audit their documents maybe intentionally or unintentionally. I don't want them to lower their quality standards. They should always improve their way of working. You know, if I told him, 'Okay, this is a minor problem, don't worry about it,' and let him walk away, then he may think, 'Okay, this is acceptable,' and may cause major problems in the future. I know people dislike us in the company, but at least we are programmed to work according to the system, which is the right thing to do.

Quality Services also tends to reduce variety by requesting forms be filled in with all the required detailed data. A Quality Services manager acknowledged this, saying:

> For every step, there is a document that you should fill out and check. You know the definition of GMP is 'Good Manufacturing Practices,' but my own definition of GMP is 'Give Me Paper,' and recently it was modified to 'Current Good Manufacturing Practices.' I just defined it in my own way – 'Continue Giving Me Paper,' so this is what it is when everybody documents things correctly, not leaving room for somebody's perceptions or understanding or philosophy to come in the way. I always say to people, 'Write as you do, and do as you write.'

While filling out forms correctly is critical to Quality Services, these required forms may pose a source of conflict, especially when the required data is not available. Indeed, analyzing the comments in the not so helpful category of "miscommunication" reveals that Quality Services makes many comments about forms with mistakes. These comments represent 53.3% of its “miscommunication.” A Quality Services manager asserted that:

> There is a total dependency on Quality Services to correct any mistakes in filling out forms. Sorry, not ‘total’ but ‘heavy.’ I don’t know, but they are careless in filling out forms. Maybe they say, ‘Quality has many comments, so let them correct the forms.’ I want to say that people here are too dependent on us. They think that since we figure out the mistakes, we should also correct them, and this is wrong!

One possible explanation for frequent errors in completing required forms is the lack of sufficient information. In other words, Inventory Control & Production Planning may not have had enough variety handling capabilities at the time to complete the Quality Services forms sufficiently.

Interestingly, some units appear to adopt workaround techniques to meet the structural constraints imposed by Quality Services. For instance, people may fill out forms with invalid data to buy time, because uncertainty declines over time. From this perspective, Quality Services continuing to insist that other units fill out these forms may only lead to more invalid data. Consequently, the tighter the control system, the more it may result in workaround activities and false data. In this context, Merton’s (1940) original work on dysfunctional consequences of bureaucracy may explain the rigidity of some nodes’ behaviors. A Pharmaceutical Development Center manager concluded, “It is very important to have technically qualified people in Quality Services who can understand product issues from a technical perspective instead of raising issues that are trivial and not critical and delay the project.”

In addition, Quality Services appears to favor formal communication channels and a formal chain of authority for decision making. For example, a Quality Services manager, commenting on the use of e-mails as a way to communicate, said:

> Consider the use of e-mails, for example, to ask us about the status of raw materials. There is supposed to be a schedule on the SAP system, which means we should all work according to the plan without any e-mails during the process. The most important thing is to avoid e-mails. When I say, ‘avoid e-mails,’ I mean also avoiding any reminders. I’m responsible for pulling data from SAP and working accordingly. You know, the material number is there and the quality control date and quality assurance date – everything is on the system. We should all focus on what’s on the system without any interference.

For Inventory Control & Production Planning, however, frequent adjustments and changes are the norm. This may explain why Inventory Control & Production Planning is reluctant to provide valid and timely data in order for the formal system to work effectively. In this sense, why should the Inventory Control & Production Planning people give Quality Services the information it requires, especially if they will end up “looking bad” in the formal system? An Inventory Control & Production Planning manager affirmed this notion:

> You know, as the Inventory Control Department, the nature of our work is fast and changes as we speak. It is not reasonable for us, for every small change in the plan, to go and change it on SAP. You will find me the whole day on SAP just changing and changing and changing!

Interestingly, the data show that different patterns of interactions develop and emerge over time. For example, most interconnected nodes may perceive Quality Services personnel as “pushy” and their requests as “annoying.” These interactions, however, seem to stabilize over time, resulting in improved IE ratios for some units (e.g., Procurement). In this regard, the IE ratio for Quality Services was calculated to be 2.00 and for Procurement it was 4.00, meaning that both Quality Services and Procurement perceive each other as a variety handler (see Figure 7.4).

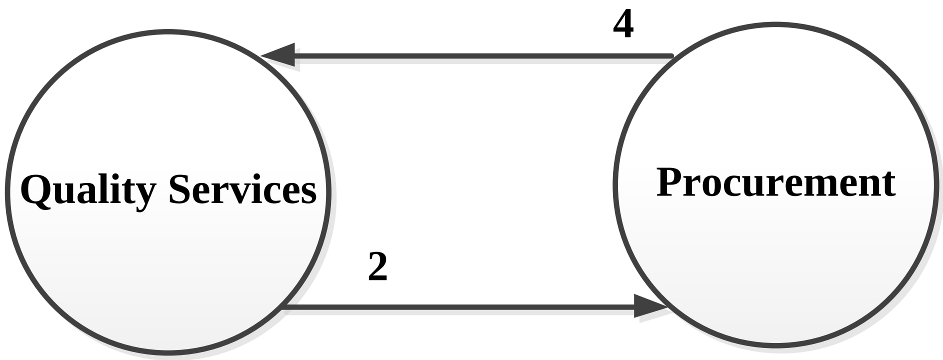

Figure 7.4: IE ratio between Quality Services and Procurement

Analyzing the helpful category of "basic job performance" reveals comments regarding the criteria Quality Services should develop for Procurement to use when evaluating and selecting suppliers and raw materials. In this context, Quality Services is reducing variety for Procurement personnel by providing them with ways to handle their input variety. As Procurement aligns its activities with Quality Services, however, it is apparently interrupting and transferring excess variety to other interrelated units, including Inventory Control & Production Planning. This idea is consistent with Mintzberg's (1979) notion, which suggests that "… conflict is not *resolved* in the Machine Bureaucracy; rather it is bottled up so that the work can get done" (p. 321). In addition, the Quality Services and Procurement Departments appear to share a similar "slow work pace" in which the goal to increase work speed was mentioned as less or not at all important in their helpful and not so helpful comments. Figure 7.5 clearly shows the effective interaction between Quality Services and Procurement, and highlights the extremely ineffective interactions between Inventory Control & Production Planning. This reflects the degree of variability in Quality Services' relationships with other nodes.

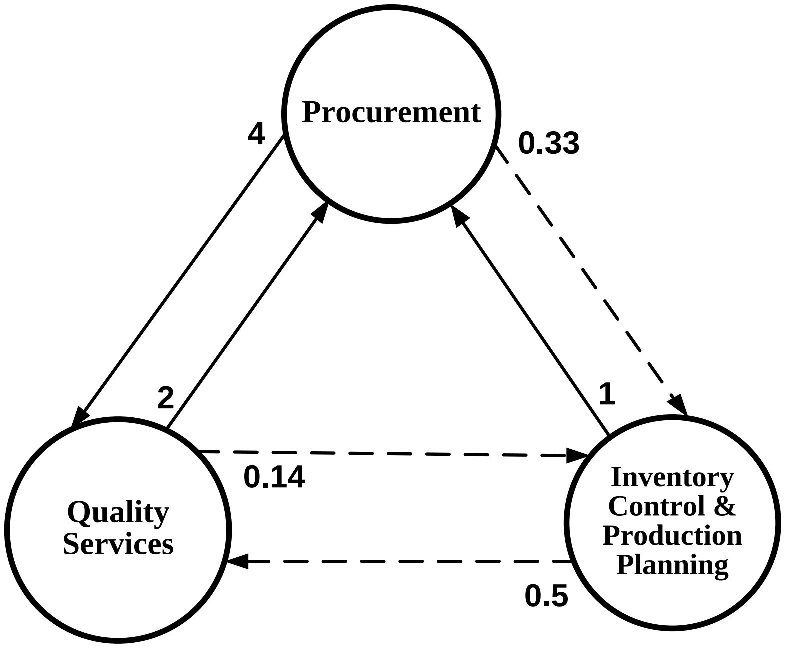

Figure 7.5: Variability of IE ratios among Quality Services, Procurement, and Inventory Control & Production Planning

While nodes are performing their individual tasks, they might overlook the context in which they jointly work with other units. An Inventory Control & Production Planning manager explained the importance of having a holistic view of the workflow:

> The goal of training people on SAP is to help them understand the logic of the workflow. I mean having people with a system-oriented mentality in the sense that they know the full cycle of the work. I don't want people entering data into the system. I can recruit anybody who can enter data with both eyes closed. I need people to know the cycle of the work. To know their role in this stage, but also to know the stage before them and after them, till the end of the project cycle and what their impact is on the final result of the project. This is what counts.

In MPC's case, both Quality Services and Procurement as low-variety handlers generate undesirable variety for Inventory Control & Production Planning by delaying the process and imposing constraints. In other words, such bureaucratic units in the task-related social network may have the dysfunctional effect of systematically generating undesirable variety for interrelated units because they introduce more rigidity into a dynamic system. On the other hand, Inventory Control & Production Planning generate excess variety for both Quality Services and Procurement by requiring a considerable degree of flexibility, relying on informal communication mechanisms, and pushing for approvals and materials with minimum lead times. A Quality Services manager asserted:

> Strangely, once we receive raw material from Procurement, they want it tested and finished immediately. Okay, where is the schedule? What's the goal of planning if this is the case? I don't know; maybe they have urgent orders all the time. But still, I think they should organize themselves so that they don't pressure us all the time. For example, I pull the schedule for today from SAP and arrange my work with others, and suddenly I am surprised to find tomorrow's schedule has changed. This is an eternal problem here, and, personally, I don't think it will be solved. You know the nature of their work is rushing things all the time and we just can't catch up with them.

7.1.4 Categorical Analysis of Helpful and Not So Helpful Comments

This section thoroughly discusses the results of the helpful and not so helpful categories presented in Chapter 5. The discussion begins at the organizational level, followed by a similar discussion at the location (Head Office and Plant) and departmental levels.

Organization-wide, "competency" (30.02%) received the highest number of helpful comments, while "cooperation" (19.64%) received the lowest proportion of helpful comments. The high proportion of helpful examples related to "competency" rather than "cooperation" reflects the relative importance of such elements in managing projects.

Analyzing the not so helpful comments reveal an uneven distribution across categories, with almost half of all remarks falling into the category of "incompetency." The high proportion of examples related to "incompetency" (49.28%) suggests that certain task connections are either not fulfilling their basic job duties in attending to the project properly or exhibit behaviors (inefficient, ineffective, inexperienced) that encompass incompetence. This proportion is much higher compared to other not so helpful categories such as "non-cooperation" (9.57%). The data appears to show that MPC employees perceive that critical problems are due largely to the incompetency of people involved in managing projects.

Interestingly, one of the largest differences between the Head Office and Plant occurred in the category of "competency." The Head Office (35.9%) perceives that the Plant (25%) is more competent at doing its work. This discrepancy in perceptions between the Head Office and the Plant might be due to the fact that the Head Office lacks technical knowledge about product development; therefore, it attributes more competent qualities to Plant personnel.

Surprisingly, only minor variations in the distribution of not so helpful comments between the Head Office (M = 25, SD = 0.21) and the Plant (M = 25, SD = 0.19) were found among all not so helpful categories. As noted, the Head Office and the Plant are separated both geographically and functionally, and they require different skills to deal with projects. Significant differences were expected, therefore, between these two groups based on their distinct roles in managing projects (i.e., managerial versus technical).

These minor variations in the not so helpful categories between the Head Office and the Plant may be the result of using higher-level categories for the analysis. The analysis captures fewer differences between groups when using a more abstract category. It may be fruitful, therefore, to develop more detailed sub-categories for each not so helpful category to capture differences between groups that would provide more essential data. For instance, when analyzing the comments under the "miscommunication" category for both the Head Office and the Plant, major differences appear in the *kind* of comments each group provided — even though all comments were classifieds initially under the category of "miscommunication." Specifically, the Plant's comments relate more to the Head Office frequently sending "incorrect information." On the other hand, the Head Office's comments relate more about receiving "delayed information" from the Plant units. Clearly, after identifying the various practices between the Head Office and the Plant, a huge difference in the types of comments is apparent, yet all comments were categorized under the label "miscommunication." This finding further affirms the importance of developing more detailed sub-categories within the qualitative study to capture distinct differences between groups.

With respect to differences *between* departments in terms of the helpful and not so helpful categories, some departments placed examples evenly across all categories, while other departments were more selective and placed significantly more examples in some categories than others. Consistently distributing examples within all categories reflects the relative importance of all categories in managing a project. For example, the Pharmaceutical Development Center had an even distribution of helpful examples across all categories (M = 25, SD = 0.04), meaning that all types of helpful behaviors by others are considered important. This may be explained by the fact that the Pharmaceutical Development Center is the most central node in the task-related social network and has a high degree of variability in its IE ratios (M = 0.78, SD = 1.28). Thus, it requires different qualities to effectively handle the greater variety that results from a larger number of interrelated nodes with divergent roles on the project. Other departments, such as Marketing, placed most of their examples in the helpful category of "basic job performance" (38.18%), indicating that other categories may not be as important for them to accomplish their tasks.

It is noteworthy that the distribution of examples across categories reflects the different needs and motives of each department. For example, employees in the Inventory Control & Production Planning Department appear to be the most concerned with the “competency” of others (34.38%), while those in the Marketing Department appear the least concerned. Further analyzing the comments participants from the Inventory Control & Production Planning Department provided indicate that they are concerned mainly about others being flexible and adapting quickly to schedule changes. This reflects partly upon their roles in projects, which include handling frequent changes in plans imposed by Marketing. Marketing staff reported most examples in the helpful category of “basic job performance” (38.18%), reflecting their primary role of providing other units with plans that must be executed accordingly.

On the not so helpful side, people in the Inventory Control & Production Planning Department appear to be the most concerned with the “incompetency” of others (58.33%). This high proportion of examples reflects the elevated difficulty facing Inventory Control & Production Planning staff, who are expected to schedule production to satisfy marketing plans, which are often a moving target. In this context, Inventory Control & Production Planning may be in a state of constant flux, with the department’s staff members facing two types of “incompetency;” indeed, Marketing staff members change plans frequently, and it is difficult, if not impossible, for the affected departments to adapt to these frequent changes.

Surprisingly, many variety senders classified numerous examples as “helpful,” while many variety recipients classified the same examples as “not so helpful.” Put differently, the same variety generated by senders may have opposite effects on receivers. On one hand, variety senders generate variety and appreciate that the recipient is able to handle such variety. In contrast, the recipient node may feel obliged to handle the variety, but does not appreciate it.

And yet, a variety sender may be unaware that its behaviors are not so helpful to the recipient nodes. One possible explanation for this disconnect is that project team members might not share a common, clear model of how the project actually functions as a system. That is, each node reflects a local and operational mindset, which leads to sub-optimal results and increased difficulties for other interrelated nodes. Table 7.2 presents many comments that appear helpful to the senders, but not so helpful to the recipients.

Department's Point of View	Helpful Example	Department's Point of View	Not So Helpful Example
Marketing	Seeking and recommending new products	**Business Development**	Difficult to convince them of new ideas (they prefer extending existing products instead of adopting new product ideas; they require many compromises before agreeing to a new idea)
Business Development	Providing us with technical information about new products that helps us convince marketing people to accept our new ideas	**Medical**	Too business oriented (oversimplifies our role in product development)
Medical	Good understanding of, and respect for, our recommendations	**Business Development**	Lack of business sense (overreacting to minor side effects of new products)
Business Development	Providing us with structured and clear answers to our inquiries	**Pharmaceutical Development Center**	Lack of initiatives to solve problems (passing all external inquiries to us)
Pharmaceutical Development Center	Minimize changes on our side and successfully changing licensor's requirements	**Business Development**	Unable to handle many of our new idea requests
Business Development	Providing us with detailed forecasts for any new idea	**Marketing**	Not providing us with complete information (scenarios) about their new ideas (many underdeveloped ideas)
Inventory Control & Production Planning	Providing us with accurate forecasts and orders through SAP	**Marketing**	Forcing us to adjust our forecasts to their batch sizes
Marketing	Informing us of our mistakes in forecasted sales	**Inventory Control & Production Planning**	Not updating their forecasts to reflect actual sales performance
Pharmaceutical Development Center	Ensuring machine availability for trials	**Inventory Control & Production Planning**	Disturbing our schedules with their new product trials
Inventory Control & Production Planning	Handling exceptional cases effectively	**Procurement**	Submitting purchase requests with difficult request dates to achieve
Inventory Control & Production Planning	Following up on orders with suppliers effectively	**Procurement**	Pressuring us with many follow-ups
Inventory Control & Production	Keeping up with schedules (sticking to plans)	**Production**	Continuous changes to plans

Planning			
Production	Solving our problems because our output is critical to their work	**Inventory Control & Production Planning**	Lack of initiative to solve even minor problems
Inventory Control & Production Planning	Quick approvals for new products	**Quality Services**	Asking for approvals at short notice
Marketing	Treating our urgent requests as high-priority items	**Medical**	Pressuring us with many urgent requests (no clear priority list)
Medical	Trying to understand our complaints and negotiate compromise solutions	**Marketing**	Lack of business sense (too academic)
Sales	Quickly responding to our inquires	**Medical**	Pressuring us with many urgent requests (no clear priority list)
Pharmaceutical Development Center	Supportive in scheduling machines for trials	**Production**	Disturbing our work schedules with their product trials
Production	React to our problems immediately	**Pharmaceutical Development Center**	Lack of initiative in solving their own problems
Production	Flexible in scheduling their trial batches	**Pharmaceutical Development Center**	Difficulty scheduling machines for product trials
Pharmaceutical Development Center	Fixing any deviations in validation parameters	**Quality Services**	Providing us with product validation methods that do not work
Pharmaceutical Development Center	Doing microbiology tests although it is part of our work	**Quality Services**	No microbiology background (sending all samples to test for microbiology although our role is to verify, not to develop)
Quality Services	Develop products based on specifications (following procedures)	**Pharmaceutical Development Center**	Narrowly focusing on the quality dimension at the expense of quantity (micromanagement)
Quality Services	Following product specifications	**Production**	Enforcing their working routines (unnecessary bureaucratic procedures)
Quality Services	Accepting our advice with high levels of trust	**Production**	Lack of technical trust although we are more expert in the production area

Table 7.2: Perceptions of Passing Variety across Interrelated Units

7.1.5 Reducing Mismatches between Variety and Variety Handling Capabilities

This section presents three approaches to mitigate the mismatches of variety and variety handling capabilities within the task-related social network. The first section introduces an organizational level approach, and is followed by two localized strategies.

7.1.5.1 Redesign the Task-related Social Network

The formal task structure can be redesigned to reduce variety mismatches inherent in the current structure. By doing so, managers can *dissolve* project management problems by changing the nature of the problem or its environment (Ackoff, 1981). That is, rather than examining the parts to find a solution, the focus becomes solving the problem by changing the characteristics of the larger system that contains the problem. For example, redesigning the task-related social network includes restructuring the organization. In MPC's case, many inter-node communication and coordination difficulties may be linked to MPC's linear management structure, namely its functional structure. One solution is to change the company's functional structure to a matrix structure that would facilitate speed, flexibility, and more efficient use of resources.

To illustrate this concept, an example of the mismatch of variety and variety handling capability is drawn from the relationship between the Quality Services and Production departments (Figure 7.6).

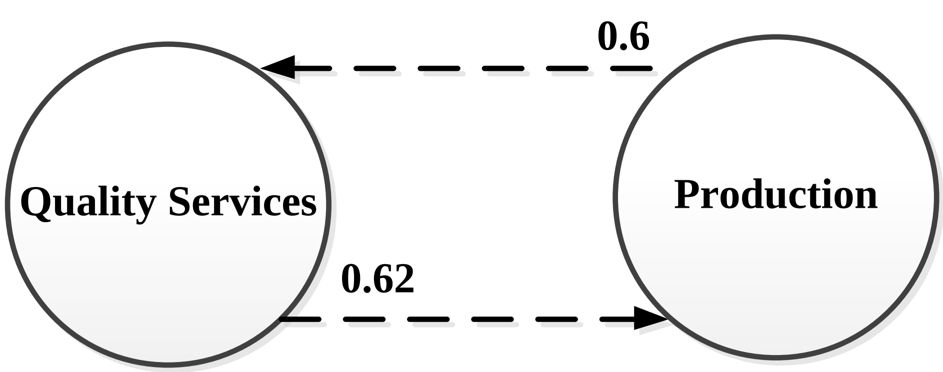

Figure 7.6: IE Ratio between Quality Services and Production

This mismatch problem can be attributed partly to the design of the two nodes. The Quality Services Department is designed to gather precise information in a strict format for documentation purposes. A Quality Services manager asserted:

> He just can't run away from that problem. As I said before, it is an integrated system and everything needs to be logged and every activity needs to be recorded, whether it's a breakdown in maintenance or changing small nuts and bolts, or even stopping the machine for any good reason.

Quality Services is thus viewed as inflexible and bureaucratic because the Production Department might not have enough variety handling capabilities at the time to complete the Quality Services forms sufficiently. A solution could be to establish an intermediate node that would be responsible for gathering raw data from the Production Department and completing all necessary forms for Quality Services. In this way, the new node would act as a buffer to filter out any excess variety. This would likely improve the IE ratio for both Quality Services and Production.

It is worth noting, however, that some researchers (e.g., Safayeni et al., 2008) asserted that major stakeholders might resist any attempt to alter the task structure. Consequently, focusing on localized strategies may be preferable, especially in the short term. To further illustrate this concept, the following subsections, therefore, present two localized strategies related to the theoretical model.

7.1.5.2 Reduce the Frequency of Not So Helpful Behaviors: Reducing Variety

Mismatches in variety mean that recipient nodes may have difficulty handling variety generated by senders. One way to reduce mismatches in variety and variety handling capability is to reduce variety at source. For example, the Business Development Department's role is to find and suggest new product ideas. The Marketing Department is then supposed to conduct feasibility studies (i.e., assess the idea) to evaluate the potential market value of the proposed ideas. Marketing employees, however, claim that Business Development often sends underdeveloped, ambiguous, and unsatisfactory ideas, which generates undesirable variety. A Marketing manager confirmed this belief:

> Usually, Business Development provides us with new ideas, but without much supporting evidence. Or they provide us with a concept without a full study and without the full picture. We need new product ideas to be fully cooked and fully prepared with scenarios and complete overviews. If I had these kinds of ideas, my job would be easier. Then, I'd be able to evaluate whether the views were right or wrong in no time. You know, if the rejection rate is 50%, which is actually what's happening here, then they should focus at least on reducing this percentage to 20%. They're sending ideas that will obviously be rejected; ideas like asking a high-tech company to produce floppy disks. Who would do that? We need this quality-versus-quantity battle to end and very soon.

From the data, it appears that the Business Development Department assumes that the Marketing Department should handle this undesirable variety. One explanation for this frequent conflict between Business Development and Marketing relates to how the company formally measures the performance of the Business Development Department; it is measured primarily according to its ability to produce new ideas. One solution to reduce variety at the source could be to include an item in Business Development's formal performance appraisal that links its performance to the number of *successful* production ideas. Business Development, therefore, would be expected to reduce its variety output to the Marketing Department. It would reduce its variety output effectively by increasing the *quality* of new product ideas rather than focusing on the *quantity* of new product ideas as a sign of high performance. Reducing variety at the source would create a high-performance work system in which performance is measured based on organizational interactions between nodes rather than the local functional activities of an individual node.

Another mismatch between variety and variety handling capability can be illustrated with the Marketing Department and the Inventory Control & Production Planning Department (Figure 7.7).

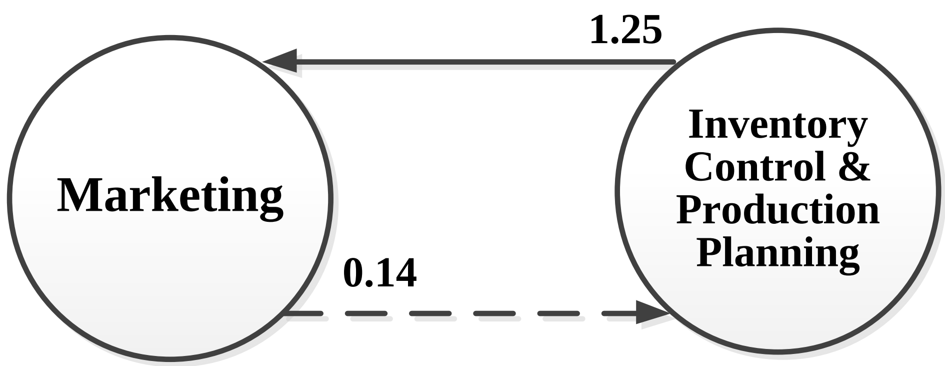

Figure 7.7: IE Ratio between Marketing and Inventory Control & Production Planning

This mismatch in variety and variety handling capability is attributable partly to frequent changes in the Marketing Department's marketing plans due to fluctuating demand over time. These changes led to increased variety that affects many departments, including Inventory Control & Production Planning. A Pharmaceutical Development Center manager commented:

> One problem is that the priority keeps changing. Sometimes, we cannot focus on one product. This is a common problem because we leave this job and go do another product….just shuffling between jobs. . .and we need to sit and try to remember. You know, we are not like a computer you shut down and open up again and it just opens on the same page. You need to warm up again. It depends on the capacity – some people remember very well without warming up. You know, when it is hot, you can hit it, but when it cools down, you need to redo the job, and this shifting of priorities is a big problem we face here.

Similarly, an Inventory Control & Production Planning manager asserted, “What bothers me most about the Marketing people is that everything is urgent. Introducing this product is urgent and canceling the same product tomorrow is urgent. These changes between orders are endless.”

In this case, a possible approach to reducing the variety at the source is to implement a six-month freeze policy after marketing plans are approved to ensure minimal disruption to all interrelated nodes. It is worth noting that this approach to reducing variety may result in a short-term decrease in profits because of missed market opportunities. The move, however, may lead to improved organizational effectiveness in the long-term because the stability of the system will increase.

7.1.5.3 Increase the Frequency of Helpful Behaviors: Increasing Variety Handling Capability

Increasing the variety handling capability by increasing the node’s adaptability—its capacity to respond sufficiently to input variety—is another option to reduce mismatches in variety and variety handling capability. In MPC’s, a mismatch in variety and variety handling capability exists between the Production Department and the Pharmaceutical Development Center (Figure 7.8), which can be used to illustrate this concept.

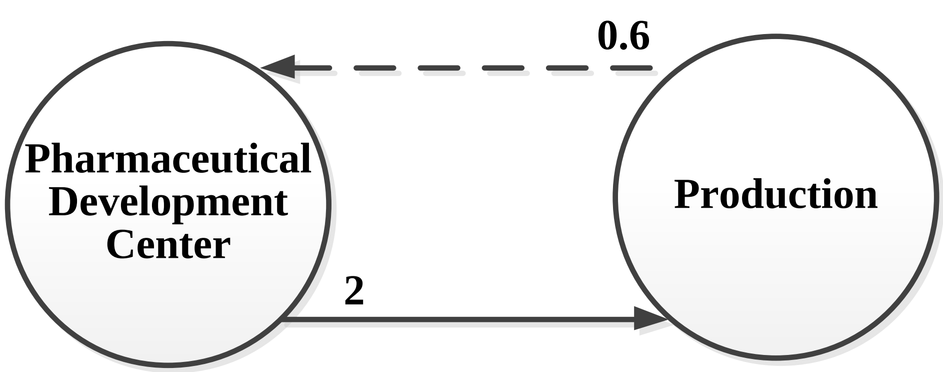

Figure 7.8: IE Ratio between the Pharmaceutical Development Center and Production

Frequent conflicts between both departments regarding scheduling using production machines for product trials explains this mismatch in variety and variety handling capability. For example, when a Production manager discussed his interactions with the Pharmaceutical Development Center, he reported:

> One of the things that disturbs us is being asked for scale-up trials on a particular day where we are working on a product and need to finish it. But, they need the machine on the same day, so we stop our work and clean the machines and then let them use our machines for their trials. These trials are disabling production.

One solution would be to establish a new, stand-alone mini-plant as a nursery production facility so that the Pharmaceutical Development Center could reduce its heavy dependence on the Production Department's machines. This would reduce coordination problems regarding machine scheduling and curtail disturbances to Production. An Inventory Control & Production Planning manager explained the importance of maintaining a degree of independence between both departments and clearly articulated this idea:

> I think a radical solution to this frequent conflict on the machines is to build a mini-plant for the Pharmaceutical Development Center on a smaller scale and with smaller machines. Yes, it may cost the company, but in the end, it will make our work and theirs easier and more productive. At least they will be independent from Production, and Production can focus on their primary job – production – not trials and experiments.

In addition to establishing independence, this solution would increase Pharmaceutical Development Center's variety handling capability. In this context, increasing variety handling capability is relatively easier than reducing variety. On one hand, variety handling activities tend to be local solutions that require the recipient node to develop ways to cope with and handle input variety (Duimering, 1991). On the other hand, reducing variety tends to be organizational, requiring one or more organizational units to change the way they work. It is worth noting, however, that some researchers prefer reducing variety at the source (as discussed), because increasing variety handling capability may have negative consequences, such as increasing costs and generating undesirable variety (Duimering, Safayeni, & Purdy, 1993).

To ensure the entire project team operates efficiently, helpful behaviors should be reinforced and not so helpful behaviors should be reduced or eliminated. Otherwise, variety may continue to amplify to the point that projects actually fail.

7.1.6 Categorical Analysis of the Impact of Helpful and Unhelpful Behaviors

As discussed, participants were asked to indicate the impact of helpful and unhelpful behaviors. This impact element can be used as a secondary indicator of what variety means to various project team members. In MPC's case, the qualitative study strongly supports the notion that mismatches in variety and variety handling capability lead to problems, including delays, reworks, and more cycles of communication. Clearly, the helpful and unhelpful impacts show that different interacting nodes recognize the consequences of interrelated units' actions on the project as a whole.

In MPC's case, the loadings on both helpful and unhelpful impacts were uneven. The majority of both helpful (68.14%) and unhelpful impacts (68.87%) related to time. The dominance of the categories "delay" and "save time" highlights the pressing importance of time. On the other hand, "psychological" impacts were mentioned the least across helpful and unhelpful impact categories (< 5%). This finding reflects that project team members are more concerned with task-related impacts than purely personal impacts (e.g., feeling overburdened).

The Head Office and Plant followed a similar pattern of reporting helpful and unhelpful impacts across all categories, except for the unhelpful impact category of “delay.” This major difference indicates that the Plant is more sensitive to project delays than the Head Office. Nodes within the Plant appear more knowledgeable about the detailed technical aspects of product development; therefore, the Plant translates any undesirable variety directly into an amount of time that will delay the project.

Major discrepancies are found between individual departments in the proportion of examples among helpful and unhelpful impacts. These differences can be attributed in part to how nodes have been designed to work together. For instance, Inventory Control & Production Planning indicated that the majority of helpful impacts from other interrelated nodes related to the category of “save time” (78.57%). Quality Services reported 57.89% of its comments in the same category. The basic role of Inventory Control & Production Planning on projects is to schedule production plans to ultimately meet Marketing launch dates. This explains why a high proportion of their examples falls within the category of “save time.” An Inventory Control & Production Planning manager noted:

> I start my work with the Pharmaceutical Development Center. Time is the most important factor here. If they can make some shortcuts in the cycles of their activities, it would give me the extra time I need. You know, there are many departments I need to work with. There are the quality people and procurement. We need them to do their work in the least time possible. This is very important for us.

The defining role of Quality Services, on the other hand, is to monitor and double-check the progress of the entire project carefully. This explains its relatively lesser concern about saving time compared to Inventory Control & Production Planning. A Quality Services manager said:

> If production work is delayed, that relaxes me. Sorry, I don't mean 'relaxes me' literally; I mean it gives me some time to work on other areas. Maybe if you calculate it in terms of cost, it really impacts the company as a whole but for me, time is not the issue . . .We are independent, and make our independent decisions, and no one can challenge them. Our decisions on any product are final. Why? Because we want to ensure the products leaving our premises are safe and effective.

In addition, Inventory Control & Production Planning seems to rely on flexible ways to deal with uncertainty. They allow specific actions to emerge as the development process unfolds. Similarly, Mckay et al. (1999) asserted that a scheduling process should generate partial solutions for partial problems, involve updates to parts of the schedule that contain certain information, and delay updates for parts with unknown data. In this context, Mckay et al. (1999) suggested that the scheduler's role is to anticipate problems and think of solutions, rather than focusing on the narrow view of sequencing tasks. That is, a scheduler's role is to ensure that future difficulties are discounted (Mckay et al., 1999). Gaining extra time by padding the production schedules, therefore, acts as a buffer for Inventory Control & Production Planning to absorb unexpected future variety because they are sensitive about meeting deadlines. For them, padding is a way to generate estimates that could be met or exceeded with minimal risk or effort. In this context, Mckay, Safayeni, & Buzacott (1995a) identified four types of schedules that schedulers use for different purposes. First, the political schedule is for formal purposes and is usually the documented version of the schedule. Second, the private or inevitable schedule represents the scheduler's personal expectations of events leading to the results. Third, the idealistic schedule represents the unconstrained version of the planned schedule based on the assumption of complete freedom, with no procedural and policy constraints. Fourth, the optimistic schedule represents the version of the schedule communicated to the line, which usually differs from the official schedule depending on the situation. In MPC's case, an Inventory Control & Production Planning manager confirmed this notion:

> To make sure I don't face any critical delays from others, I always keep this extra time in my planning. If, for example, the Pharmaceutical Development Center gives me a deadline – say January 1 or March 31 – then I give them the date of the 20th or something like this. I never tell them the real deadline because I know delays will usually be in the range of four to five days, so it does not affect my job, basically. Let me say, even counting on a delay of four to five days, I follow up with them. I send them an email every two days and call them to say, 'Please, this is an urgent matter.' In general, the delays are within an acceptable range, so I put extra time into ensuring that no critical delays will happen.

Analyzing the qualitative comments indicates that the extra time generated by padding practices is wasted internally. It appears that those who pad schedules may be under pressure to stick with inflated schedules to avoid being perceived as dishonest or incompetent estimators. This idea is in line with a study by Gutierrez and Kouvelis (1991) in which they suggested that "slack" in projects is covered by Parkinson's Law: "Work expands so as to fill the time available for its completion." Furthermore, the fact that project teams are rarely rewarded for early project finishes can also explain padding (Hegazy, 2002).

Another major discrepancy was found between Inventory Control & Production Planning and Quality Services in the helpful impact category of "quality/resources." Specifically, quality/resources received the highest proportion of comments from Quality Services (15.79%), but no comments from Inventory Control & Production Planning. Again, this major discrepancy can be linked to the way in which these nodes are designed to work on projects. On one hand, Quality Services' role is to ensure that all products, materials, and processes conform to pharmaceutical industry standards. On the other hand, Inventory Control & Production Planning employees are concerned with the number of units produced (i.e., quantity). This explains the lower proportion of examples they reported in the category "quality/resources." A Quality Services manager emphasized:

> As a quality person, I think about quality issues. Let me tell you frankly, I don't care about the quantity produced. Maybe Inventory Control & Production Planning are concerned about the quantity and they accelerate the process to achieve the plan, but I don't care. I know some people may say Quality Assurance is costly. My only concern is for the drug to be safe with active ingredients. This is the only thing I think about on the job – safe and active ingredients.

Looking at major differences between departments in the categories of unhelpful impacts, shows that "delay" received the highest proportion of examples from the Production Department (92.86%) and the lowest proportion of examples from Inventory Control & Production Planning (65.12%). Production, as the last stop in the product development process, faces the pressure of being blamed for any delays on the project, as opposed to units involved in earlier stages such as Inventory Control & Production Planning. Interestingly, it appears that the meaning of *time* in projects changes over the project's life cycle. Similarly, Mckay et al. (1999) suggested a temporal dimension to scheduling tasks (i.e., "time zones") in which time directly influences the types of expected risks and productivity levels on the job (e.g., Monday mornings versus Friday afternoons).

In addition, the unhelpful impacts category of "quality/resources" received the highest proportion of examples from Inventory Control & Production Planning (25.58%) and the lowest from Production (4.76%). One explanation for this major discrepancy may be that Inventory Control & Production Planning is responsible for allocating resources. The Production Department is likely less concerned with problems allocating resources because Inventory Control & Production Planning's role is to reduce variety for Production by ensuring that Production has sufficient raw materials and labor. For example, a Production manager described how Inventory Control & Production Planning helps him handle problems he encounters on the job:

> Whenever a machine is not working or we have a production problem, we should notify them because they schedule the plans. Any trouble in Production will directly impact them. They are scheduling production, and we are implementing their plans. For us, they are problem solvers; even better, they keep us away from problems in the first place.

7.2 Variety Handling Mechanisms

Variety handling mechanisms are the corrective actions available to the recipient node in the task-related social network. This section discusses adhocracy and procedural variety handling mechanisms, using both quantitative and qualitative data as they relate directly to the research hypotheses. The subsequent section reviews categorical analyses of specific variety handling mechanisms captured in the qualitative data.

7.2.1 Adhocracy and Procedural Variety Handling Mechanisms

The survey results support the basic notion that as project complexity increases, people rely more on adhocracy variety handling mechanisms to handle input variety. On the other hand, as project complexity decreases, people rely more on existing rules and procedures to handle variety.

As presented in Chapter 5, variety handling mechanisms were divided into six main categories: (1) following up/pressuring, (2) discussing, (3) escalating, (4) suggesting, (5) accepting, and (6) fixing. Broadly speaking, adhocracy variety handling mechanisms involve “discussing,” “escalating,” “suggesting,” and “fixing,” because these mechanisms act reactively to some degree, without referring to a predefined course of action. On the other hand, applying rules and procedures to handle variety can be considered part of the “following up/pressuring” category, because this mechanism involves the recipient node repeatedly asking the variety sender to handle variety according to the technical system's specifications. The category of "accepting" involves the recipient node noticing the variety, yet being forced to handle it to some degree. In turn, this type of variety handling mechanism cannot be classified as adhocracy or procedural; thus, this category is treated as a neutral mechanism. Table 7.3 presents the distribution of all adhocracy and procedural comments perceived by all units.

Variety Handling Mechanism	%	Typical Example
Adhocracy	62.18%	Give them a personal visit to work things out
Procedural	20.63%	Ask them to follow Standards Operating Procedure (SOP)

Table 7.3: Distribution of Variety Handling Mechanism Examples by Adhocracy and Procedural Categories

It is worth noting several items concerning the dominance of "adhocracy" mechanisms (62.18%) as a way of handling input variety. First, relying on adhocracy mechanisms to handle input variety reflects a substantial lack of predefined solutions. Second, relying heavily on adhocracy mechanisms reflects a strong social structure in projects, because different nodes are figuring out suitable ways to handle input variety. Adhocracy mechanisms as a problem-solving approach are iterative in nature, requiring a sequence of actions to achieve desired outputs more effectively. Third, adhocracy mechanisms are not strictly about developing novel solutions to handle unexpected input variety; they may involve developing ways to work around existing procedures and organizational routines that may be impeding a goal. For example, a Marketing manager explained:

> You know, rules are black and white, but the important thing on projects is the way we interpret these rules to smooth things here. What was happening before, if we had a big problem, we used to meet and fight together, but now we are trying to understand each other and figure out ways to ease things on the go.

Adhocracy, however, may be perceived as a costly technique because it treats every case as unique. This idea is consistent with Mintzberg's (1979) notion that "The root of its inefficiency is Adhocracy's high cost of communication. People talk a lot in these structures…" (p. 463). In this light, adhocracy mechanisms have their own challenges and problems. Mintzberg (1979) asserted that the adhocracy approach involves frequent conflict and aggressiveness.

Procedural variety handling mechanisms, in contrast, reflect the fact that the projects function within an organizational context, and that the organization has its own routines, constraints, and predefined ways to handle input variety. In other words, rules and procedures can be seen as the collective representation of the organization's experience in handling variety. In addition, using procedural variety handling mechanisms indicates that although a project may be unique by definition (PMI, 2004), many of its elements may have been experienced before. That is, procedural mechanisms, in contrast to adhocracy mechanisms, reflect a degree of predictability in both variety and variety handling. It is worth noting that relying on procedural mechanisms as variety handling mechanisms reflects a strong activation of task structure to handle predictable input variety within the organization's formal and predefined rules and procedures. In this case, expectations in the social structure are based on formal rules and procedures.

For simplicity, adhocracy and procedural mechanisms were analyzed and discussed separately. In practice, however, procedural and adhocracy mechanisms are not mutually exclusive, but may occur simultaneously to handle input variety. For instance, employees may try to handle input variety with existing rules and procedures; however, if these procedural mechanisms fail, employees may employ adhocracy mechanisms.

7.2.2 Categorical Analyses of Variety Handling Mechanisms

The categorical analysis of variety handling mechanisms shows that loadings on categories are uneven. “Suggesting” (22.06%), “fixing” (20.92%), and “following up/pressuring” (20.63%) as a proportion of total variety handling mechanisms comments received the highest number of comments, followed by “accepting” (17.19%). In contrast, the lowest proportion of comments, 10.6% and 8.6% of variety handling mechanisms examples, fall into the categories of “discussing” and “escalating,” respectively. In this section, each type of variety handling mechanism is analyzed to uncover possible reasons for this uneven distribution of comments.

Conceptually, using “suggesting” mechanisms reflects a perception that the recipient node is responsible for handling input variety. On closer examination, “suggesting” as a variety handling mechanism demonstrates a learning element, where people may believe they actually understand the right way to handle variety. For example, the Marketing Department, among all departments, placed the highest proportion of variety handling mechanism examples in the category of “suggesting” (40%). This reflects its role in developing plans that other departments need to fulfill and to which they must adapt without asking for adjustments. A Marketing manager asserted:

> All we want from the Sales staff is to properly and successfully implement our plans. Just stick to plans without changes because any deviation from the plan will require us to change all plans. Everything is good when they are implementing our plans; it supports us a lot.

In contrast, the “following up/pressuring” mechanism reflects a perception that variety should be reduced at the source. “Following up/pressuring” received the highest proportion of examples from Inventory Control & Production Planning (30%), indicating that this unit depends heavily on other units to meet project deadlines successfully. In other words, Inventory Control & Production

Planning's tasks seems conditional on the performance of its interrelated units. An Inventory Control & Production Planning manager explained:

> If we only had an ideal system. I mean, if people were perfect and worked like machines, we wouldn't need any follow-ups. But, in reality, this does not exist and everyone is busy with his own work. In the current situation in the company, we have to follow up for things to be done on time. I don't like my people to say, 'We didn't receive this,' or 'Nobody answered my request.' You shouldn't expect things to land on your desk. You need to take the initiative and defend your position, and sometimes it is necessary to fight. You are responsible for doing the job, not blaming others because they didn't do their part. You need to keep following up and making sure the work will be done on time if not sooner.

Combined, the "suggesting" and "following up/pressuring" categories comprise almost half (42.69%) of all variety handling mechanism comments, reflecting a belief by both the variety sender and recipient that variety should be handled by the other interrelated node.

As a variety handling mechanism, "fixing" (20.92%) unveils the recipient's tendency to handle undesirable variety. "Fixing" presents a short-term solution to annoying problems; for example, the total expected effort of forcing the variety sender to reduce variety is weighed against the total expected benefit of handling the variety oneself. For instance, Quality Services placed the highest proportion of variety handling mechanism examples in the category of "fixing" (28.57%), reflecting this department's tendency to correct other units' errors when filling out required forms. It appears easier for Quality Services to fix the forms rather than suggesting corrections and reviewing resubmitted forms, which might lead to increased effort and cycles of communication. Overall, "fixing" reflects handling undesirable input variety within the recipient's range of expected variety.

“Accepting” reflects a type of generated variety in which recipient nodes are receiving input variety and being forced to handle it to some degree. Interestingly, additional analysis of comments within the category of “accepting” shows that this variety handling mechanism is frequently used to handle not so helpful behaviors within the category of “unreasonable expectations.” In this context, “accepting” can be seen as a coping strategy in circumstances in which reducing the variety at the source is beyond the unit’s control and the only way to handle the variety is to accommodate and live with it until an appropriate opportunity to reduce the variety at the source presents itself. A Pharmaceutical Development Center supervisor asserted:

> This is reality. Whenever my manager tells me that the vice-president is personally involved in this situation and is waiting for this product to be done, I don’t have a choice. I mean, it is a military order from senior-level management, and I can’t do anything about it. I’m used to living with this illness.

Further, “accepting” reflects an imbalance in the power structure in organizations in which nodes with lower hierarchal ranks may be forced to handle excess variety from higher levels. For example, a Production supervisor’s manager was insisting that the supervisor do a task he believed was not part of his job. He stated:

> The first thing I do is I talk with my manager and try to convince him that they should do it again, but if he insists we should do it, I realize then that this task is urgent. You know, ultimately, he is my manager and I must do it. You know, at the end of the day, everyone understands the mood of his manager.

“Discussing” represents only 10.6% of all variety handling mechanism comments. This result may be explained by the difficulties in cross-functional communication and coordination within functional structure organizations. In addition, discussing requires higher levels of coordination, because this variety handling mechanism involves two or more units, in which both parties must be prepared and willing to engage actively in joint problem-solving. This idea is consistent with Mintzberg's (1979) notion that "…job specialization creates a number of its own problems, notably of communication and coordination" (p. 73). Mintzberg (1979) further noted, "Unit grouping encourages intragroup coordination at the expense of intergroup coordination" (p. 108).

In MPC's case, among all departments, the Production Department was found to rely most heavily on "discussing" (21.05%) as a way of handling input variety. This reflects, in part, the Production Department's dependency on other nodes, such as the Pharmaceutical Development Center, to help handle input variety. A Production manager commented:

> Sometimes, the Pharmaceutical Development Center has a leadership role in the work. For example, when we face problems that are purely technical, they will give us a clear diagnosis of the problem. Is the cause of the problem in the methods or materials or machinery? If the problem is in the materials, they will give us a definite answer. If the problem is in the way of manufacturing, they will share their opinions and jointly work with us to find solutions.

Interestingly, "escalating" (8.6%) is the least used variety handling mechanism in the organization. This finding highlights many important issues regarding the role of top management in handling project problems. First, this finding underscores the managers' role in solving project management problems. People seem to approach managers only in exceptional, extremely unbearable situations to avoid undesirable consequences. One explanation for not approaching managers as a frequent variety handling mechanism is that people want to avoid additional undesirable variety, such as tension with other project participants that may result from managers' being involved in the situation. For example, an Inventory Control & Production Planning scheduler explained, "To be honest, I try to solve things with them personally. If I ask my manager about this situation, he may say it isn't our business or he may blame me for even mentioning it. So, I try to solve things quietly to ensure our relationship with them is based on respect."

Second, it appears that employees perceive "escalating" as an inadequate way of handling variety. Project members may feel that managers do not appreciate being approached about a project's problems. For example, a Pharmaceutical Development Center supervisor commented, "I don't know how my manager perceives it. Maybe he thinks I can't handle things by myself or I'm too dependent. You know I'm trying to get his opinion on every problem, but maybe I'm bothering him by taking his time." Nevertheless, it is worth emphasizing that further analyzing the specific comments within the category of "escalating" indicates that managers are usually approached with requests to either adjust a task's priority or to increase time or resources. Overall, these findings add to the accumulating evidence that "escalating" may not be widely used as a means to handle input variety effectively. Instead, leadership's role can be seen as a distributed function across different nodes, as opposed to relating leadership to a single actor in the network (e.g., the project manager). This distributed leadership in project management is consistent with Mintzberg's (1979) notion that "Decision-making power is distributed among managers and non-managers at all the levels of the hierarchy, according to the nature of the different decisions to be made" (p. 436).

7.3 Role Ambiguity

The survey results support the notion that "role ambiguity" within a project will increase among nodes as the complexity of the project increases. The qualitative study, however, reveals no support for the dominance of role ambiguity, with project team members making relatively few comments regarding this notion. Additional analysis of the comments within the not so helpful category of “unreasonable expectations” assessed the degree of “role ambiguity” in MPC. In relation to the proposed theoretical framework, “unreasonable expectations” can take three forms, which is in line with Katz and Khan’s (1978) role model. First, role ambiguity occurs whenever the recipient node is required to handle unclear input variety. Second, role overload occurs whenever the recipient node is required to handle input variety that exceeds the recipient’s variety handling capability. Third, role conflict occurs when the recipient node is required to handle input variety that opposes another required task, but is about equal in strength.

Specifically, analyzing the category of “unreasonable expectations” showed that 51.4% of all comments pertained to “role overload” followed by “role conflict” (36.5%). Interestingly, only 12.1% of all “unreasonable expectations” comments relate to “role ambiguity.” Table 7.4 shows the distribution of all “unreasonable expectations” examples, with a typical example for each subcategory.

Unreasonable Expectations	**% of Examples**	**Typical Example**
Role Overload	51.4%	Making changes at later stages of product development, which requires backward adjustments to earlier stages
Role Conflict	36.5%	Disturbing our schedules with their new product trials
Role Ambiguity	12.1%	Assigning plans to us without sufficient stocks

Table 7.4: Distribution of Examples per “Unreasonable Expectations” Categories

This high registry of “role overload” comments compared with “role ambiguity” suggests that role overload contributes more to the variety existing in the system than role ambiguity. One possible explanation for the modest status of “role ambiguity” may be related to the degree of predictability in MPC’s input/process/output as a generic drug company. In this context, Kahn (1964) defined role ambiguity as a discrepancy between the information available to the person and the information required to perform a role adequately. Duimering et al. (2006) indicated that ambiguity “exists when relationships between project decision variables and even the variables themselves are unknown" (p. 240). In this case, a finished drug, for example, would be expected to be different from the original product idea. As discussed in Chapter 4, MPC is a generic drug company that develops mainly generic drugs that are chemically equivalent to brand-name drugs. This type of work may contribute to reducing role ambiguity incidents, because internal units are experiencing higher levels of predictability related to their input variety. Role ambiguity, however, still affects unique, novel, and transient projects for which the company lacks expertise in handling that project's unique elements.

The conflict between the qualitative and quantitative results regarding "role ambiguity" likely occurs for several reasons. First, this contradictory result may originate from the common practice of designing surveys to capture general opinions and abstract levels of project management concepts. In other words, to elicit relevant answers from different people, we need to develop an abstract concept that asks all participants relatively the same questions. The more abstract the question, the more abstract the answer. In this sense, the questionnaires, as opposed to the qualitative approach, comprise broad statements that do not link directly to specific task situations.

Second, participants answered all "role ambiguity" questions using Likert scales ranging from 1 = not very complex projects to 7 = very complex projects. This type of survey, however, may encourage participants to answer the questions based on the "reasonableness" of the statements. "Role ambiguity" and "complexity" both share a negative connotation, implying an unfavorable influence on the project, such as difficulties and problems. In this respect, participants may be associating "role ambiguity" and "complexity" as concepts that are both "reasonably" and "logically" related, regardless of specific task situations. To summarize, role ambiguity is supported conceptually and quantitatively, yet lacks support from the qualitative data for the dominance of role ambiguity incidents in project management.

7.4 Working Relationships

The survey results add to existing evidence on the role of working relationships in influencing variety handling capability and variety-generating behaviors. In addition, analyzing the IE ratios for links with both positive and negative working relationships yields interesting findings.

Helpful to others comments significantly outweighed not so helpful to others comments for people with positive working relationships, resulting in a relatively high IE ratio (2.03). This finding, therefore, confirms a significant relationship between positive working relationships and improved IE ratios, showing that people with positive working relationships manage to adjust their activities to facilitate handling the variety (i.e., increasing variety handling capability or reducing variety), even while dealing with their own urgent tasks and troubles. In contrast, people with negative working relationships provided fewer helpful to others comments and greater not so helpful to others comments, resulting in a lower IE ratio (1.09). Thus, people with negative working relationships are less likely to handle input variety if they perceive it extends beyond their roles on the project. In addition, people with negative working relationships may even generate additional undesirable variety to nodes with which they interact.

The above-noted IE ratio of 1.09, however, means there was approximately one helpful to others behavior for one not so helpful to others behavior. It is worth mentioning that several items were associated with this moderate IE ratio for people with negative working relationships. Self-reports are often biased because participants tend to provide socially desirable answers. They may overestimate their helpful behaviors and underestimate their not so helpful behaviors, especially when thinking about their negative working relationships. In contrast, people may be more critical about how others are helpful or not so helpful to them. Nevertheless, the IE ratio of 2.03 for the links with the most positive working relationships confirms a significant relationship between positive working relationships and improved IE ratios compared to links with negative working relationships (IE =

1.09). The following subsection analyzes comments about helpful to others and not so helpful to others for both positive and negative links.

7.4.1 Categorical Analysis of Helpful to Others Comments

For links with a positive working relationship, the most salient helpful to others categories were “communication” (36.56%) and “cooperation” (32.26%), reflecting a proximal and tight integration in which it appears both parties are willing to get the work done. In other words, positive working relationships lead to effective internal communication and a willingness to ultimately achieve a positive future state. This social property of managing projects is similar to the way people manage to avoid bumping into one another in a confined space; namely through communication and cooperation. This tight coupling may involve extra work and time, yet it appears to actually improve the morale of project team members by presenting more opportunistic interactions for socializing. Further analyzing the “communication” category shows that people with positive working relationships mainly articulate useful information (e.g., a “heads-up”) in a timely manner. Analyzing the comments within the category of “cooperation” indicates some degree of willingness to increase variety handling capability at some point. Specifically, these adjustments can take the form of favors in which one individual expects to gain the advantage of benefiting from someone else based on a previous favor. This favor mechanism may appear in the form of increasing the priority of a particular task for a person to whom one owes a favor. In addition, people with positive working relationships may use social mechanisms to bend rules that reduce the variety imposed on the recipient. In this context, reciprocal favors in the process of managing projects may be as important to influencing people’s behaviors as authority (Baker & Wilemon, 1977). For example, a Production manager illustrated how flexible he is in applying rules as a way to ensure better working relationships:

> Concerning incident reports, if the mistake is minor, I warn them verbally to maintain a good relationship so that they will ease my work in the future. You know, if I'm playing the tough guy here, nothing will finish. I mean, we haven't reached the point where, if we work strictly according to the system, everyone will respect us, and we will do our work to the fullest.

Similarly, a scheduler admitted that he sometimes voluntarily helps Production supervisors reduce their required work:

> On Wednesday afternoons [the beginning of the weekend in the Middle East], for example, if a production section has completed its batch early, let's say at 3:00 pm, as a planner I would overlook the two or three hours left since they don't have another batch to work on. I mean, I wouldn't ask the supervisor to transfer some of his staff to other production sections in need. Usually, I tell them to finish their work on hand and stay free until the end of the day.

In contrast, it appears that people with negative working relationships reduce their "communication" (16.98%) and "cooperation" (15.09%) levels with one another while relying more on "basic job performance" (49.06%). This finding reflects some degree of being mutually remote and isolated. In a similar vein, a scheduler asserted:

> Because of our personal problems the issue that lets me avoid dealing with him is that his relationship is with the Director. I mean, he communicates directly with the managers although I'm the planner and the one with whom he is supposed to be dealing. Now, even if I want to help him with something, I'm afraid he will turn it against me; I don't know, he may go tell the manager or someone and become a problem to me. So, personally, I keep my distance from him.

Relying heavily on “basic job performance” as a way of interacting indicates some degree of dependence on the formal design of the work. That is, rather than working to promote mutual understanding, people in negative working relationships often rely on the formal system, which limits their work interactions.

7.4.2 Categorical Analysis of Not So Helpful to Others Comments

Overall, participants with positive working relationships (M = 25, SD = 0.18) and negative working relationships (M = 25, SD = 0.15) follow a similar pattern of reporting not so helpful to others comments across all categories. This result is particularly noteworthy for several reasons. First, sharing a similar pattern of categorizing not so helpful to others examples implies a degree of similarity in the *kind* of examples generated, yet does not imply a similarity in the *frequency* and *probability* of behaviors generated for each type of link. Methodologically, the interview questions did not measure the frequency and probability of not so helpful to others behaviors occurring in each case. This study implicitly assumed an equal weight for all examples, especially for the individual level analysis. People with positive working relationships, however, may behave similarly to people with negative working relationships in terms of the types of behaviors generated. Yet the frequency and probability of a specific potential behavior occurring may be lower for those with positive working relationships than for those with negative working relationships.

Second, “unreasonable expectations” for both positive and negative links constituted the highest category of not so helpful to others behaviors, with almost 40% of all comments. It seems that people are noticing, to some degree, how difficult their requests are for others on the project. In addition, these notable unreasonable expectations may relate to the task structure, which requires people to follow rules and procedures that subsequently cause problems for others. For example, many participants were aware of their not so helpful behaviors, yet felt that their negative actions were essential to complete their daily jobs. For example, a Pharmaceutical Development Center manager described his interaction with Production:

> I don't have the production-size machine with me. I need to frequently lock their machines based on my requirements or emergency requests. So, their work is stopped. I know this delays their work and maybe they are upset. But what can I do? I don't have a choice. I mean I don't have production-size machines, and I need to do the work. It's a conflict of interests.

According to this study's quantitative and qualitative findings, the variety handling capability of a role is flexible and dynamic and can be expanded or contracted based on working relationships. Projects take place in social settings, and the social nature of project team members operates as an important means of handling potential variety. Unlike machines, people adjust their behaviors based on many factors, including working relationships.

7.5 The Effectiveness of Project Management Software

The survey's findings seem to conflict and suggest that participants perceive software to be more effective for complex projects, which opposes the initial hypothesis. Further analyzing the differences between software users and non-users, however, yields an interesting result regarding the differences in their perceptions of software's role in managing projects. On one hand, users with previous experience with the software could not distinguish between its usefulness for simple versus complex projects. On the other hand, people unfamiliar with project management software (i.e., non-users) considered the software significantly more useful for very complex projects than for simple ones.

The tendency of users to have a relative "no agreement" position on the exact types of projects in which the project management software can be used effectively reflects how perceptions are based on diverse previous experiences. Specifically, some users perceived that the software performs work well for simple tasks (39.10%). Other users, however, perceived the software to be most suitable for supporting complex tasks and decisions (30.40%), while still other users perceived the software as effective in handling any type of project (30.40%). Having an undecided consensus of the software's applicability indicates that some users may have had negative experiences with the software in situations when it could not meet their requirements or expectations. On the other hand, some users may have had positive experiences with the tool, resulting in a more positive view. In this light, using specific project management software may result in different levels of perceived effectiveness that depend on factors relating to the organization, individuals, the tasks at hand, and the technology. Overall, this study indicates the importance of recognizing the *experiential properties* of using project management software.

In contrast, the tendency of non-users to perceive software as useful for complex projects may be explained by the social interpretation of technology as a good thing, which often occurs when people overestimate IT's capability to handle problems. In other words, IT may be treated as an independent variable that unconditionally affects organizations in many positive ways, regardless of the context. Pentland (1992) offered a succinct review of how more optimistic literature views IT:

> A more serious problem is that this book seems to equate technology with progress, without any critical reflection on whether new technologies are desirable and, if so, to whom. The image of technology presented here is almost uniformly good, even glowing (p. 497).

It appears that non-users are evaluating the tool based on *pre-conditioned expectations,* resulting in a more biased view of the software's capability to handle variety.

This chapter discussed the results of the qualitative and quantitative studies. The following chapter presents this study's major conclusions. The study's limitations, along with recommendations for future research are also discussed.

Chapter 8
Conclusions, Limitations, and Future Research

This chapter includes two sections. The first section summarizes the study's findings and interprets their significance. The second section discusses the study's limitations and potential future research directions.

8.1 Summary and Concluding Remarks

To date, little, if any, research has examined project management-related interactions from a qualitative perspective. This study's purpose was to conduct a qualitative analysis based on a theoretical approach to modeling project management and its effectiveness. The conceptual model examined the social and technical components of projects jointly, as a network of task-related social interactions that occur within an organizational context. As Kurt Lewin stated, "There is nothing so practical as a good theory" (quoted in Cunningham, 2001, p. 153). This study demonstrated the practical utility of the cybernetics theory in uncovering and understanding the interactions between different organizational functions within project management. This approach to project management differs from traditional approaches, which does not explicitly consider the organizational context in their models.

Methodologically, the Echo-based method used in the interviews provided concrete examples and rich descriptions of task-related social interactions. Data generated by the Echo method was analyzed at different levels of aggregation, which elucidated the project management system, its sub-systems, and its relevant environment. At the organizational level of analysis, the relationship between the Head Office and the Plant indicated a discrepancy in Interaction Effectiveness (IE) ratios. This suggested that the Head Office perceived the Plant as a variety handler (decreases variety in the system), while the Plant perceived the Head Office as a variety generator (increases variety in the system). The departmental level analysis of the concrete examples was used to understand the dynamics occurring between organizational units. For instance, when coupling low-variety handling nodes (e.g., Quality Services) with high-variety handling nodes (e.g., Inventory Control & Production Planning), relationships were found to be “tense,” with IE ratios below the organizational average.

The Echo method also teased out multiple perspectives on given situations, because employees from multiple nodes with different roles on the project were interviewed. For instance, many variety senders classified numerous examples as “helpful,” while many variety recipients classified the same examples as “not so helpful.” A practical implication of the Echo-based method can be found in the concrete examples of both “helpful” and “not so helpful” behaviors; perhaps such examples can help managers understand why problems may be occurring as projects progress. In turn, a cycle of continuous improvements can be applied in which managers can develop strategies to reinforce positive behaviors (increase variety handling capability) and undermine negative behaviors (reduce variety at the source).

One of this study’s major findings relates to the value of the Interaction Effectiveness ratio, which inferred two structural properties of the task-related social network. First, most network relationships were asymmetrical (76.5%), reflecting a significant discrepancy in perceptions between interrelated nodes. Second, the variability of IE ratios (standard deviation) ranged from 0.10 to 1.28, reflecting the degree of consistency among the relationships of each single node and its interrelated nodes.

The qualitative study provided significant evidence that illustrated the method’s sensitivity to capture a most pressing element of project management; namely, “time” (White & Fortune, 2002). Whenever input variety to a node *exceeded* its variety handling capability, more comments concerning “delays” (68.87%) were captured by the qualitative study. Furthermore, whenever input variety to a node was *reduced*, more comments relate to “saving time” (68.14%).

The findings also showed that a node's variety handling capability can be flexible and dynamic. This capability can be expanded or contracted based on the working relationships between the sender and the recipient. Specifically, participants were found to have almost double the IE ratio with links to their most positive working relationships compared to links with their least positive working relationships.

The results of the follow-up survey indicated that project complexity has a significant relationship with certain concepts from the organization theory; namely, role ambiguity, adhocracy, and procedural decisions. Specifically, when project complexity increases, people rely more on adhocracy decisions; role ambiguity becomes more frequent; people perceive project management software to be more effective; and mismatches between variety and variety handling capability magnify across all nodes. On the other hand, as project complexity decreases, people rely more on existing rules and procedures to handle variety.

8.2 Limitations of the Study and Avenues for Future Research

This study includes several conceptual and methodological limitations that require further examination and additional research:

1. Most notably, the qualitative study's sample size (one organization with 33 participants), although sufficient to capture patterns in managing projects, is too small to warrant generalization. The study's conclusions are directly relevant, however, to the organizational setting in which the study was conducted. Nevertheless, because a specific organization within the pharmaceutical industry was observed and analyzed, this study may prove beneficial to companies with similar organizational settings.
2. This study treated every "helpful" and "not so helpful" example as if each had an equal impact on projects. Analyzing the qualitative data (i.e., helpful and unhelpful impact

comments), however, shows that some helpful and not so helpful behaviors have greater impacts than others. Future research could explore and develop relative weightings for each helpful and not so helpful behavior, based on the perceived frequency and likelihood of each one. If weightings are developed, helpful and not so helpful examples might reflect the extent to which a particular example influences the Interaction Effectiveness ratio (IE ratio) of a specific link more accurately. In other words, more weight would be given to examples with higher impacts and less weight to those with little impact.

3. Due to memory limitations, the helpful and not so helpful examples that participants provided may be influenced by events that are most recent, frequent, and have higher impacts (i.e., subjective probability), and thus do not represent an average or general view of the task situation. It can be argued, though, that these immediate experiences are, in fact, the most significant examples for participants, and therefore represent an up-to-date version of the task situation.

4. This study presents some quantitative and qualitative data about task-related social networks, yet other types of data were not collected. For instance, some researchers have defined and analyzed social networks from a purely quantitative perspective. Quantitative data sets include, for example, data extracted from Web page links and log files of e-mail traffic. These quantitative measures of social networks focus on a network's structural properties (e.g., density, centralization). Quantitative approaches to analyzing social networks may provide a more accurate representation of networks and reduce the effect of temporal changes in relationships between nodes because all data are collected in real time (Hossain, 2009). Qualitative approaches to defining social networks are frequently self-reported rather than derived objectively; therefore, they may not reflect comprehensive, complete, and actual networks. In addition, asking participants to define their own task-related social networks

may result in weak and ephemeral ties being overlooked due to short-term memory problems. Nevertheless, a mix of quantitative and qualitative methods can complement existing quantitative-based social network analysis approaches and cross-validation methods or triangulation of the results. In this context, social network analysis may provide some insights about input variety in the network. Specifically, the "centrality" of a node (i.e., a node in a network that is highly connected) may correlate with the amount of input variety a recipient node is required to handle. A node's centrality, however, does not mean it is more capable of coordinating among nodes (i.e., increased variety-handling capability). Such qualities of a node cannot be inferred from the node's location, but can be captured by the extent to which a recipient node is capable of handling variety another interrelated node generates.

5. The Echo method yielded rewarding data to describe actual behaviors in a project management situation, yet it has limitations:
    a. On the participants' side, the Echo method was a demanding, time-consuming, and resource-intensive technique. The Echo method requires the participant to spend about two hours to develop a sufficient list of helpful and not so helpful behaviors. This long time to collect data frequently interrupted ongoing work activities.
    b. From the researcher's perspective, the Echo method was also demanding and required a considerable amount of attention to record each helpful and not so helpful example accurately and comprehensively during the interview. Precision was important because these examples were used as a basis for further questioning (e.g., helpful impact, unhelpful impact, and variety handling mechanisms). The quality of the interviews depends heavily on the researcher's individual skills, and therefore may be influenced by the researcher's personal biases. The extensive demand placed on the researcher raised the possibility of errors in how helpful and not so helpful

examples were recorded because some examples may have been inadvertently omitted or paraphrased incorrectly. To overcome this problem, it would be much easier to conduct interviews in pairs. In this case, one researcher would focus on listening, probing, and keeping interviewees on track, while the other researcher would concentrate on identifying and recording the helpful and not so helpful examples for further questioning.

c. The process of transcribing and analyzing the interviews was tedious and time consuming, especially considering the need to further categorize all examples into subcategories that did not fit together easily. Categorizing comments into different subcategories involved a degree of subjectivity on the researcher's part.

6. Selecting the single case study design also resulted in some limitations:

a. MPC is a functional organization. Projects are thus designed to be shuffled around to different departments, with each department ensuring that it completes its parts of the project. In this case, project management-related coordination and communication activities are managed by essentially the same members, resulting in difficulties distinguishing and mapping specific examples to particular projects (e.g., complex or simple). The distinction between complex and simple projects, however, can be important. One future research direction is to examine a company with a matrix structure in which different groups of people from functional departments are assigned to work on one or more projects that are led by a project manager. In this case, participants should find it much easier to distinguish and map specific examples to particular projects because they are interacting with heterogeneous groups.

b. MPC's main focus is developing generic drug formulations; however, the active ingredients are already known and are found in brand-name drugs. As such, both external and internal variety is predictable, to some extent, compared to companies that spend substantial time and money to research, develop, market, and promote novel drugs. Analyzing projects with higher levels of uncertainty and complexity would help us understand mismatches between variety and variety handling capability better. One possible direction for future research is to replicate the study of projects within different organizational settings. For instance, if the organizational setting changes (e.g., organic or mechanistic), what are the consequences on the amount and kind of input variety to the task-related social network?

c. Although MPC has a project management software package (Microsoft Project), its main role in the company was limited to IT-related projects. An opportunity was not available, therefore, to conduct an in-depth case study to examine the software's role in managing projects. Further research may yield interesting findings if, for instance, the software is placed as the focal node in the network in which participants are asked about helpful and not so helpful examples the software generates on the job. With this view, examining the software's role would go beyond surveying the extent to which it assists project team members in developing plans, assigning resources, tracking progress, and managing budgets to analyzing their actual and potential variety handling capability and variety- generating patterns within the task-related social network.

   In addition, many researchers claim that using traditional project management tools in different projects does not help build project management-related knowledge in the long term because they do not develop principles applicable to future events (Bailetti, Callahan, & DiPietro, 1994; Jaafari, 2003; Pinto, 1998; Schindler & Eppler, 2003). One future research direction is to explore the possibility and applicability of integrating and adding new features to current software packages that enable users to input data related to the variety and variety handling capability of each node in the process of managing projects. These new features may result in understanding project management-related processes, difficulties, and interdependencies better.

d. MPC, as a functional organization, does not create special project teams to handle new projects that are led by a project manager. Instead, projects are assigned to a specific marketing manager, who then coordinates with other departments such that each contributes. This study did not examine, therefore, the actual role of project managers in task-related social interactions. According to the literature, the project manager's main role is to keep projects under control. In the process of controlling projects, however, project managers may have a mixed role of generating and handling different types of variety in the network. In particular, one possible direction for future research is to examine the types of helpful and not so helpful examples that project managers generate for others in the network.

7. There is no reason to believe that the period in which the interviews were conducted was atypical. The possibility of this being true for some units did exist, however. Whenever a new project is introduced in a task-related social network, certain parts of the entire organizational network are activated, while other parts might only be heavily involved at later stages. For instance, the Business Development, Marketing, and Pharmaceutical Development Center may be involved in earlier stages of product development, as opposed to Production and Quality Control, which are usually involved in the later stages. One future research direction is to examine the temporal patterns of variety and variety handling capability. More specifically, helpful and not so helpful examples could be collected throughout the life cycle of a particular project. This longitudinal data would help indicate specific differences in the

kinds of variety and variety handling mechanisms that might be evoked at different points in time (i.e., from project initiation to closure). For instance, at the beginning of a new project, variety may relate more to scheduling and allocating resources. As the project progresses, variety may relate more to changes in the project's requirements and objectives. As the project concludes, variety may be related to difficulties in achieving the project on time, within cost, and with all requirements. Another possible research direction is to trace the relative IE ratios from the beginning of developing a new product (i.e., source units) until the end of the project (i.e., sink units). It may be hypothesized that IE ratios will tend to improve as the project progresses assuming that variety or part of it is handled during the process. Examining these patterns can provide more specific implications for planning and coordinating project tasks.

8. As do all methods, survey research has limitations. Unlike the qualitative study, the statements in the quantitative survey were designed to capture general opinions and abstract levels of project management concepts. This structured technique for collecting data, although convenient for testing hypotheses, had inherent limitations and complex assumptions underpinning the numbers. In particular, participants were restricted to answer most questions using Likert scales ranging from 1 = not very complex projects to 7 = very complex projects. Using "project complexity" as a scale with a negative connotation, however, may imply an unfavorable state (e.g., difficulties and problems). In this respect, participants may associate some statements to "very complex projects" because both are "reasonably" and "logically" related, regardless of the specific task situations. One possible direction for future research is to focus on improving the survey validity and reliability in specific contexts if their benefits are to be realized.
9. This study's other findings have opened important opportunities for related research:

a. In this study, higher-level categories were used to describe and analyze project management-related interactions. It may be fruitful, however, to develop lower-level categories for each higher-level category to capture differences between groups. In this context, content analysis (e.g., the frequencies of most-used keywords) within each category can help determine the relative importance of an attribute within a category. Table 8.1 presents some proposed mid-range categories that were developed during this study, but were not used.

Categories	**Sub-Categories**
Competency	Adaptability, Mobilizing, Expertise
Communication	Accuracy, Reliability, Relevance, Timeliness, Alerting
Cooperation	Lubricating, Approachable, Prioritizing , Supportive
Basic Job Performance	Basic Understanding, Resource Availability
Incompetency	Errors, Amateurish
Miscommunication	Incomplete, Late, Inconsistent
Noncooperation	Conditional Effort, Annoyance
Unreasonable Expectations	Constraining, Pressuring, Frequent Changes

Table 8.1: Mid-Range Categories for Helpful and Not So Helpful Comments

b. Conceptually, directionality of relationships (e.g., sequential, reciprocal) between interdependent nodes was found to influence the degree of symmetry in the relationships between nodes. We felt it was premature, however, to establish hypotheses in this study regarding the relative strength of directionality in predicating symmetrical and asymmetrical relationships in social networks. One future research direction is to examine the impact of the directionality of relationships between nodes on the types of variety-reducing behaviors by recipient nodes. For instance, in the case of a sequential interdependency, the recipient's response to a variety-reducing practice by the sender may tend to be social in nature (e.g., being more polite and thankful), because the opportunity afforded by the task dependence is limited. On the other hand, variety reduction by the sender in a reciprocal relationship may be expected to result in more potential future task-related variety-reducing practices from the recipient as a return.

c. Job satisfaction is one of the attributes organizations frequently measure. In this context, some of the variety-related concepts this study discusses may be directly or indirectly related to job satisfaction. For instance, it may be hypothesized that people will tend to be relatively satisfied with variety handlers as opposed to variety generators.

d. Categorical analysis of the "helpful to others" comments that people with negative working relationships generated indicated some degree of being mutually remote and isolated. In this state, most comments were related to "basic job performance" (49.06%) as a way to interact with others. One possible direction for future research is to further analyze these basic job performance comments to capture emergent themes. For instance, analyzing the qualitative data shows that people with a negative working relationship will usually tend to help others on a conditional basis. That is, the degree of helpfulness to others with a negative working relationship is contingent on another set of circumstances. These helpful to others examples may take the form of "If [condition], then [helpful behavior]." Interestingly, analyzing the qualitative data shows two typical examples, such as "When I have time, I will help him" or "If he is willing, I will help him."

From both theoretical and practical perspectives, significant challenges and opportunities are ahead. Nevertheless, the overarching aim of this research was to step back and ask, “What is happing in project management? and “How do different units interact together to deliver projects?’ In closing, this study presents one possible theory and method to find answers to these fundamental questions.

Appendix A
Qualitative Study Interview Questions

Overview of Job

1) Could you briefly describe the main types of activities you do with respect to this project (your main job responsibilities)?
   a) Approximately what percentage of your time is spent on each major activity?

Task Networks

2) In the course of working on this project, you no doubt interact with a number of others, either within MPC, or outside of the MPC organization.
   a) **For this project**, we would like to know **who** you interact with in the course of doing your job. (Use diagram)
   b) Using the diagram, could you please identify other people (or groups, departments, etc.) that you interact with most as you do your job.
   c) Can you rank order the interaction links that you have indicated, from most to least important as it relates to your job on this project?
   d) Can you rank order the interaction links that you have indicated, from best to worst performance as it relates to your job on this project?

Network Interactions

For this project, we would like to ask about the kinds of interactions you have with each of these other people (groups, departments, etc.). Naturally, sometimes these interactions may be helpful to you in doing your job and other times they may not be. You will have an opportunity to comment on both.

3) **For each link identified**

a) **For this project,** could you give some specific examples of the kinds of things they do that are helpful to you in your job?

b) **For this project,** could you give some specific examples of the kinds of things they do that are not so helpful to you in your job?

For all links: *(Questions will be asked in relation to each identified behavior.)*

4) Impact? (Helpful)

i) How does that help you?

5) Impact? (Not helpful)

i) How does that not help you?

6) What do you do when that not so helpful behavior happens?

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

For both most positive and least positive links

a) Could you give some specific examples of the kinds of things you do that are helpful to them in their job?

b) Could you give some specific examples of the kinds of things you do that are not so helpful to them in their job?

8) **For the most positive link** *(Questions will be asked in relation to identified helpful behavior.)*

a) Are all these helpful behaviors part of your job?

9) **For the least positive link** *(Questions will be asked in relation to identified helpful behavior)*

a) Could you have been more helpful? If yes, how? If no, why?

Background

10) What is your official position or job title?

11) How long have you been in this position?

12) How long have you been with MPC?

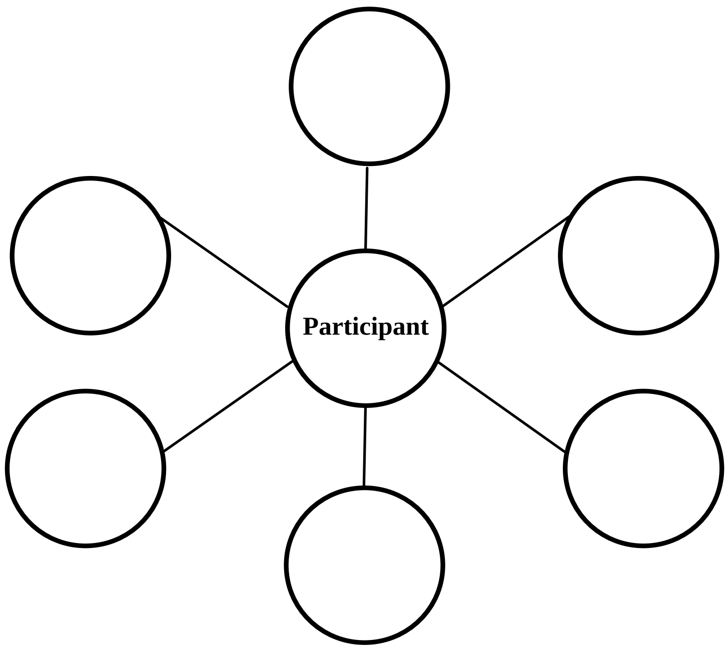

Figure A.1: Diagram of interactions

Appendix B

Categorization of Comments from Interviews

1. Helpful Comments

Competency	Communication	Cooperation	Basic Job Performance
Very competent legal advisors	Providing us with detailed forecasts for any new idea	Easily communicating with them (cooperative in holding *ad hoc* meetings)*	Jointly working on bioequivalence studies with external agencies
Deep understanding of legal issues	Providing us with technical information about new products that helps us convince marketing people to accept our new idea	Trying to understand our complaints and negotiate compromise solutions	Reviewing and writing legal statements for new agreements
Quick at studying agreements and reviewing drafts	Providing us with structured and clear answers to our inquiries	Taking all of our suggestions seriously	Internally double-checking licensors' forecasts
Expert staff	Providing us with technical information and manufacturing feasibility since they have deep understanding of manufacturing requirements*	Listening to and appreciating our concerns*	Providing us with scientific materials
Good understanding of market needs, competitors, and customers	Easily communicating with them (cooperative in holding *ad hoc* meetings)*	Good understanding of, and respect for, our recommendations*	Following marketing plans (selling according to product mix)
Very competent in writing technical reports	Flexible at developing new products in various forms (answering our 'what if' questions)*	Keeping up with due dates (honest at giving deadlines)*	Sticking to marketing plans
Able to independently develop new products without external assistance (licensors)	Strong relationships with Ministry of Health, from which they can easily obtain any information based on their connections*	Very cooperative in answering our requests*	Sticking to marketing plans
Flexible at developing new products in various forms (answering our 'what if' questions)*	Involving us in business development agreements	Approving our requests informally and agreeing to fill required documents at later stages*	Involving us in their sale visits (double visits) to evaluate our product strategy
Highly competent, which strengthens our	Updating us with information about new	Very cooperative	Evaluating our marketing plans to develop

negotiation position in new agreements (we transfer head office visitors to plant to reflect a positive image of the company as a whole)	products since we are overloaded with our daily activities		future product factors and metrics
Providing us with technical information and manufacturing feasibility since they have deep understanding of manufacturing requirements*	Involving us in every activity they do	Treating our urgent requests as a high-priority item	Reviewing and approving all marketing promotional materials
Good understanding of Ministry of Health rules and regulations	Filling technical forms for us (expediting our task of reviewing them)	Cooperative in solving our problems	Reviewing and approving all advertisement brochures
Strong relationships with Ministry of Health, from which they can easily obtain any information based on their connections*	Involving us at early stages of new product development to inform them about potential problems	Quickly responding to our urgent requests (avoiding normal procedures)*	Providing us with medical training for new marketing and sales staff
Good understanding of, and respect for, our recommendations*	Listening to and appreciating our concerns*	Quickly responding to our inquires*	Providing us with medical training for new marketing and sales staff
Well-organized (compared to other departments in head office)	Promptly answering our inquires	Advance notifications about potential product cancelations*	Providing us with medical training
Well-organized in their work and thoughts, even though they are overloaded	Answering our requests promptly	Quick actions to solve production problems*	Searching and recommending new products
Keeping up with due dates (honest at giving deadlines)*	Sending all corrections to us as softcopies	Quick responses to our inquires*	Seeking and recommending new markets
Skillful adaption to stressful situations (to our frequent changes of plans)	Electronically sending printing materials	Advance notifications about new products that help us start material purchasing process (enough lead time)*	Seeking and recommending new products
Fast comprehension and implementation of our ideas	Providing us with feedback about product performance and competitors	Easy to obtain approvals from them*	Adjusting new products to fit marketing requirements during development process

Highly competent	Providing us with competition reports	Very friendly supervisors	Selling products within commercial boundaries (less bonuses, rewards, gifts)
Very strong auditing capability	Providing us with parameters about sales information (e.g., number of prescriptions)	Handling our requests as high-priority items	Ensuring stock availability by transferring materials to places of need
Good understanding of their sales territories	Providing us with information about expected product development dates	Strong working relationship (relies on informal communication)*	Ensuring stock availability for sales
Preparing registration files for Ministry of Health as soon as possible	Providing us with technical information about products for new launches	Gives specific time and date for urgent requests*****	Ensuring availability of stock
Good understanding of regulatory procedures	Providing us with technical information for designing product packs	Alerting us of potential problems at early stages of product development*	Providing us with giveaways and tools
Providing us with clear initial packaging designs based on market needs since we are technical-oriented (good at transferring their ideas to us)*	Providing our artwork section with barcodes and item codes to finalize packaging designs	Supportive in scheduling machines for trials	Using the "Sales Force System" and "Customer Relationship Management System"
Strong tracking system	Providing us with clear initial packaging designs based on market needs since we are technical-oriented (good at transferring their ideas to us)*	Allowing us to use their machines in case we need them	Communicating well and following up with external parties to solve marketing problems*
Powerful communication system (less approvals, easy process for approvals)	Communicating well and following up with external parties to solve marketing problems*	Lending us some of their staff in case we are overloaded	Increasing the number of new products
Effective performance management system to evaluate marketing staff	Informing us of our mistakes in forecasted sales	Handling our requests as a high priority	Maintaining a good relationship with many companies
Effective automated system for administrative-related issues	Approving our requests informally and agreeing to fill required documents at later stages*	Supporting us in solving product formulation problems	Providing us with many incentive programs
Practical experience in initiating new	Very cooperative in answering our	Approving some documents even if he is	Providing us with cost allocations for each

business ideas	requests*	not completely convinced (since he understands our work pressure)	country
Preparing well-written documents about each country's delivery requirements	Quickly responding to our inquires*	Asking me to visually examine abnormalities in samples at early product development stages (some problems can be easily observed on the site)*	Providing us with marketing plans and materials
Well-organized	Quickly responding to our urgent requests (avoiding normal procedures)*	Double-checking product specifications although it is not part of their job	Providing us with detailed marketing plans
Experts in the local market, which helps us in our international sales (knowledge transfer)	Providing us with accurate forecasts and orders through SAP	Preparing microbiology tests although it is not part of their work	Providing us with technical information for our sales rep
Well-skilled staff	Advance notifications about potential product cancelations*	Doing microbiology tests although it is part of our work	Ensuring availability of stocks
Preparing good production forecasts	Quick responses to our inquires*	Double-checking development methods although it is not required of them	Ensuring enough stocks for our sales
Clear objectives and deadlines	Advance notifications about new products that help us start material purchasing process (enough lead time)*	Lending and exchanging their standards in case we are out of stock	Implementing the 'Customer Relationship Management System'
Effectively following ups with agents to ensure delivery of orders on time	Updating us on production progress	Lending us their machines in case we are overloaded	
Competent at doing their work	Updating us with actual production progress	Supporting us in implementing strategic decisions	Working according to schedules
Correcting our production plans based on their experience (active, not passive, in the planning process)*	Correcting our production plans based on their experience (active, not passive, in the planning process)*	Supporting us in the process of scheduling machines for trials from production	Keeping up with schedules (sticking to plans)
Practical experience	Easy to obtain approvals from them*	Supporting us in any request for a new material or machine	Maintaining machines to ensure stable and continuous production

Quick at doing their work (highly efficient)	Informally communicating and updating work priority lists every three weeks*	Good motivator (presents many opportunities to help us grow)*	Developing products and materials that fit our machine capabilities (adjusting new products to increase machine efficiency)
Effective preventive maintenance progress	Informally communicating and updating product priority list every three months*	Highly flexible in terms of accepting our views on how to deal with head office on some issues*	Following up with suppliers about material orders
Highly skilled staff	Informally communicating and updating task priority list*	Developing medical requirement documents for European registration files although it is part of my job description	Adjusting products based on market requirements
Quick actions to solve production problems*	Submitting initial analysis results on time	Handling bioequivalence sample communication issues although it is part of my job description	Evaluating packaging tools needed for new products
Accurately documenting all product recipes and production processes on SAP	Gives specific time and date for urgent requests*****	Filling our data into their formats and tables (accepting our raw data)*	Identifying and providing us with old packaging designs
Effectively handling exceptional cases	Holds meetings at initial stages of any new product to share information	Alerting me of potential problems based on his practical experience*	Evaluating packaging material samples for new products
Effectively following up on orders with suppliers	Providing us with useful opinions to solve problems based on their experience*	Alerting us of potential sample failures at early stages of product development*	Fixing any deviations in validation parameters
Quick approvals for new products	Providing us with practical suggestions to solve material problems based on their experience*	Adjusting their work schedules to meet our urgent requests	Advising us during equipment selection process
Well organized in doing their work	Updating us with recent product development rules	Accepting analytical requests although it is not part of their job (in case analytical development people are overloaded)	Providing us with printing design samples
Effective at handling Ministry of Health's requirements at early stages of product development	Prompt in sending analytical results	Very cooperative	Validating product stability for commercial purposes

Expertise with machines (useful inputs during scale up batches)*	Prompt communication	Informally communicating and updating work priority lists every three weeks*	Evaluating and approving packaging specifications
Practical experience	Following up with other departments about our pending requests	Informally communicating and updating product priority list every three months*	Evaluating packaging suppliers
Very competent	Providing us with technical information about know-how	Informally communicating and updating task priority list*	Reviewing and updating all manufacturing processes
Strong technical background	Informing us of each machine's capability	Strong working relationships (rely on informal communication)*	Validating analytical methods
Submitting an extra batch for testing	Informing us about machines' capability to handle specific packaging materials	Fair (over-evaluates our performance)*	Using competitor formulas as a reference
Critically reviewing our documents to ensure product quality	Providing us with analytical results about product samples	Supportive in purchasing all required packaging components	Identifying new suppliers for packaging
Practical experience in the field of quality control	Providing us with useful input to finalize and improve product formula	Understanding our work overload	Ensuring that products meet both quality and auditors' standards
Good connections with Ministry of Health	Asking us about stable products to try new packaging materials on them	Does not intervene with our technical specialty (respects our technical background)*	Advising us during packaging and packing selection process
Very competent	Notifying us about any meetings in advance to prepare relevant data	Does not intervene with our daily work*	Advising us during supplier selection process
Strong technical background in 'solids'	Good communication and presentation skills	Dose not intervene with our technical area of expertise*	Providing us with packaging requirements for new products
Practical experience	Strong working relationships (rely on informal communication)*	Does not intervene with our technical specialty*	Providing us with analytical methods by means of their required tools, reagents, and columns
Asking us for specific tasks since they are knowledgeable about the sequence of tasks involved in the product development	Good communication and presentation skills	Immediate reaction to our problems*	Develops manufacturing process summary

cycle*			
Very knowledgeable about export registration requirements (acts as reference)	Filling our data into their formats and tables (accepting our raw data)*	Flexible in scheduling their trial batches	Issuing Certificate of Stability (COS)
Strong practical experience	Informing me of my work priorities	Approachable (easy to reach) since they have an office on the site*	Ensuring machine availability for trials
Strong technical background (correctly diagnoses problems)	Providing us with information to handle our daily activities	Very flexible in scheduling maintenance for urgent requests	Providing us with raw materials and their specifications
Practical experience	Effective communication with head office (providing necessary input for decision making)	Very cooperative in changing schedules based on our requests (flexible)	Searching and evaluating potential suppliers to ensure availability of standby suppliers
Providing us with useful opinions to solve problems based on their experience*	Calling for a departmental meeting at initial stages of any new product development to share information	Very cooperative	Developing in-house standards to use instead of expensive primary reference standards
Suggesting alternative machines for our trials based on their experience	Calling for a departmental meeting at initial stages of any new product development to share information	Supportive in accelerating the delivery of validation protocols	Develops samples for analysis certificates in case production is out of stock
Providing us with practical suggestions to solve material problems based on their experience*	Providing us with useful input to fill up formal documents	Supportive in accelerating the release of packaging materials	Providing us with all packaging materials that meet both technical and quality requirements
Minimize changes on our side and successfully change licensor’s requirements	Passing our suggestions to head office	Separating large quantities of raw material into small bags to make it easier for loading	Developing multiple formulas for the same product (parallel working, not sequential)
Flexible at adjusting product designs based on our capability	Providing us with technical data about new products	Separating large quantities of raw material into small bags to make it easier for loading	Suggesting alternative packaging components in case of product sample failure
Alerting me of potential problems based	Providing us with information about the	Helping us solve our problems	Suggesting alternative packaging materials

on his practical experience*	life cycle of any new product development		for the same product
Providing us with all required analysis standards and columns in advance	Providing us with product history to use as a reference in developing new similar products	Accepting our suggestions about machine problems*	Suggesting alternative packaging materials to improve product stability
Suggesting courses of action for decision making (reduces role ambiguity)	Providing us with product history	Very cooperative (willing to help us at any time)	Preparing product registration files at early stages although it is the last stage in product development (working in parallel instead of sequentially)
Does not intervene with our technical specialty (respects our technical background)*	Providing us with the history of any product	Doing calibration without being asked*	Fair (over-evaluates our performance)*
Ability to create a good work environment	Providing us with useful comments about integrity of packaging components to avoid potential problems at later stages	Flexible at scheduling machine maintenance and calibration	Analyzing worst sample case for production packaging size and only requesting stability for it
Does not intervene with our daily work*	Updating us with product stability results on a regular basis	In urgent situations, accepting our requests through informal communication (phone, email or even after finishing the actual work)*	Gathering detailed information about new product specifications from multiple sources (centralized source of information)
Has a strong personality (dares to say no to PDC manager)	Providing us with useful monthly reports about product stability	Immediately solving our problems*	Providing us with technical literature
Strong personality (dares to say no to PDC manager)	Seeking our feedback about stability results	Accepting our advice with high levels of trust	Handling Ministry of Health packaging samples requests at early stages of product development
Dose not intervene with our technical area of expertise*	Strong working relationship (relies on informal communication)*	Quickly responding to our requests for *ad hoc* meetings*	Providing us with task priorities
Does not intervene with our technical specialty*	Expertise with machines (useful inputs during scale up batches)*	Easy to work with their manager since he has more trust in us in comparison to his	Evaluating suppliers

		staff	
Good relationships and reputations with top management due to his management style	Alerting us of potential problems at early stages of product development*	Lending us some people from other departments to help us analyze samples	Developing plans based on available manpower (ready to execute plans)
Does tasks beneath his position (humble)	Asking me to visually examine abnormalities in samples at early product development stages (some problems can be easily observed on the site)*	Very cooperative in understanding our wrong sample submissions by new trainees	Developing plans based on available raw materials (ready to execute plans)
Once he is convinced, he is prepared to discuss top management	Asking us for specific tasks since they are knowledgeable about the sequence of tasks involved in the product development cycle*	Backs us up during meetings (deeply understands the nature of our work)	Developing plans based on available raw materials (ready to execute plans)
Good motivator (presents many opportunities to help us grow)*	Alerting me of potential problems based on his practical experience*	Frequently following up with us instead of us following up with them*	Supervising our production process
Highly flexible in terms of accepting our views on how to deal with head office on some issues*	Alerting us of potential sample failures at early stages of product development*	Flexible in scheduling their sample requests	Double-checking our formulas
Has a clear work scope	Rarely sends documents with mistakes	Advance notifications about urgent changes to plans*	Reviewing our production documents
Good negotiator with top management	Explaining to us the reasons behind their urgent requests (providing justifications)*	Availability of a very cooperative person who directly informs us of any water shutdowns*	Reviewing available raw material against production progress
Well recognized by top management (good working reputation)	Submitting purchase requests with precise information		Following up with related departments to reduce production disturbance
Well recognized by top management (good reputation)	Placing requests with their machine model and serial numbers		Following up with Quality Assurance to ensure timeliness of material release based on our priority list

Overall view of any project requirements	Updating us on a daily basis	Following up with procurement department to ensure availability of raw material
Well recognized by top management	Providing us with confident answers	Assigned person on the line
Has a good sense of our exact requirements	Sharing opinions with all related departments	Availability of quality inspectors to verify product quality
Political communicator with other departments	Fast and direct communication with us	Developing alternative production plans in case of material shortage
Political communicator with top management	Involving us in scale up batches to ensure that production has available capabilities to produce new product	Accountability of product release
Providing us with all required analysis standards and columns in advance	Providing us with product specifications for both formulas and materials	Providing us with production parameters
Providing us with clear procedures to follow	Effective two-way communication between us	Solving our problems since our output is critical to their work
Providing us with practical modifications to trials	Involving us in the scale-up batch to ensure production capability to produce new product	Providing us with solutions to technical problems
Providing us with reagents, performing machine calibration and qualification tests on time	Providing us with complete information about all production machines	Following procedures
Providing us with all required analysis standards and columns in advance	Suggesting useful solutions to production errors	Develop products based on specifications (following procedures)
Makes decisions as a group	Fast and easy communication between us	Following procedures
Explaining to us the reasons behind their urgent requests (providing justifications)*	Providing us with useful information based on his experience*	Following Good Manufacturing Practices (GMP)
Submitting packaging materials with clear	Approachable (easy to reach) since they	Following product specifications

specifications	have an office on the site*		
Effective technology transfer from lab scale to production scale (effective scale up process)	Providing us with information about our staff		Following procedures
Practical experience	Responding to all of our inquires		Maintaining product storage within specifications
Well-experienced staff (having an experienced person)	In urgent situations, accepting our requests through informal communication (phone, email or even after finishing the actual work)*		Performing preventative maintenance
Very expert staff due to slow rotation between departments	Quickly responding to our requests for *ad hoc* meetings*		Training us on GMP and job-related issues
Very knowledgeable in production rules and regulations	Forced to provide us with specific dates since they are required to work through SAP		Writing job descriptions
Well experienced staff (having an experienced person)	Frequently following up with us instead of us following up with them*		Providing us with analytical method validations
Delivering packaging components on time	Advance notifications about urgent changes to plans*		Providing us with sampling instructions
Providing us with packaging components with no mistakes	In urgent situations, they afford raw materials to us, even with higher prices*		Providing us with procedures and specifications for products and materials
Providing us with useful information based on his experience*	Providing us with useful input during scale up process		Accepting our suggestions about machine problems*
Providing us with packaging materials on time	Providing us with medical updates about existing products		
Quality Assurance staff members are available on time to take samples for	Availability of a very cooperative person who directly informs us of any water		

analysis	shutdowns*
Leadership role in solving technical problems	
Providing us with quick decisions	
Immediate reaction to our problems*	
Requesting materials on time	
Clear documentation in which both item codes and lot numbers can be easily found	
Immediate problem solving for any water fall injection problems	
Performing calibration and maintenance on time	
Practical experience	
Very effective preventive maintenance program	
Effective preventive maintenance program	
Installing machines correctly	
Well-educated staff	
Well-trained staff	
Make products on time	
Very quick at requesting raw materials and machines	
Well experienced person in their department	
In urgent situations, they afford raw materials to us, even with higher prices*	
Ensuring raw material availability in	

advance
Doing calibration without being asked*
Immediately solving our problems*

2. Not So Helpful Comments

Incompetency	Miscommunication	Noncooperation	Unreasonable Expectations
Local legal advisors lack sufficient legal background	Requires a long time to explain technical issues related to new products	Difficult to convince them of new ideas (they prefer extending existing products instead of adopting new product ideas; they require many compromises before agreeing to a new idea)	Pressuring us with many urgent requests (no clear priority list)
Lack of business sense (overreacting to minor side effects of new products)	Not providing us with specific deadlines to help us finalize our agreements with licensors (busy with their day-to-day activities)	Passing any external inquires to us, though they have the ability to answer them (trying to play it safe)*	Pressuring us with many urgent requests (no clear priority list)
Unable to handle many of our new idea requests	Not answering our inquires	Resisting some of our development programs	Pressuring us with many urgent requests (no clear priority list)
Delays in registering new products in Ministry of Health	Requires a long time to provide us with technical information and manufacturing feasibility for new dosages forms	Not taking our recommendations seriously about new markets and products (we suggested many ideas which resulted in no action or feedback from them)*	Passing any external inquires to us, though they have the ability to answer them (trying to play it safe)*
Lack of commitment to their proposed deadlines	Not providing us with specific answers to our inquires (providing us with possible answers)	Too bureaucratic in following Standard Operating Procedures (SOP) (lack of flexibility when handling urgent orders)	Pressuring us with many urgent requests on short notice
Lack of practical experience	Lack of complete information	Lack of initiative to solve even minor problems	Pressuring us to adjust our internal system to meet customer needs
Delays in writing legal statements	Passing any external inquires to us, though they have the ability to answer them (trying to play it safe)*	Handling our requests as a low priority	Forcing us to adjust our forecasts to their batch sizes
Delays in approving new products	Not involving us deeply enough in	Lack of initiatives to solve problems	Overloading us with multiple requests at

	business development agreements	(passing all external inquires to us)*****	the same time
Slow at writing technical reports	Delays in providing us with feedback about product performance and competitors	Difficult at scheduling machines for product trials	Dealing with us as if we were a sales department by focusing on units sold rather than on market requirements
Too business-oriented (oversimplifies our role in product development)	Delays in providing us with feedbacks about new ideas	Many conflicts over scale up batches issues	Not concerned about searching for new markets, but they depend on our initiatives and advice (no business development person dedicated to search for new markets)*
Unorganized (difficult to adjust our work to fit their schedule; disorganization is the norm in the head office)	Delays in providing us with required technical information on products	Withholding information (unwilling to share information, preferring verbal communication to ensure continuous dependency on him – information monopoly)*	Assigning plans to us without sufficient stocks*
Lack of skillful staff (lack of informal connections with Ministry of Health – Lack of detective role)	Delays in both responding to our inquires and approving our advertisement brochures*	Lack of initiative in solving production problems	Frequently changing plans without informing us*
Making agreements on new products for which we either have low demand or lack the manufacturing capability to produce	Late information about possible production delays	Lack of initiative in solving their problems	Disturbing our schedules with their new product trials
Recommending few new products or markets for our expansion and growth	Informing us of our mistakes in forecasted sales after the fact	Difficult to schedule machines for trials*	Working based on task priority rather than on fixed dates
Relying on old methods of advertisement (paper brochures), unwilling to begin using animated materials (we do not want to be forced to change)	Not providing us with complete information (scenarios) about their new ideas (many underdeveloped ideas)*	Treating our tasks as a low-priority item	Working based on priority rather than on fixed dates
Lack of managerial sense (too technical)	Lack of effective coordination between	Need for many follow-ups to obtain	Unpredictable requests (asking to work on

	PDC, Business Development, Medical, and Regulatory Affairs (no trace of new idea's status)	information*	old and pending projects)
Lack of business sense (too academic)	Lack of updated information about their activities	Too picky about noncritical issues during the process of approving packaging component*	Pressuring us with many requests to accelerate product development
Too technical (lack of managerial sense)	Submitting incomplete requests	Too picky on minor issues*	Pressuring us by overusing 'urgent' label on their requests
Providing us with noncompetitive prices for giveaways and tools (too expensive)	Need for many cycles of communication to approve a packaging design	Acting as a bureaucrat instead of informal communicator*	Pressuring us with many urgent requests
Poor at adapting to stressful situations	Lack of pharmaceutical industry background (lack of common language between Marketing, Sales, and Human Resources)*	Difficult to convince	Pressuring us to finish our part of the product registration file on short notice
Lack of financial analysis of markets on a regular basis	Not taking our recommendations seriously about new markets and products (we suggested many ideas which resulted in no action or feedback from them)*	Too picky on minor issues when reviewing our documents*	Pressuring us to send as many product registration files as possible to head office
Lack of pharmaceutical industry background (lack of common language between Marketing, Sales, and Human Resources)*	Not clearly communicating new product launch dates	Rigid about following their product specifications	Frequent changes to work priorities
Lack of technical background (no materialization skills)	Frequently changing plans without informing us*	Many follow-ups are needed for our requests to be completed*	Frequent changes to priorities
Lack of business sense (too attached to regulations and policies with no clever maneuvers to overcome them)	Unclear forecasts and orders	Lack of flexible communication (tension while communicating with them)*	Accepting frequent changes to plans from top management (pressuring us to meet top management's requirements)

Delays in developing new products	Not communicating clear outputs from the new product steering committee	Need for many follow-ups to provide us with clear finishing dates for analysis of samples*	Frequent changes to already submitted analytical results
Delays in registering new products for international markets	Sending incomplete forms	Always blaming materials for machine problems	Frequent changes to priorities
Delays in product registration due to external factors (e.g., delays in receiving bioequivalence results)	Difficult to trace approval requests	Dislike Quality Assurance inspectors	Frequent changes to priorities
Delays in obtaining bioequivalence results	Requiring too many follow-ups for our requests to be completed	Their manager is uncooperative	Dealing with us like production (well-defined tasks vs. ill-defined tasks)
Not providing us with complete information (scenarios) about their new ideas (many underdeveloped ideas)*	Need for many follow-ups for our requests to be completed	Frequent conflict, disagreements and tension between us	Frequent changes to work priorities
Lack of informal connections and information from Ministry of Health about our competitors	No clear updates about shipment status and content	Disliking Quality Assurance inspectors	Unpredictable requests (asking to work on old pending projects)
No direct interactions with licensors (they do not follow up on their orders)	Not notifying us about problems ahead of time (no lead time)	Their manager criticizes our Quality Assurance inspectors in an impolite way	Pressuring us with many urgent requests
Delays in providing us with giveaways and tools	Not informing us of their preventive maintenance schedules	Their manager is inflexible in changing production plans to accommodate our staff shortage	Making changes at later stages of product development, which requires backward adjustments to earlier stages
Imbalance between their rewarding and control systems (more emphasis on control at the expense of rewarding)	Many follow-ups are needed to obtain approval	No clear decisions about pending products (only clear decisions are obtained within group meetings but not on a personal basis)*	Overloading us with many formula analysis requests since they have a fast work pace
Not sticking to marketing plans	Difficult to trace approval status	Frequent need for follow-ups for both training and recruitment issues*	Passing any external inquires to us for answers*

Not following procedures or company requirements since they have a "customer's mindset"	Inconsistent approval response time	Avoiding working in our production area since it is a controlled area	Sending the same external inquiry to multiple people to answer*****
Delays in both responding to our inquires and approving our advertisement brochures*	Some operators lack proficiency in English	Backward inspection for minor errors (overreacting)	Asking us to follow up with other departments for urgent cases
Lack of both advance and updated medical information (since they are overloaded)	Delays in responding to our requests and documents	Lack of technical trust although we are more expert in the production area	Lack of initiatives to solve problems (passing all external inquires to us)*****
Not concerned about searching for new markets, but they depend on our initiatives and advice (no business development person dedicated to search for new markets)*	Passing any external inquires to us for answers*	Too picky in reviewing our documents*	Asking us not to send finished product registration files until they request them*
Incorrect order deliveries since they deal with many countries with different conditions and requirements	Sending the same external inquiry to multiple people to answer*****	Having a person that is uncooperative	Passing all Ministry of Health inquires to us with no effective discussion*
Rushing new products to the market without careful studies	Lack of initiatives to solve problems (passing all external inquires to us)*****	Handling our requests as a low-priority item in comparison to inventory control and production planning department	Overloading us with many new product requests
Delaying our requests since they are overloaded with international and export requests	Providing us with incorrect information about machine's status (machines working on paper but not on the site)		Asking us to analyze some of their formulas when they are overloaded
Lack of manufacturing flexibility to meet customers' special requirements	Not scheduling their inspection visits		Too picky about noncritical issues during the process of approving packaging component*
Lack of in-house training center	Unclear product registration status at Ministry of Health		Too picky on minor issues*

Lack of monitoring mechanisms to evaluate the effectiveness of their training courses	Need for many follow-ups to obtain information*	Narrowly focusing on the quality dimension at the expense of quantity (micromanagement)
Delaying our requests since they are overloaded with international and export requests	Providing us with information in an inconsistent timeframe (unpredictable)	Too picky on minor issues when reviewing our documents*
Delays in recording expenses and debt notes	Providing us with incomplete information	Accepting frequent changes to plans from top management
Lack of warehouse in remote areas to ensure stock availability	Delays in providing us with analytical results	Pressuring us with many follow-ups
Assigning plans to us without sufficient stocks*	Delays in providing us with information about new product cancelations	Submitting purchase requests with difficult dates to achieve
Lack of stocks due to production line shutdowns	Reviewing and updating manufacturing processes without consulting us or at least informing us	Pressuring us to provide them with materials early enough to meet production targets
Lack of technical infrastructure due to some external factors	Lack of prompt follow-ups	Overloading us with many requests
Not assigning a person or section for forecasting	Lack of prompt follow-ups	Overloading us with many requests
Requiring a long time to develop new products	Lack of effective communication, which results in coordination problems	Frequent changes to plans
Requiring a long time to register new products	Lack of accurate information about packaging specifications	Frequent changes to plans
Lack of buyer talent	Delays in providing us with packaging specifications	Pressuring us with many requests to meet their targets
Not well organized as a department	Lack of effective communication, which results in coordination problems	Pressuring us at the end of each month with their sample requests since they do

			not have a choice
Lack of training on SAP	Difficult to communicate technical parts of product design (lack of face-to-face communication)		No microbiology background (sending all samples to test for microbiology although our role is to verify, not to develop)*
Delays in registering products with Ministry of Health	Many follow-ups are needed for our requests to be completed*		Losing samples and then requesting them again even though it is a lengthy process to acquire samples*
Lack of effective follow-ups with suppliers	Not informing us about machines' capability when they are overloaded		Many requests to reanalyze and recheck samples
No effective follow-ups with suppliers	Not updating us with new regulations on time		Asking for approvals on short notice*
No proper monitoring of production progress	Delays in microbiology test results		Ordering materials through our department, which increases our cost
Delays in approving validation protocols	Reviewing and updating manufacturing process without consulting or at least informing us		Perceiving us as an excess cost to the company
Too many pending approvals (very lengthy approval process)	Sending specious results (never sending negative microbiology results)		Careless in developing procedure drafts since they rely on Quality Control to fix their mistakes afterward*
Underutilizing available machine capacity (only focusing on solids)	Lack of effective communication, which results in coordination problems		Conflicting schedules between their maintenance and calibration and our work schedules
High turnover rates	Asking us not to send finished product registration files until they request them*		Frequent changes to plans
No proper resource allocation (lack of manpower)	Submitting analytical results in an inconsistent timeframe (unpredictable)		Frequent changes to plans
Delays due to product changeovers or	Delays in providing us with analytical		Disturbing our work schedules with their

machine breakdowns	results	product trials
Delays in material dispensing	Providing us with requested information in an inconsistent timeframe (unpredictable)	Disturbing our schedules with their trial batches
No proper resource allocation (lack of sufficient manpower)	Passing all Ministry of Health inquires to us with no effective discussion*	Enforcing hard constraints on us that are difficult to achieve
Not changing old machines in low-demand production sections	Delays in some product stability results	Enforcing their working routines (unnecessary bureaucratic procedures)
Not releasing raw materials on time for production to start	Minor mistakes in stability documents since they are overloaded*	Requesting multiple tasks at the same time
Delays in releasing new products and raw materials	Many wrong comments on our work since they lack 'hands-on experience'*	Requiring us to follow up with other departments although there is a clear work flow system
Not updating SAP properly	Withholding information (unwilling to share information, preferring verbal communication to ensure continuous dependency on him – information monopoly)*	Too picky in reviewing our documents*
Delays in updating SAP with actual production progress	Acting as a bureaucrat instead of informal communicator*****	Requesting unclear tasks*
Dealing with both new and existing product materials alike although developing new products is a strategic goal for the company (no serious efforts to ensure new product success)	Difficult to schedule machines for trials*	Focusing on quality without considering quantity dimension in their standards*
Frequently changing parts rather than fixing them	Lack of flexible communication (tension while communicating with them)*	
Not following quality control procedures	Need for many follow-ups to provide us	

	with clear finishing dates for analysis of samples*
Not working according to schedules (significant variance between what is planned and produced)	Sending incomplete requests
Not updating their forecasts to reflect actual sales performance	Directly communicating to suppliers (not following proper channel of communication)
Lack of technical background about product development	Frequent need for follow-ups for both training and recruitment issues*
Many wrong comments on our work since they lack ‘hands-on experience’*	Not notifying us about their sampling visits
Lack of skillful analysts	Submitting procedures with many mistakes
Developing formulas based on trial and error of existing raw material	Submitting incorrect forms
Lack of practical experience (too academic)	Late submissions of monitoring results
Not well organized (no effective documentation)	No clear timetable for preventive maintenance schedules
Weak personality (cannot make decisions himself)	Starting batches without our approval
Lack of timely actions	Sending validation protocols with many mistakes
Lack of timely actions	Sending back validation protocols without incorporating our comments
Requires a long time to finalize issues	Submitting incorrect forms

with licensors	
Providing us with overly expensive raw material	Delays in providing us with analysis results
Lack of technical background	No clear decisions about pending products (only clear decisions are obtained within group meetings but not on a personal basis)*
No timely actions	Asking for approvals on short notice*
Using old stability data that is not accepted by export	Relying on informal means of communication (emails) rather than the formal system (SAP)
Not doing antimicrobial efficacy tests	Starting the validation process without checking with Quality Control department
Not rejecting any of our samples (lack of trust in their analysis)	No specific periodic preventive maintenance schedules
Not testing antiseptics for minimum inhibitory concentration	Delays in submitting documents
Not validating their methods	Providing us with incorrect numbers of packaging materials
Lack of technical background about packaging components	Minor mistakes in number of trays delivered*
Not validating all analytical methods	Requesting unclear tasks*
Rushing samples for stability before validating analytical methods	
Low-quality outputs to stability (later stage) since they are overloaded (indirectly affecting us)	

Lack of practical experience
Overloaded although their task is critical to the development process
Producing low-quality outputs to stability (later stage)
Using old packaging materials
Working on old packaging machines
Starting tests with low-cost packaging materials
Overloaded
Developing lab batch size samples for stability instead of production batch size
Developing formulas based on trial and error of existing raw material
Using old raw materials for product development
Lack of salesperson talent (not very smart)
Lack of technical background about packaging components
No effective discussion with plant director about our new machine requests
Lack of effective communication with licensor
Delays in evaluating packaging samples
Claim that machines are ready for trials although they are not clean
Not reviewing and approving documents

properly
Delays in doing microbiology tests
Delays in submitting validation methods
Delays in providing us with alternative packaging materials for the same product
No effective discussion with head office (does not present project reality to them)
No effective communication with head office (accepting accountability for mistakes we did not do)
No effective discussion with head office about our capability and capacity to develop new products
Incorrectly summarizing our part (formulation) in the product registration file
Rushing samples for stability without proper analysis (sending samples as trial and error)
Careless in adding product ingredients since they rely on us to solve production problems at later stages (second-chance syndrome)
Careless in adding product ingredients since we fix their mistakes afterwards (second-chance syndrome)
Not preparing reference standards for

Ministry of Health although it is part of their job
Accepting all requests from PDC manager without question
Bureaucratically dealing with product registration files as paper, not as a product, since they are not involved in product manufacturing
Work is handled sequentially, not in a parallel way
Not fighting back for increase in staff but relying on internal audit recommendations
Unable to force head office to follow procedures (SOP)
Accepting any requests from head office as a must (courtesy at the expense of the project)
Accepting all orders from PDC Manager without question
Not analyzing our samples as a three-stage process (sequentially) but analyzing samples all together (in parallel)
Working in a sequential way (they should work in parallel since we are the last product development stage)
Does not get information from marketing quickly

Delays in acquiring brand name information from Marketing
Minor mistakes in stability documents since they are overloaded*
Long process for machine request approval
Delay in recruitments, which results in overloading our people
Delays in recruiting new staff
Human resources staff in plant lacks sufficient talent
Lack of a managerial rank in plant
No clear evaluation criteria for departmental manpower needs (recruitment process not based on scientific studies but on personal judgment)
No training officer
Careless in developing procedure drafts since they rely on Quality Control to fix their mistakes afterward*
Providing us with product validation methods that do not work
Lack of understanding of the nature of microbiology work
No microbiology background (sending all samples to test for microbiology although

our role is to verify, not to develop)*
Lack of expertise (only one person with experience)
Lack of staff (overloaded)
Many task delays due to external factors
Some staff members are not well-educated
Losing samples and then requesting them again even though it is a lengthy process to acquire samples*
Delays in taking action on our requests
Lack of expertise (only one person with experience)
Lack of educated staff
High rates of turnovers due to non-competitive packages offered
Unable to serve us when busy with other departments
Not providing us with enough user names to work on SAP
Delays in providing us with materials due to external factors
High turnover rates
Focusing on quantity at the expense of quality (accelerating production to achieve their plans)
Centralized recruitment in head office
Minor mistakes in following procedures

Sending scale up batches for sales before completing a full validation cycle
Minor mistakes in following procedures
Not cleaning machines after trials
Not labeling machines under maintenance
Not recording activities in logbook
Minor mistakes in following procedures
Hiding some production mistakes (talking about mistakes off the record)
Not following product specifications
Violating Good Manufacturing Practices (GMP) (carelessness)
Bypassing procedures and making shortcuts at the expense of product quality
Lack of experience with production machines (starting with lab equipment for product formula development)
Lack of knowledge (limited ability)
Lack of expert staff
Lack of experienced staff (having an inexperienced person)
No proper monitoring for oxygen gadgets
Lack of experienced staff (having an inexperienced person)
Errors in technology transfer from lab scale to production scale
Errors in product specifications for scale

up process
Very slow at communicating with machinery suppliers
Delays in analyzing samples
Requiring a long time to review documents
Errors in raw material weights
Errors in raw material weights
Delays in providing us with raw materials due to external factors
Assigned planner to our department does not have a permanent office in production (not available)
Raw materials not available on time
Overloaded (limited capacity)
Lack of staff (limited capacity)
No assigned person on production line
Delays due to machine breakdowns (out of their control)
Lack of staff (limited capacity)
Quality Assurance staff not available on time to take samples for test
Overloaded (limited capacity)
Not available at the beginning of any production batch to approve samples
Not available at the end of any production batch to test samples

Lack of staff availability during overtime shifts
Slow work pace
Focusing on quality without considering quantity dimension in their standards*
Minor mistakes in number of trays delivered*

3. Helpful Impact Comments

Save Time	Less Work	Psychological	Quality/Resources
Saved time	Allowed us the ability to plan	Created strong relationships with external agencies, which eases our work with them (adds a personal touch)*	Increased the quality of the output
Saved time	Provided more ability to focus on other tasks (less need to rework tasks)	Reduced possibilities of causing errors (Created more confidence in the method)*	Improved corrective actions
Saved time	Saved time because our work becomes more “mechanical” (there is less need to think about things)*	Increased motivation toward work	Allowed more effective discussions with our staff
Saved time	Reduced the need to fix many problems at later stages of product development	Created more confidence	Increased our knowledge
Received fast responses to our inquires	Created strong relationships with external agencies, which eases our work with them (adds a personal touch)*	Maintained a positive reputation for our department	Increased product quality
Saved time	Ability to make corrective actions	Highly support us	Reduced possibilities of causing errors (Created more confidence in the method)*
Saved time	Increases our ability to meet schedules	Personal issue (not task related)	Created a clearer sequence of tasks
Saved time	Resulted in fewer production stoppages	Creates more confidence in our output*	Resulted in fewer errors
Saved time	Reduced our tasks	Felt more confident about our work*	Established a clear set of priorities
Saved time	Reduced our tasks	Increased our trust in the machines (less breakdowns)*	Resulted in fewer errors
Saved time	Reduced our tasks		Resulted in fewer errors
Saved time because our work becomes more “mechanical” (there is less need to think about things)*	Reduced communication		Set clear priorities for us

Need less time to correct mistakes	Reduce our task	Produced a more accurate review
Saved time	Reduced our work	Resulted in fewer errors when replying to external inquiries
Handled our requests as a priority	Reduced my tasks	Resulted in fewer errors
Saved time	No need for additional work in data entry in SAP	Increased success with trials
Saved time	Easily fix problems from their side because they submitted the whole bundle	Created more accurate decisions
Saved time	Reduce my task	Enhanced product quality (Resulted in fewer defects)
Saved time	Reduce our task	Resulted in fewer defects
Saved time	Gained approvals easily	Resulted in fewer backward inspections
Saved time	Increased ease of replying to any external inquiry	Creates more confidence in our output*
Saved time	Reduce task reworks	Felt more confident about our work*
Saved time	Resulted in less task rework	Increased our trust in the machines (less breakdowns)*
Saved time	Made it difficult to disturb his schedule	Resulted in fewer machine breakdowns
Saved time	Gave us more time to review (less last-minute pressure)*	Exceeded our expectations in terms of time and quality*
Saved time	More ability to focus on our work (product development)	
Saved time	Created more focus because the path is clear	
Saved time	Resulted in fewer misunderstandings	
Saved time	Allowed us to focus more on the task	
Saved time	Allowed us to focus more on the task	

Saved time	More focus on production because our work becomes more routine
Saved time	Easier to coordinate work
Saved time	Our staff can work directly on production (saves energy)
Saved time	Increased productivity
Gives us the ability to register a new product on time	No need for task rework
Saved time	Gives us a better ability to accomplish work
Saved time	Resulted in fewer production stoppages
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Experienced fewer delays
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Reduced time needed to justify our requests
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Amplified the time saved for the whole group
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Gave us more time to review (less last-minute pressure)*
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Saved time
Achieved production targets
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Started production on time
Saved time
Saved time because we do not need to rely on face-to-face communication
Saved time
Saved time
Saved time
Saved time
Saved time
Saved time
Saved time
Launched new products on time
Saved time
Saved time
Saved time
Resulted in fewer delays in production
Saved time
Saved time
Saved time
Exceeded our expectations in terms of time and quality*
Saved time
Saved time
Ability to place another more promising formula in parallel with an existing formula
Gave us a better ability to accomplish

work in a parallel way

4. Unhelpful Impact Comments

Delay	Additional Work	Psychological	Quality/Resources
Caused delays	Bypass the plant by importing new product ideas as a finished product (therefore, there is no need for manufacturing)	More panic in our department	Cancelled the project because they lack the capability
Caused delays	Need to frequently refer to officials at the Ministry of Health to obtain information	Became frustrated	Makes decision-making difficult
Caused delays	Disturbed our relationship with licensor because we give them dates that frequently change	Not able to handle my daily work (need to take my work at home, which is a burden)*	Lack of available stock
Caused delays	Produced excess supplies that we need to determine how to sell	Caused stress	Poor reward systems
Caused delays because they are located in a different city	More communications cycles	Created tension with marketing department	Resulted in lack of focus (more errors are made)
Caused delays	Not able to take counteractions to solve problems	Created less confidence in their work*	Decreased accuracy
Caused delays	Difficult to convince them to rewrite advertisement brochures in a more exciting style	Increased our suspicion (we have less confidence in their output)*	Decreased our market share because competitors take the opportunity
Caused delays	Created more difficult problems that must be solved at later stages of product development	Created a negative image of our department	Wasted resources
Caused delays	Disturbed our schedule	Feeling blamed for delayed projects (burden)	Resulted in financial loses to the company as a whole
Caused delays	Disturbed our schedule	Created role ambiguity	Produced higher levels of unused

			inventory
Caused delays	Disturbed our schedule	Creates more frustration	Reduced material shelf life
Caused delays	Not able to handle my daily work (need to take my work at home, which is a burden)*	Created tension and made it difficult for us to maintain a friendly relationship with others	Resulted in fewer staff with multitasking capabilities
Caused delays	Needed to clean and change machine settings	Caused depression	Had more products on "holds"
Caused delays	Created the need to work more overtime	Reflected a negative image of the company (difficulties with external auditors)	Accumulated problems
Caused delays	Created additional tasks		Resulted in many machine breakdowns
Caused delays	Many communication cycles		No technical support
Caused delays	Increased communication cycles		Caused delays in providing production with raw materials*
Caused delays	Increase my task		Hindered effective interactions with SAP and other operators
Caused delays	Need to find them ourselves (increases our tasks)		Created more problems with quality
Caused delays	Caused more tasks to be reworked		Resulted in lower quality
Caused delays	Caused additional work in data entry in SAP		Created more stability errors
Caused delays	Caused more tasks to be reworked		Increased errors
Caused delays	Causes more tasks to be reworked		Increased errors and problems at later stages*
Caused delays	Caused more tasks to be reworked		Made it difficult to learn because he relies on verbal communication (no records)
Caused delays	Increased costs, delays, and tasks*		Difficult to figure out cause of failure (we

		start with internal cause then we discover afterward that it is because of using old raw material)*
Caused delays	Completed tasks beyond our role	Resulted in ineffective communication and negotiation with suppliers
Caused delays	Caused more tasks to be reworked	Created less confidence in their work*
Caused delays	Caused more tasks to be reworked	Increased our suspicion (we have less confidence in their output)*
Caused delays	Disturbing our schedules	Increased number of defective ampoules
Caused delays	Disturbed our schedule	More errors
Caused delays	Made it difficult to plan our tasks	Affected machine durability on the long run
Caused delays	Made it difficult to plan our tasks	Increased cost
Caused delays	Difficult to figure out what causes the problem	Lack of expertise
Caused delays	Disturb our schedule	
Caused delays	Disturbing our schedule	
Caused delays	Difficult to figure out cause of failure (we start with internal cause then we discover afterward that it is because of using old raw material)*	
Caused delays	Resulted in no focus (distracted)	
Caused delays	Increased errors and problems at later stages*	
Created delays depending on the quantity	Created more problems in scale up batches	
Caused delays	Created redundant tasks (doing the same tasks twice)	

Caused delays	Caused additional work to fix and sign corrections
Caused delays	Increases our task
Caused delays	Prevented us from taking sufficient corrective actions
Caused delays in providing production with raw materials*	Changed our internal plans (changing sequence of tasks)
Caused delays	Needed to work overtime
Caused delays	Created delays because we need to do a backward inspection*
Caused delays	Created delays because we need to do a backward inspection*
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	
Caused delays	

Took a longer time to perform tasks
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused minor delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays

Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays (impact amplified because it affects multiple projects)
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays

Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Amplified delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Amplified delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Increased costs, delays, and tasks*
Forced us to work sequentially instead of

in parallel
Get surprised with delayed results about failure samples
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Amplified delays because production is a sequence of tasks. If one task gets delayed all will delay
Caused delays
Caused delays
Delays may amplify based on the source of the error (internal vs. external)
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays

Caused delays
Caused delays
Caused delays
Caused delays
Created delays (depending on the nature of the problem)
Created delays (depending on the product and the problem)
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays (depending on the nature of the document and their load)
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Created need for additional time
Created delays (depending on whether information is in SAP or with another department)
Created delays (depending on the type of communication)

Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Created delays because we need to do a backward inspection*
Created delays because we need to do a backward inspection*
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Caused delays
Required more time to complete the same task
Took a longer time to explain

5. Variety Handling Mechanism Comments

Following up/Pressuring	Discussing	Escalating	Suggesting	Accepting	Fixing
Conduct follow ups	Conduct many personal visits to explain technical issues and terminologies	Ask our manager to intervene (escalate)	Ask them to request an increase in their resources	Nothing because it is beyond our control	We ask an expert person who was transferred to another department
Conduct follow ups	Give them a personal visit to work things out	Ask our manager to transfer project ownership to the Business Development department to ensure higher quality ideas, which will ease PDC's work*	They need to be exposed to other and new dosage forms	Nothing because they are improving over time	Document answers for future reference (refer to previous similar answers instead of waiting for their answers)
Pressure them with many follow ups	Try to convince them of our point of view by negotiating things together	I asked our manager to transfer project ownership to Business Development because they initiated the project*	Inform them with specific contacts based on our practical experience	It's beyond our control, but we hope top management will invest in new machines	Conduct more meetings and training sessions*
Conduct follow ups	Establish a regular meeting with them	Ask our director to provide us with new product steering committee meeting minutes*	Advise them based on our practical experience	We hope a recent "restructuring" in the company will fix such internal problems	Involved in each step of the Business Development process
Conduct many follow ups	Have informal chats to justify our position	Escalate	Help them structure their work	Nothing because Business Development is a new department with no clear role, and they claim that	Place early requests to give them enough lead-time

				providing scenarios will constrain us	
Pressure them to accept our opinion except for critical comments	Call for a one-time meeting to negotiate with them	Ask our manager to pass this information to them both formally and informally	Ask them to check with Medical department for technical reviews	Nothing because it is beyond my control	Implement development programs gradually.
Challenge their forecasts because we feel they are overestimating the time needed to the develop new products	Have a regular meeting with them (new product steering committee) to facilitate and ensure product development	Notify our manager	Ask Human Resource department to recruit medical advisors from the business sector rather than the medical or academic sector to ensure business experience and knowledge	We hoped that the last restructuring would solve this problem, but nothing happened. Our director, however, perhaps feels some improvements have been made.	Do not provide them with actual deadlines, but with earlier dates (padding)
Conduct follow-ups to understand reasons for delays (controllable vs. uncontrollable)	Conduct more meetings and training sessions*	Escalate (ask our manager to question their forecasts)	Ask them to request an increase in their staff	Nothing because it is their responsibility	Ask for an increase in manpower
Conduct follow-ups	Involve them in the planning process so that they will have a sense of "ownership"	Escalate (ask our manger to question them so that such a problem will not happen again)	Ask our manager to transfer project ownership to the Business Development department to ensure higher quality ideas, which will ease PDC's work*	Hope that top management will add such a function to their formal job description	Request an upgrade for our old machines to more efficient ones
Reject them and ask them to search for other alternatives	Explain program objectives to convince them that it is not against	Ask their managers to give us more lead time*	I asked our manager to transfer project ownership to Business Development	Nothing	Adjust our priorities

	them		because they initiated the project*		
Conduct follow ups (e-mail, sending our secretary, and a personal visit)	We initiated a subcommittee in the plant to exchange information	Escalate if we feel that our request is lost	Ask our director to provide us with new product steering committee meeting minutes*	If we are unable to cure the problem, nothing	Ask for an increase in our manpower
Ask them at the beginning of each quarter to inform us of their plans; however, the problem remains because they do not stick to their plans	Accept changes, but ask for a compromise (negotiate with them)	Include a comment in the audit report	I asked him to add me to the mailing list to receive regular updates about PDC, but he did not add me	We are hoping that they will perceive us as useful and in turn involve us more	Assign one of our staff to search for new markets
Ask them at the beginning of each quarter to inform us of their plans; however, the problem remains because they do not stick to their plans	If the case is urgent, we travel to them to have a face-to-face meeting	Include a comment in the audit report	Ask them to implement a databank of their contacts (backups for urgent requests)	Nothing because it is beyond our control; top management should intervene to fix things	Change our form formats to make it easier for the recording process
Provide frequent follow up from our side (feedback seeking)	Give them a friendly and personal visit	Include this problem as a comment in the audit report	Ask them to get training on real market cases	Nothing because they claim it is their top priority item	Change sales plans by redistributing customers orders
Ask marketing to provide us with better plans	Coordinate with related departments to find a solution	Ask our manager to intervene	Ask them to be involved in more workshops and training sessions regarding the pharmaceutical industry to be exposed to	Nothing because they are in the process of assigning permanent staff at multiple locations	Educate them on SAP because all required information is on the system

			other company practices		
Send reminders (conduct follow ups)	Discuss issues in a diplomatic way	Ask our manager to discuss in his meetings with the head office	Ask them to deal with multiple centers for bioequivalence analysis	Nothing because it is beyond our control and theirs	Immediately stop production
If it is a local order, we pressure them to finalize it	Give them a friendly and personal visit	Escalate	Ask them to have a technical person assigned to bioequivalence studies to receive better estimates of time needed	They assigned a person responsible for this task	Transfer old machines to them
Conduct follow ups	Agreed to work jointly on new packaging materials	Call for a meeting that will involve our manager*	Ask them to have a technical person to better prepare registration files	Nothing because they are in the process of expanding their department (increase in manpower)	Work on tasks in parallel to gain more time as a buffer for unexpected events
Frequently monitor their progress and ensuring they are following the plans	Ask him for ways to solve problems that result	Ask our manager to establish two new positions (analytical seniors) with whom I can coordinate and easily pressure them compared to supervisors*	Ask them to automate the whole communications process to reduce time needed to accomplish tasks	Nothing because it is the Business Development department's responsibility to take action	Directly communicate with warehouse for updates
Follow up with them first by phone then by e-mail	Call for a meeting with all six section supervisors to openly discuss the issue	Ask our manager to intervene (escalate)	Change formal system (i.e., SOP) to include such a function	Nothing because it is not part of my job responsibility	Reallocate staff based on priorities
Resend requests as a priority	Call for a meeting to involve others in solving pending problems	Include their manager during our follow up (cc) to put some pressure on	Reinforce the mission and vision of the company	Nothing because it is not part of my job responsibility	Task rework (redo the batch)

		them*			
Follow up with them to accelerate the approval process	Call for a meeting	Document the mistake (incident report)	Reinforce the mission and vision of the company	Nothing because this problem is a norm in the company	Reallocate free production staff to sections in need
Clearly notify them about our deadlines, and go ahead without their approval if they do not meet our specified deadline*	Call for a meeting that will involve our manager*	Directly communicate issue with Human Resource director to assign it as a high priority item	I asked them for a regular report, but nothing happened	Nothing because it is a norm in the company to follow up	Reallocate free staff to production to sections in need
Conduct follow ups	Call for a meeting	Directly contact their manager to discuss this problem*	There should be incentives and punishments for both well-organized and not well-organized departments	Nothing	Ask experts within our department about strategies that were effective in similar situations
Explain the impact of such delays	Call for a meeting	Rely on official communication methods (e.g., incident reports)	Ask them to at least pass along requests to review with their suggested answer	Nothing because head office is against changing them for financial reasons	Work on alternative tasks to continue production
Conduct follow ups	Work jointly on new product trials to adjust any specifications easily	Escalate (involve our manager to intervene)	Suggest they improve their coordination with customers	Wait and call for recent updates*	Search for the approval
Conduct follow ups	Work jointly on scale up batches	Escalate (ask our manager to intervene)	Ask them to coordinate better with plant to ensure material availability	Nothing but to solve their problem because it is beyond my role as a supervisor*	Clearly notify them about our deadlines, and go ahead without their approval if they do not

					meet our specified deadline*
Immediate follow ups with production supervisors	Discuss the problem with them	Directly talk to their supervisor about the mistake	Suggest planning in advance (at least six months before introducing any new product to the market)	Nothing	Educate them by providing technical justifications of our packaging references
Ask them to follow SOP, which indicates a three-month frozen budget	Negotiate with them because it is a personal problem	Explain to our manager the size of the problem	Suggest they buy new packaging machines with more flexibility	Wait until we are sure that their submitted results are final (uncertainty reduction)	Provide them with technical measurements to evaluate suppliers
Wait and call for recent updates*	First, explain our opinion to avoid the long cycle of correction	Conduct an internal audit	Ask them to establish a forecast section or at least forecast coordinator	Nothing because it is not part of my job	Point out mistakes without correction if we do not have time
Conduct follow ups	Communicate with them to find an alternative person		We suggested establishing a mini-plant for PDC to work independently	Nothing because it is beyond our control	Solve their problem
They pass any technical inquiry to us to evaluate it, and we send it back	Directly contact Quality Assurance supervisor to search for an alternative person		Ask them to learn from skillful buyers within the company	Nothing because it is a company policy to search for the lowest cost materials	Solve problem on-site
Follow up through multiple channels	Directly contact Quality Assurance supervisor to search for an alternative person		Redefine their job descriptions to include more functions	Accept changes because it is beyond my control	Take samples to our labs for trial-and-error problem solving
Conduct follow ups	Jointly working with production department to		They should recruit expert people instead of	Nothing because he claims it is a request from	Ask for time extension from Inventory Control

	figure out an internal action	accepting local staff reallocations within the company	top management	and Production Planning department to clean machines
Conduct follow ups	Working jointly to develop product validation methods	Ask their managers to give us more lead time*	Nothing	Clean machines
Follow up to increase the priority of our request	Call for a one-time meeting	Recommend they counter sign each production step	Nothing but we hope to implement new project management techniques that will create transparent channels of communication to reflect reality (top management and PDC manager are against this idea because it will uncover problems)	Search for old products to reanalyze their stability
Request a machine clean up before one day of our trials (feed forward control)	Directly contact their manager to discuss this problem*	Ask them to request an increase in manpower	Nothing because it is beyond my capacity as a supervisor	Ask for our own microbiology lab
Send an e-mail to explain the impact of such errors on the project as a whole		Ask them to request training opportunities for all staff	Nothing because it is beyond my control and it is useless to suggest anything to top management	We voluntarily developed a documentation system
Conduct follow ups to increase the priority of our		Ask them to request an increase in manpower	Nothing because we have become accustomed to it	Crash the project time

request					
Rarely follow up with them because our responsibility ends by transferring the product registration file to them			Ask formulation development department to reduce the number of product samples because they are the source of the problem	Nothing because it is beyond their capacity (the head office is the source of the problem)	Correct mistakes if we have time
Conduct follow ups			Ask them to increase their number of analysts	Nothing because it is impossible to solve. Top management is aware of the problem, but not willing to implement any corrective action	We transferred one of our staff members to work with them
Conduct follow ups			Request all analytical documents to be transferred to stability through our department to review them and ensure that they meet Regulatory Affairs' requirements (later stage)	Nothing because top management is against working on production size in early stages of product development (high cost)	Double check any documents sent from analytical development to stability
Conduct follow ups			Request all analytical documents to be transferred to stability through us to review them	Nothing because we prefer to give them a hand instead of leaving them overloaded, which leads to developing low-quality formulas that will affect	Review and correct their letters to suppliers

		us later*	
Conduct follow ups	Ask them to develop a data bank	Work on non-critical tasks until the results are submitted	Nothing but to solve their problem because it is beyond my role as a supervisor*
Conduct follow up	Ask the supervisor to request an increase in manpower to ensure that problem will remain a short-term issue	Accept their request because it is forced from the head office*	In urgent situations, accept requests because top management is involved
Make frequent requests to submit information in writing	Ask them to increase manpower on the task	Nothing because they will solve it for us	Nothing because we prefer to give them a hand instead of leaving them overloaded, which leads to developing low-quality formulas that will affect us later*
Conduct follow ups	Ask our manager to establish two new positions (analytical seniors) with whom I can coordinate and easily pressure them compared to supervisors*	Nothing because it is out of our control	Reduce our communication with them
Follow up on the follow ups	Ask them to use competitors as a reference to reduce errors	Nothing because it has become a norm	Accept their request because it is forced from the head office*

Conduct follow ups (if he has information)	Develop a data bank for future reference	Nothing because backward inspections are enforced by a formal system	Ask for an increase in our manpower to work on another line or train them to work without us
Conduct follow ups	Ask them to reduce their work rate and put in more time to ensure formula quality (reduce quantity and increase quality)	I have learned over time what is included on my manager's implicit priority list	Work on alternative production schedules with available materials
Ask them to justify any request	Ask them to have their own inventory and rely on production inventory	If he insists we do the new task, I know that the last request is a high priority item, so I rearrange my priority list	If it is an urgent trial batch, we stop our production and work overtime later
In normal situations, ask for initial tests before accepting any request	Ask our manager to give us an exact number of product registration files that should be developed each year	If he insists we do the new task, I know that the last request is a high priority item, so I rearrange my priority list	Search for alternative person to do the task
Explain to them the impact of such behavior	Request a monthly registration index report as an update about product registration status	I tried to convince him to have more faith in the formal system, but it did not work	Start production without their approval and take full responsibility for any mistake
In normal cases, we follow up by e-mail	Ask him to provide us with at least one alternative, not multiple	Nothing because they are learning over time	If they are not convinced, we fix the document by incorporating their comments

In urgent cases, we follow up by phone		Ask for a clear timeframe for each project	Nothing because it is the responsibility of Quality Assurance to stop them	Reorder new raw materials
Communicate by e-mail or phone		All registration staff should have sufficient technical background to answer any external inquiry	Nothing because they are learning over time	In urgent cases, we are forced to work overtime
Follow up to increase the priority of our request		Automation may be the solution	Nothing because it works to our advantage (results in more time to work on other tasks)	Train him
First, I remind him about previously requested tasks		Request they inform us in advance in order to provide them with better service	Nothing because I am sure that our manager knows about this problem and it exists for a reason	Educate them about the importance of quality in production
Include their manager during our follow up (cc) to put some pressure on them*		Ask them to work jointly in the lab on stability tests to acquire practical experience	Nothing because it is their responsibility to train a backup person	Enforce rules for major problems, but for minor things I personally solve problems by talking to the person involved
Ask them to be more focused to avoid future mistakes		I am planning to send a false sample that is contaminated to test them	Nothing because we have adapted to the situation	Train their staff on procedures
Inform them about our double shifts in advance		Ask them for a flexible date		Seek support from PDC because they may advise production people to

		reduce production speed for successful product development
First, I explain that an unclear request will require a long time to figure out and it may impact other tasks	Ask them to reduce their follow ups	Trace it
Send back to rework	Ask them to increase their staff	Double check everything
Pressure them by putting a hold on the production line	We ask them to have a logbook	Double check everything
I follow up if production department asks for a follow up and if I want to do so, because it is not part of my job	Ask Inventory Control and Production Planning department to give them enough lead time	Double check everything
Prove that they lost the sample by going to logbook	Ask them to send additional packaging materials	Train one of our staff on production engineering to act as a backup
Ask them whenever I see them if they have any near sampling visits (feed forward)	Ask them to change their old machines because it limits them by calculating all results at once	We transferred one of our staff to their department to gain experience and to work as a backup
Ask them to follow procedures	Ask them to update us with partial results instead	Personally monitor different staff with

	of waiting until the end to send the entire results	different levels of attention (tight for some and loose for others)
Ask them to follow procedures and send results in any form (onscreen, telephone, e-mail)	Ask them to increase their manpower	Request an increase in manpower
Ask them to correct mistakes	Ask to implement incentives for staff that report mistakes	Ask for an increase in our manpower
Rely on IT to force people to follow procedures	Ask for training sessions about the role of Quality Assurance	Strengthen our working relationships to increase their cooperation with us
Ask them to communicate with us through SAP, not updating plans through e-mails	Ask them to assign a backup person	Double check their work against procedures
	Ask them to work on their request tomorrow	Assign an extra person (if available) to work on the task
	Ask them to reschedule because they are very cooperative	
	They should have staff members who can multitask so that they can	

	be easily shifted when needed	
	Encourage employees to report mistakes	
	Provide them with Quality Assurance cell phone numbers to at least inform us by phone	

6. ‘Helpful to Others’ Comments for Most Positive Working Relationships Links

Competency	Communication	Cooperation	Basic Job Performance
Quickly finishing their requests (especially urgent requests)*	Approving their requests informally and completing required documents at a later stage*	Approving their requests informally and completing required documents at a later stage*	Providing them with all required plans and tools
Providing them with guidelines and directions based on our practical experience*	Providing them with useful advice (feedback seeking)	Giving their staff priority in being promoted to our department	Providing them with marketing plans
Organizing my work well to gain time when he wants to accelerate projects*	Providing them with feedback about how they are implementing their strategy	Not needing duplicate visits on the last five days of any sales closure	Reviewing and correcting their submitted technical information about packaging material
Reviewing product registration files because they lack the technical background	Providing them with information about their spending expenses levels	Quickly finishing their requests (especially urgent requests)*	Sticking to their marketing plans
Sending packaging samples immediately for design purposes	Handling their external communications to obtain all product technical information required	Helping with head office inquires (giving him credit to develop a positive image of himself)*	Providing them with new technologies to support them in developing new products
Providing them with technical experience because Quality Assurance employees work with different departments (knowledge transfer)*	Providing them with feedback about marketing materials and campaigns	Organizing my work well to gain time when he wants to accelerate projects*	Resolving their pending issues and problems with the licensor
Reducing production mistakes by enforcing rules and specifications	Providing them with feedback about the market and competitors	Requesting their reagents through our department	Developing and following bioequivalence studies
Releasing finished products on time to help meet their targets*	Providing them with feedback about competitors’ technical material	Preparing all analytical requirements even though this work is another department’s responsibility	Reviewing technical files and scientific appraisals

Helping them meet their targets by providing them with materials either on time or earlier than expected*	Providing them with guidelines and directions based on our practical experience*	Responding to external inquiries that should be answered by another person*	Providing them with product samples to assist the evaluation of their new product process
Supporting them during the technology transfer process in lab scale (being involved from the beginning of product development to ensure fewer errors in later stages [scale up])	Providing them with information about new products and our relationship with our partners	Correcting their mistakes with a personal touch (healthy communication)*	Reviewing and validating analytical methods
Accepting any validation or revalidation requests immediately	Answering external inquires	Being flexible with non-product development issues such as product inspection time	Being responsible for providing and updating both reference standards and in-house standards*
	Following up on delayed tasks	Pressuring our staff with overtime work to meet their targets	Explaining to them why they should follow procedures
	Updating them regarding our problems in product development	Releasing finished products on time to help meet their targets*	Finding alternative packaging materials to fix production mistakes
	Helping with head office inquires (giving him credit to develop a positive image of himself)*	Providing them with flexible schedules	Supporting them with quality advice on their double visits
	Being responsible for providing and updating both reference standards and in-house standards*	Being flexible in scheduling their product trials	Training them on production rules and regulations
	Responding to external inquiries that should be answered by another person*	Handling their requests as a high priority item compared to other departments	Correcting their reports by re-sampling results if they are beyond limits
	Immediately providing required technical information	Minimizing pressure on them by trying not to accept any urgent requests from marketing	Ensuring their work is completed according to procedures (inspection visits)
	Correcting their mistakes with a personal	Scheduling production batches as a mass	Planning production according to their

	touch (healthy communication)*	production to ensure stability on their end	resources
	Providing them with technical experience because Quality Assurance employees work with different departments (knowledge transfer)*	Not transferring any production staff to other sections on Wednesdays	
	Providing them with immediate reviews and feedback about their product specifications	Personally solving production problems without involving higher management	
	Informing them about work priorities	Asking them informally about their production status rather than relying on their daily reports*	
	Involving them in developing production plans	Accepting their urgent requests through verbal communication*	
	Asking them informally about their production status rather than relying on their daily reports*	Handling their urgent requests as a priority	
	Sending non-job related emails to ensure a continuous flow of communication	Helping them meet their targets by providing them with materials either on time or earlier than expected*	
	Visiting them on-site for informal conversations	Maintaining high levels of flexibility to handle their requests	
	Accepting their urgent requests through verbal communication*	Building two-way trust in our relationship	
	Providing them with ideas for improving production	Being able to afford production machines for trials	
	Reporting actual production situations (both ability and capacity)	Following up for materials because they are overloaded*	

	Reporting accurate information about actual production status (e.g., progress, number of operators, problems)	Informing them informally about mistakes in material delivery*	
	Following up for materials because they are overloaded*	Updating them informally about production progress*	
	Informing them informally about mistakes in material delivery*		
	Providing them with accurate estimates about task duration based on my experience (e.g., different staff members have different productivity rates)		
	Providing them with daily reports that reflect actual production progress		
	Updating them informally about production progress*		

7. ‘Helpful to Others’ Comments for Least Positive Working Relationships Links

Competency	Communication	Cooperation	Basic Job Performance
Placing orders early to give them enough lead time	Providing them with detailed information about business opportunities	Personally taking pictures of myself to prepare more representative brochure samples*	Doing all of their required tasks (e.g., business cases, forecasting exercises)
Personally taking pictures of myself to prepare more representative brochure samples*	Providing them with feedback about the market and competitors’ marketing material (e.g., brochures, giveaways)	Adjusting new products to fit existing tools and equipment (this avoids the need for new tools and equipment)*	Providing them with detailed technical information about new products (cost elements, forecasts, manpower)
Quickly completing their requests	Providing them with initial comments about the physical properties of packaging components	Adjusting new products to make it easier for the products to be manufactured*	Providing them with sales estimates for new products based on our experience
Adjusting new products to fit existing tools and equipment (this avoids the need for new tools and equipment)*	Providing practical opinions about the best way to sequence tasks*	Checking validation protocols because I have access to their machines	Providing them with financial profitability analysis and feasibility analysis for new products
Adjusting new products to make it easier for the products to be manufactured*	Updating them with training status and certificates without delay	Requesting training courses for our staff, even though it is part of their job to follow up	Designing packaging that is difficult to imitate
Providing practical opinions about the best way to sequence tasks*	Being approachable (making it easy to find me)*	Scheduling preventive maintenance on the weekends to reduce production disturbances	Arranging their visits to external regulatory agencies
Providing them with quality programs that eliminate their problems	Submitting sample requests with complete specifications	Being approachable (making it easy to find me)*	Providing them with required documents or certificates from the licensor
Releasing materials without delay	Providing them with useful information during the supplier assessment process	Offering overtime for non-local staff	Connecting them with external agencies
Training our staff to correctly operate machines, which results in fewer	Informing them about our changeovers in advance		Explaining technical issues about new products

breakdowns	
Assigning an expert production person to assist them during trials	Providing evidence about product effectiveness, which assists them in making sales transactions with customers
	Providing them with technical training
	Providing them with product samples to test new tools and equipment
	Providing them with business opportunities
	Solving production problems
	Providing required packaging information and material for evaluating machines
	Reviewing analytical methods
	Supporting them during the recruitment process (interviewing, sending reports, and providing them with timetables)
	Providing them with microbiology analysis
	Ensuring their work is completed according to procedures (cross checking for mistakes)
	Meeting their targets
	Providing them with production plans
	Giving them enough time to test samples
	Providing them with enough lead time
	Giving them enough lead time to request materials

	Ensuring that both machines and the area are clean for trials
	Providing them with machines and sufficient time for trials

8. ‘Not So Helpful to Others’ Comments for Most Positive Working Relationships Links

Incompetency	Miscommunication	Noncooperation	Unreasonable Expectations
Frequently changing plans	Not providing them with immediate responses to their requests	Being very particular on minor issues*	Disturbing them with many requests
Not sticking to their marketing plans	Delays in providing them with analysis results	Following the system too strictly (too rigid)*	Tight parameters on their financial activities with customers
Errors in marketing materials (leaflets)	Delays in providing information about packaging components		Overloading them with quickly completed tasks (our work rhythm is faster than their work rhythm)
Delays in product development	Forcing them to follow procedures based on our views and preferences (requiring many negotiation cycles for things to be done)*		Pressuring them with many urgent requests
Errors in scale-up batches, which may result in blaming him for production delays (because he represents our department)	Delays in reporting machine downtime, which disturbs their schedules		Disturbing their schedules with many requests
Becoming too dependent on his opinions for every problem	Causing delays in preparing daily reports		Pressuring them with many new projects
Delays in reviewing analytical methods			Asking them to work on dissimilar project types (many non-routine tasks)
Errors in analytical reports			Disturbing their schedule with many urgent requests
Perceiving our role as inspectors rather than as advisors			Forcing them to follow procedures based on our views and preferences (requiring many negotiation cycles for things to be

	done)*
Delaying them because we work with different departments	Isolating any suspected batch into a "quarantine"
Delays in releasing raw materials, which requires them to change production plans	Being very particular on minor issues*
Making frequent changes to production plans	Disturbing their schedules in order to fit our schedules
Delays in providing them with raw materials, which disturbs their plans	Pressuring them to fix production problems
Not being able to afford production machines for trials due to conflicting schedules	Disturbing their schedule with urgent production requests
Consuming a large amount of packaging material during downtime	Transferring available staff to help other production sections
	Asking for additional operators
	Following the system too strictly (too rigid)*

9. ‘Not So Helpful to Others’ Comments for Least Positive Working Relationships Links

Incompetency	Miscommunication	Noncooperation	Unreasonable Expectations
Delays in preparing plans or scenarios for them	Delays in providing them with feasibility studies for new products	Being too particular about procedural issues*	Pressuring them with many urgent requests
Delays in finishing their requests, which requires many follow-ups on their side*	Delays in finishing their requests, which requires many follow-ups on their side*	Not handling their requests as a priority (compared to the production department)	Asking them to provide us with less expensive materials based on our budget changes
Not preparing well-defined plans and scenarios that meet their expectations	Conducting numerous negotiation cycles to reduce material prices	Feeling that our frequent follow-ups with them are personal rather than professional	Disturbing their plans by changing our monthly forecasts due to certain sales abnormalities
Not achieving sales targets, which affects their relationships and future agreements with our partners (this reflects a negative image of the company)	Delays in providing them with analysis results		Pressuring them with many urgent requests
Feeling that we are too business oriented when explaining new product development (imposing our view on them)*	Delays in providing them with analysis results		Disturbing their schedules with many requests
Frequently changing agreements before final approval	Delays in providing required packaging information and material for evaluating machines*		Feeling that we are too business oriented when explaining new product development (imposing our view on them)*
Accompanying them on double visits	Requesting they document all of their daily activities in detail*		Pressuring them with many agreements to review
Changes to product development plans	Delays in submitting some microbiology results		Disturbing their schedule by extending our use of production machines (lack of

		commitment on our side)*
Changes to product shape	Asking for frequent forecast updates	Frequently using production machines for product trials
Disturbing their schedule by extending our use of production machines (lack of commitment on our side)*	Sending some item requests with errors	Disturbing their schedule with many urgent requests
Not cleaning the machines after finishing our product trials	Delays in updating them about Human Resource issues (we do not provide information if they do not ask about an issue)	Forcing them to work based on my views and preferences because I have previous hands-on experience (I worked in their department)
Delays in providing required packaging information and material for evaluating machines*		Performing backward inspections
Making frequent changes to production plans		Being too particular about procedural issues*
Operating machines without fully following preventive procedures		Questioning and asking for justification about their forecasts based on previous sales performance
Working on materials that do not match the machine properties		Transferring their available staff to help other production sections
Not giving them enough lead time to request materials		Making unplanned requests that result in additional tasks for them
Creating delays in providing them with raw materials from the dispensary (they request material through the production department)		Asking local staff to work overtime
		Dealing with the difficult nature of the

	work (once production begins, it should continue without any breaks)
	Requesting they document all of their daily activities in detail*

Appendix C

Follow-up Survey

The purpose of this questionnaire is to gain an understanding of the perspective that project participants have regarding project management practices, problems and tools.

Please indicate on the scale provided your judgment on each of the following statements on project management.

Each scale allows you to choose either no difference between very complex projects and not very complex projects or to indicate the extent the statement is true about either complex or not complex projects.

Please use the comment space under each question if you like to elaborate more on your answer.

Project Complexity

1. Usually, it is easier to accurately calculate the expected completion date for the project.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

2. Usually, it is easier to accurately calculate the expected budget for the project.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

3. Usually, projects may involve more people and departments from the company.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

4. People working on various tasks are more likely to experience more difficulties/or challenges.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____

5. Typically, appropriate and accurate calculation of required staff is done for the project.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____

6. Typically, the project may involve more unanticipated problems.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____

7. Typically, the project may involve more external contractors and suppliers.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____

8. The project personnel usually have all the required knowledge/skills.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____

9. Usually, the project may include tasks that were never done before.

1 2 3 4 5 6 7

Not Very Complex Projects — No Difference — Very Complex Projects

Comments:____

10. If you are interacting with another department that is characterized with more not helpful behaviors, the impact of such not helpful behaviors will be more on.

1 2 3 4 5 6 7

Not Very Complex Projects — No Difference — Very Complex Projects

Comments:____

Project Management Problems

11. Some departments may end up with more difficult problems to deal with than other departments.

1 2 3 4 5 6 7

Not Very Complex Projects — No Difference — Very Complex Projects

Comments:____

12. Usually, some departments experience lack of resources and expertise whereas other departments don't.

1 2 3 4 5 6 7

Not Very Complex Projects — No Difference — Very Complex Projects

Comments:____

13. Typically, the number of conflicts between departments will tend to decrease.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____

14. Typically, some departments grossly misestimate time required for their tasks whereas others are reasonably accurate.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____

15. Typically, different departments have more/or less the same share of problems to deal with.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____

16. Typically, some departments in the process of working on their task may end up creating, unintentionally, unanticipated problems for other departments.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____

17. Most people are unclear about the scope and responsibilities of their job on the project.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

18. Most people are not likely to be fully qualified to handle all aspects of the project.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

19. Most people are not likely to get all the information needed to carry out their job on the project.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

20. Most people are likely to be clear about their responsibility on the project.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

21. Most people are likely to be clear about their limits of authority on the project.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____________________

22. Typically, the project may involve many unscheduled meetings.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____________________

23. Typically, people may face difficulties in following the exact procedures.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____________________

24. Usually, people in the department may feel lower levels of anxiety to cope with the project's requirements.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____________________

25. Usually, people may come up with new, original ideas for handling novel aspects of the work.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

26. Typically, existing rules and procedures may work well on the project.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

27. Usually, people may by-pass official channels when they want something done in a hurry.

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

28. Typically, the project involves more communication (e.g., e-mails, meetings).

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

Working Relationships

Note. In this part, each scale allows you to choose either no difference between very positive relationships and not very positive relationships, or to indicate the extent the statement is true about either positive or not positive relationships.

29. The person from another department is more likely to quickly respond to my request(s).

1	2	3	4	5	6	7
Not Very Positive Relationship			No Difference			Very Positive Relationships

Comments: ____

30. The person from another department is more likely to not be willing to go out of his/her way to help me with my task difficulties.

1	2	3	4	5	6	7
Not Very Positive Relationship			No Difference			Very Positive Relationships

Comments: ____

31. The person from another department is more likely to provide me with information that may affect my task.

1	2	3	4	5	6	7
Not Very Positive Relationship			No Difference			Very Positive Relationships

Comments: ____

32. The person from another department is more likely to be cooperative in scheduling meetings for necessary project coordination.

1 2 3 4 5 6 7

Not Very Positive Relationship | No Difference | Very Positive Relationships

Comments:____

33. The person from another department is more likely to act in a way that makes the project more difficult on my end.

1 2 3 4 5 6 7

Not Very Positive Relationship | No Difference | Very Positive Relationships

Comments:____

34. The person from another department is more likely to go beyond his/her formal job description in order to ensure project coordination.

1 2 3 4 5 6 7

Not Very Positive Relationship | No Difference | Very Positive Relationships

Comments:____

35. Usually, I need to have many follow ups to the person from another department before my request is done.

1 2 3 4 5 6 7

Not Very Positive Relationship | No Difference | Very Positive Relationships

Comments:____

36. The person from another department is more likely to not be willing to do any task that is slightly different than usual.

1	2	3	4	5	6	7
Not Very Positive Relationship			No Difference			Very Positive Relationships

Comments: ______________________________

37. The person from another department is more likely to treat my request as a high priority item:

1	2	3	4	5	6	7
Not Very Positive Relationship			No Difference			Very Positive Relationships

Comments: ______________________________

38. The person from another department is more likely to come up with excuses for not helping me on my request although I know he/she can do it.

1	2	3	4	5	6	7
Not Very Positive Relationship			No Difference			Very Positive Relationships

Comments: ______________________________

39. The person from another department is more likely to modify his/her way of doing his/her task to minimize difficulties at my end.

1	2	3	4	5	6	7
Not Very Positive Relationship			No Difference			Very Positive Relationships

Comments: ______________________________

Project Management Software

40. Are you familiar with any project management software package?

☐ Yes, please answer sections (a) & (c); also (b) if applicable.

☐ No, please answer section (b) & (c)

Section (a)

41. Please indicate the project management package you are most familiar with:

☐ MS Project ☐ Primavera ☐ Timeline ☐ Work Bench

☐ Project Scheduler ☐ Other, specify:______________

42. The project management package as a planning tool is most appropriate for:

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

43. The project management package as a tracking tool is most appropriate for:

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

44. The project management tool provides precise information:

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

45. The information content meets the need of the users:

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____________________

46. The project management tool provides reports that seem to be just about exactly what the users need:

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____________________

47. The project management tool provides sufficient information for the users to perform their job:

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____________________

48. Users are satisfied with the accuracy of the project management tool:

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____________________

49. The project management tool provides up-to-date information:

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments: ____________________

Section (b)

In my opinion, our company is not using a project management software package because:

____
____
____
____
____
____
____
____

Section (c)

50. Overall, based on your understanding of the project management software, it is most useful with:

1	2	3	4	5	6	7
Not Very Complex Projects			No Difference			Very Complex Projects

Comments:____

Background

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?____

If you have any additional comments, please provide them below:

____
____
____
____
____
____
____
____

Thank you for your participation in this survey!

Appendix D
Statistical Analysis of Demographic Data

Various job-related variables were collected from participants, including job title, length of time performing the same job, and length of time in the company. Based on the demographic variables, an ANOVA test was used to test whether the means of these different groups are equal.

Departments

A total of 122 employees were selected from within 17 different departments. Table 1 shows the distribution of respondents by department.

Departments	Participants
Marketing	5 (4.1%)
Sales	5 (4.1%)
Business Development	3 (2.5%)
Pharmaceutical Development Center	19 (15.6%)
Quality Services	12 (9.8%)
Inventory Control and Production Planning	6 (4.9%)
Procurements	2 (1.6%)
Production	6 (4.9%)
Medical	2 (1.6%)
Logistics & Distribution	5 (4.1%)
IT	16 (13.1%)
Human Resources	9 (7.4%)
Legal	1 (0.8%)
Finance	2 (1.6%)
Accounting	7 (5.7%)
Regulatory Affairs	1 (0.8%)
Production Engineering	21 (17.2%)
Total	**122 (100%)**

Table 1: Survey Respondents by Department (N = 122)

To generate a sufficient sample size for the analysis, only departments with more than five respondents were considered in the test. Using the one-way ANOVA, the hypothesis that "all means are equal among departments" was tested; those constructs with *p*-values of less than 5% indicated that the perception of project management differs among employees working in certain departments. Table 2 shows the results of the one-way ANOVA based on departments.

Construct	Assumption	Sum of Squares	df	Mean Square	F	*p*-value
Project Complexity	Between Groups	4.26	6	.710	2.289	**.043**
	Within Groups	25.77	83	.310		
	Total	30.03	89			
Mismatches of Variety/Variety Handling Capability	Between Groups	1.59	6	.264	.641	.697
	Within Groups	34.23	83	.412		
	Total	35.81	89			
Role Ambiguity	Between Groups	10.07	6	1.679	2.006	**.074**
	Within Groups	69.46	83	.837		
	Total	79.54	89			
Adhocracy Mechanisms	Between Groups	7.30	6	1.217	1.472	.198
	Within Groups	68.66	83	.827		
	Total	75.96	89			
Procedural Mechanisms	Between Groups	2.35	6	.392	.580	.745
	Within Groups	56.14	83	.676		
	Total	58.49	89			
Positive Working Relationship Behaviors	Between Groups	1.96	6	.327	.572	.751
	Within Groups	47.48	83	.572		
	Total	49.44	89			
Negative Working Relationship Behaviors	Between Groups	8.01	6	1.335	2.507	**.028**
	Within Groups	44.21	83	.533		
	Total	52.22	89			
Project Management Software	Between Groups	26.89	6	4.481	1.600	.157
	Within Groups	232.40	83	2.800		
	Total	259.29	89			

Table 2: Results of the One-way ANOVA based on Departments

As Table 2 shows, participants demonstrate differences in their understanding of project complexity, role ambiguity, and negative working relationship behaviors among departments. At this point, however, it is not possible to determine from which departments these differences emanate. Thus, a multiple comparison test determined which departments differed from the others. Specifically, we used a post-hoc test (i.e. Waller-Duncan); differences are identified for variables in which the null hypothesis from the ANOVA was rejected (project complexity, role ambiguity, and negative working relationship behaviors).

For the project complexity factor, a difference exists in the perception of employees working in IT (subset 4) versus the remaining departments (subsets 1, 2, and 3). Table 3 shows the results of the Waller-Duncan test for project complexity.

		Subset for alpha = 0.05			
Department	N	1	2	3	4
Production Engineering	21	4.70			
Human Resources	9	4.73	4.73		
Accounting	7	4.90	4.90	4.90	
Quality Services	12		5.01	5.01	
Production	6			5.03	
Pharmaceutical Development Center	19			5.04	
IT	16				5.33

Table 3: Waller-Duncan Test for Project Complexity

For the role ambiguity factor, a difference exists in the perceptions of employees working in Production Engineering and Quality Services (subset 3) versus Production and IT (subset 1). Table 4 shows the results of the Waller-Duncan test for role ambiguity.

		Subset for alpha = 0.05		
Department	N	1	2	3
Quality Services	12	4.42		
Production Engineering	21	4.90	4.90	
Pharmaceutical Development Center	19		4.92	
Accounting	7		5.00	5.00
Human Resources	9		5.36	5.36
Production	6			5.43
IT	16			5.46

Table 4: Waller-Duncan Test for Role Ambiguity

For the negative working relationship behaviors factor, a difference exists in the perception of employees working in Production Engineering and Quality Services (subset 3) versus IT, the Pharmaceutical Development Center, Human Resources, and Production (subset 1). Table 5 shows the results of the Waller-Duncan test for negative working relationship behaviors.

		Subset for alpha = 0.05		
Department	N	1	2	3
IT	16	2.21		
Pharmaceutical Development Center	19	2.25		
Human Resources	9	2.44		
Production	6	2.47	2.47	
Accounting	7		2.83	2.83
Production Engineering	21			2.84
Quality Services	12			2.97

Table 5. Waller-Duncan Test for Negative Working Relationship Behaviors

Location

Based on the department locations (i.e., Head Office or Plant), participants were divided into two groups that are both geographically and functionally separated. The Head Office includes managerial departments (e.g., Marketing, Sales, Business Development, Human Resources, Legal and Regulatory

Affairs), whereas the Plant includes departments with more technical roles (e.g., Production, Quality Services, Pharmaceutical Development Center, Production Engineering & Inventory Control, and Production Planning). Table 6 shows the distribution of respondents by location.

Location	**Participants**
Head Office	51 (41.8%)
Plant	71 (58.2%)
Total	**122 (100%)**

Table 6. Survey Respondents by Location (N = 122)

As the Table 7 indicates, we tested the difference in means for each variable according to participants' location (Head Office versus the Plant). The results indicate that participants' perception regarding role ambiguity and procedural mechanisms differs according to the work location.

Construct		Levene's Test for Equality of Variances F	p-value	t-test for Equality of Means t	df	p-value	Head Office	Plant
Project Complexity	Equal variances assumed	.065	.800	.819	120	.41	5.05	4.96
	Equal variances not assumed			.827	111.614	.41		
Mismatches of Variety/Variety Handling Capability	Equal variances assumed	4.390	.038	.453	120	.65	4.74	4.68
	Equal variances not assumed			.429	85.266	.67		
Role Ambiguity	Equal variances assumed	.582	.447	2.207	120	.03	5.28	4.92
	Equal variances not assumed			2.251	114.716	.03		
Adhocracy Mechanisms	Equal variances assumed	.011	.916	-1.248	120	.21	5.05	5.26
	Equal variances not assumed			-1.257	110.342	.21		
Procedural Mechanisms	Equal variances assumed	.494	.483	-1.632	120	.09	2.92	3.17
	Equal variances not assumed			-1.616	103.802	.09		
Positive Working Relationship Behaviors	Equal variances assumed	.199	.657	-.090	120	.93	5.19	5.20
	Equal variances not assumed			-.089	105.653	.93		
Negative Working Relationship Behaviors	Equal variances assumed	3.284	.072	-1.166	120	.25	2.53	2.70
	Equal variances not assumed			-1.133	95.921	.26		
Project Management Software	Equal variances assumed	.456	.501	-.315	120	.75	4.94	5.04
	Equal variances not assumed			-.314	106.246	.75		

Table 7: Levene's Test and t-test Results for Location

Years of Experience on the Job

Years of experience on the job ranged from 6 months to 20 years, with a mean of 6.6 years (*SD* = 4.9). Table 8 shows the distribution of participants by years of experience on the job.

Years of Experience on Job	Participants
< 2 years	22 (18%)
2-5 years	43 (35.2%)
5-10 years	31 (25.4%)
10-15 years	19 (15.6%)
>15 years	7 (5.7%)
Total	**122 (100%)**

Table 8: Distribution of Respondents by Years of Experience on the Job

Using a one-way ANOVA, no significant difference existed for any factor among groups related to years of experience because the *p*-value is greater than 5%. We concluded, therefore, that duration in a specific position does not make a difference in understanding the proposed factors for employees (see Table 9).

Construct	Assumption	Sum of Squares	df	Mean Square	F	p-value
Project Complexity	Between Groups	1.105	4	.276	.860	.490
	Within Groups	37.564	117	.321		
	Total	38.669	121			
Mismatches of Variety/Variety Handling Capability	Between Groups	.212	4	.053	.116	.977
	Within Groups	53.291	117	.455		
	Total	53.503	121			
Role Ambiguity	Between Groups	1.011	4	.253	.292	.883
	Within Groups	101.371	117	.866		
	Total	102.382	121			
Adhocracy Mechanisms	Between Groups	1.950	4	.487	.566	.688
	Within Groups	100.764	117	.861		
	Total	102.714	121			
Procedural Mechanisms	Between Groups	2.878	4	.720	1.042	.389
	Within Groups	80.820	117	.691		
	Total	83.698	121			
Positive Working Relationship Behaviors	Between Groups	1.353	4	.338	.600	.663
	Within Groups	65.981	117	.564		
	Total	67.334	121			
Negative Working Relationship Behaviors	Between Groups	1.402	4	.351	.526	.717
	Within Groups	78.034	117	.667		
	Total	79.436	121			
Project Management Software	Between Groups	9.468	4	2.367	.777	.542
	Within Groups	356.532	117	3.047		
	Total	366.000	121			

Table 9: Results of the One-way ANOVA for Years of Experience on the Job

Years of Experience in the Company

Employees' years of working in the company ranged from 1 to 23, with a mean of 10.1 years (*SD* = 5.5). Table 10 shows the distribution of participants by years of experience in the company.

Years of Experience in the Company	Participants
< 2 years	8 (6.6%)
2-5 years	23 (18.9%)
5-10 years	35 (28.7%)
10-15 years	32 (26.2%)
>15 years	24 (19.7%)
Total	**122 (100%)**

Table 10: Distribution of Respondents by Years of Experience in the Company

Using a one-way ANOVA, no significant difference exists for any factor among years of experience, except for negative working relationship behaviors at the 10% level of significance. We can conclude, therefore, that the perception of negative working relationship behaviors varies depending on how long the employees have worked within the company (see Table 11).

Construct	Assumption	Sum of Squares	df	Mean Square	F	*p*-value
Project Complexity	Between Groups	.772	4	.193	.596	.666
	Within Groups	37.897	117	.324		
	Total	38.669	121			
Mismatches of Variety/Variety Handling Capability	Between Groups	.431	4	.108	.237	.917
	Within Groups	53.072	117	.454		
	Total	53.503	121			
Role Ambiguity	Between Groups	2.264	4	.566	.661	.620
	Within Groups	100.118	117	.856		
	Total	102.382	121			
Adhocracy Mechanisms	Between Groups	2.687	4	.672	.786	.537
	Within Groups	100.027	117	.855		
	Total	102.714	121			
Procedural Mechanisms	Between Groups	2.399	4	.600	.863	.488
	Within Groups	81.299	117	.695		
	Total	83.698	121			
Positive Working Relationship Behaviors	Between Groups	1.400	4	.350	.621	.648
	Within Groups	65.934	117	.564		
	Total	67.334	121			
Negative Working Relationship Behaviors	Between Groups	4.608	4	1.152	1.801	.103
	Within Groups	74.828	117	.640		
	Total	79.436	121			
Project Management Software	Between Groups	4.287	4	1.072	.347	.846
	Within Groups	361.713	117	3.092		
	Total	366.000	121			

Table 11: Results of the One-way ANOVA for Years of Experience in the Company

To determine the range of years of experience that differs from the others, we used a post-hoc test (i.e., Waller-Duncan). Based on the results of the Waller-Duncan test, a significant difference was found in the perception of the negative working relationship behaviors between employees with less than 2 years of experience and those with more than 15 years of experience. In other words, employees with more years of experience (>15 years) may have better working relationship behaviors than employees with fewer years of experience (<2 years). Table 12 shows the results of the Waller-Duncan test for negative working relationship behaviors.

		Subset for alpha = 0.05		
Experience in Company	N	1	2	3
<2 years	8	2.20		
5-10 years	35	2.49	2.49	
10-15	32		2.63	
2-5 years	23		2.63	
>15 years	24			2.95

Table12: Waller-Duncan Test for Negative Working Relationship Behaviors

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