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Management Control Systems in Technical and Administrative Development Projects

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Mika Ylinen

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ABSTRACT

Ylinen, Mika (2004). Management control systems in technical and administrative development projects: The effects of interactive and diagnostic use of project feedback and measurement systems on project innovativeness – Moderating effects of project manager tolerance for ambiguity. *Acta Wasaensia* No. 126, 179 p.

This survey-based empirical study focuses on the interactive and diagnostic use of project feedback and measurement systems as defined by Simons as the central constructs of interest. The responses of 119 project managers, drawn from technical and administrative type development projects, to a questionnaire survey were analysed by using the partial least squares approach to structural equation modelling. Based on previous findings it is suggested in this study that formal project management control systems (MCS) may present a negative or a positive effect on innovation at the project level depending on the style of use of formal project MCS. It was argued that variety in the use of interactive and diagnostic styles of formal project MCS explains some of the inconsistencies of the previous studies. Interactive use of feedback and measurement systems has an important role on expanding opportunity seeking, learning and enhancing innovativeness. This suggestion of Simons was confirmed in technical type development projects, as results indicate a significant positive relationship between interactive style of use project MCS and innovativeness in project.

These findings supported, also, some arguments from the dual-core theory, which claims that an organic structure is needed when changes in organizational products, services and technology are necessary and thus, high professionalism, low centralization and low formalization facilitate the bottom-up process of technical innovation. Results of this study indicated that there is significant positive effect of interactive use of formal project MCS on innovation in technical type development projects but not in administrative type projects. However, the results indicated that in administrative type development projects diagnostic use of formal project MCS has an important role in achieving and keeping projects on track with project performance targets. This suggests that in administrative type development projects diagnostic use of formal project controls provide discipline that may motivate action and drive efficiency.

The findings of this study are consistent with previous arguments that to achieve effective outcomes, tasks with high uncertainty must be executed differently from tasks with low uncertainty. The results also provide support for previous research evidence that personality has a moderating effect on the characteristics of information perceived to be useful in uncertain environments. Specifically, this study provides some support for the proposition that the extent to which individual project manager use interactive or diagnostic type formal project controls under highly uncertain conditions is a function of their personality variable of tolerance for ambiguity.

In summary, these results suggest that while innovation requires a high degree of flexibility in the structural and communication processes, formal project MCS also has an important role in project management. Project type, also, affects how different control strategies to manage development projects are best achieved when facing uncertain conditions. Additionally, the project manager's personality characteristic of tolerance for ambiguity seems to play an important role in determining the use of interactive and diagnostic type project controls under task uncertainty.

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Key words: project control systems, innovation, task uncertainty, tolerance for ambiguity.

1. INTRODUCTION

1.1. Introduction to research area

This research was motivated by an interest in understanding the role of project management control systems (MCS) in business settings where innovativeness is important to successful operations. Previous research has shown that enhancing the creative performance of employees is a necessary step if organizations are to achieve competitive advantage (Amabile 1988; Devanna & Tichy 1990; Kanter 1983; Shalley 1995). When employees perform creatively, they produce novel and useful products, ideas, or procedures that provide an organization with important raw material for subsequent development and possible implementation (Amabile 1988; Staw 1990; Woodman, Sawyer & Griffin 1993). The initiation and implementation of these products enhance an organization's ability to respond to opportunities and, therefore, to adapt, grow, and compete (Kanter 1983, 1988; March & Simon 1958; Van de Ven 1986; Van de Ven & Angle 1989).

Creativity and innovation can be fostered by allowing a considerable degree of freedom or autonomy in the conduct of individuals work (e.g. Bailyn 1985; Paolillo & Brown 1978; Pelz & Andrews 1966; Oldham & Cummings 1996). However, previous research has suggested that also several aspects of project supervision appear to be important, starting with an ability to clearly set overall project goals while allowing procedural autonomy to have choice in how to go about accomplishing the tasks that they are given (e.g. Amabile, Conti, Coon, Lazenby & Herron 1996; Amabile 1997). In addition, project supervision is likely to foster creativity when there is clear planning and feedback, good communication between the supervisor and the work group, and enthusiastic support for the work of individuals as well as the entire group. Management practises for creativity also include the ability to constitute effective work groups that represent a diversity of skills and are made up of individuals who trust and communicate well with each other, challenge each other's ideas in constructive ways, are mutually supportive, and are committed to the work they are doing (Amabile 1997, 1998).

This study is focusing on project teams as they are important entity of organizations research and development work and have been largely unexplored in management accounting research (Chenhall 2003a). Previous research has stated that success in development projects requires both innovation and efficiency. Thus, a significant challenge for managers is how to ensure efficiency by exercising adequate control over project teams, while at the same time encouraging flexibility, creative freedom and participative decision processes (Imai, Nonaka & Takeuchi 1985; Jelinek & Schoonhoven 1990). However, only a few studies have investigated the effects of different project management styles on efficiency and innovation (Brown & Eisenhardt 1995; Jelinek & Schoonhoven 1990). Task uncertainty is important antecedent to characteristics of project MCS. Tasks with high levels of uncertainty require greater and more careful pre-task planning than tasks with low levels of uncertainty. Further, to achieve effective outcomes, tasks with high uncertainty must be executed differently from tasks with low uncertainty (Daft 1986; Galbraith 1977). For example, it has been claimed that tasks with high uncertainty require "organic" organizational approaches in order to be successful, whereas tasks with low uncertainty require "mechanistic" organizational approaches in order to be successful (Burns & Stalker 1961; Galbraith 1973; Tushman & Nadler 1978).

However, while some degree of freedom and flexibility seems to be an essential condition to the relative speed and success of cross-functional development project teams, it may also be essential to combine this with more formal type of control mechanisms. These teams must also consider that those choices and actions, which they make during the project, fit to changing customer needs and desires, that they fit with the firm's strategies and competencies and resources, and that projects are on schedule and do not exceed budget. At an individual project level traditional formal controls may play a role in management's attempt to keep project teams on an appropriate strategic track and to avoid unwelcome surprises. But too much or the wrong type of formal control may decrease the team's creativity, impede their progress, and inhibit ultimate performance. Therefore, an important and interesting research question becomes how do different styles of use of formal project control systems impact on project teams' innovativeness.

It is important to recognize that the effect of formal project control systems on important dimensions of organizational performance like innovation is not only theoretically significant, but also of great practical significance. In a world in which firms must confront simultaneous demands to be innovative and efficient (Bartlett & Ghoshal 1989), it can be a challenge to maintain the optimal amount and type of control that is necessary to stimulate innovation.

While accounting research has studied formal control mechanisms in other contexts[1], these mechanisms have received less attention in management accounting research from the point of view of research and development environments[2]. More importantly, the specific types and characteristics of formal controls and their influence on research and development project performance have been largely unexplored. Additional empirical evidence and theoretical concepts are needed to fully understand management control systems in research and development environments (Davila 2000).

The main focus of this study is on formal project management control systems and draws on Simon's (1995) definition of management control systems as the formal, information-based routines and procedures managers use to maintain or alter patterns in organizational activities (Simons 1995: 5). According to Simons (1995) formal control systems can be classified in three categories, depending on their design attributes: belief systems, boundary systems and feedback and measurement systems. Belief systems are explicit sets of organizational definitions that define the basic values, purpose and direction of the organization. Boundary systems are sets of rules, indications and proscriptions that delineate the acceptable domain of activity. Feedback and measurement systems are data-based systems that capture information on either inputs, processes or outputs in order to both monitor past actions and detect future opportunities. Examples of formal feedback and measurement systems are budget systems, project management systems and balanced scorecard systems. Formal project feedback and measurement systems and their relationship with project innovation is the main subject of this thesis.[3]

While feedback and measurement systems can capture information on inputs, processes or outputs, the focus of this study is on process and output-oriented feedback. The study examines feedback and measurement systems at the project level and specifically diagnostic and interactive styles of use those formal control mechanisms. The study distinguishes the application of these formal controls in technical and administrative type development project environments. Output-oriented controls are mechanisms used to directly influence the desired ends from projects. For example, such controls include

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[1] For extensive literature reviews see Shields & Shields (1998), Hartmann (2000) and Chenhall (2003a).

[2] See Rockness & Shields (1984), Abernethy & Brownell (1997), Nixon (1998), Davila (2000) and Hertenstein & Platt (2000) for exceptions.

[3] The terms project feedback and measurement system, project control system and project MCS are used interchangengeably in this study.

setting deadlines, budgets, and target performance objectives for the project team to meet and performance evaluation of those according those targets. Process controls monitor project actions, which means controlling the project execution phase to ensure that project is going to be finished by the scheduled completion date, the produced work is going to meet the stated specifications and that the project is going to be done within estimated costs.

Simons management control framework is particularly important from the point of view of this study as it relates also to project management systems and more importantly because it distinguishes different styles of use those control mechanisms. Simons suggests that in order to characterize management control systems in organizations it is necessary not only to identify design features of MCS, but also to examine how management attention is distributed among the various formal control subsystems and what are the patterns or styles of use of MCS by management[4] (Simons 1990, 1994, 1995). Simons identified two different styles of use of formal feedback and measurement control systems: a diagnostic style and an interactive style. These two styles of use (diagnostic and interactive type) of project feedback and measurement systems are the central research variables of this study. The central proposition is that different styles of use formal project MCS have an important role in increasing innovativeness and performance in development projects.[5]

Existing constructs that are related to diagnostic and interactive type of control (Simons 1995, 2000) have been introduced in the literature, such as, organic and mechanistic type management control systems (Chenhall & Morris 1995; Chenhall 2003a) control system tightness (Merchant 1998), administrative controls (Hopwood 1974), constructs of performance evaluative style e.g. rigid vs. flexible use of targets in performance evaluation (Otley & Fakiolas 2000; Van der Stede 2000), participative standard setting and standard tightness (Shields, Deng & Kato 2000), static vs. flexible budgets (Brownell & Merchant 1990), tightness of budgetary control (Anthony & Govindarajan 1998; Van der Stede 2001), and MCS that provide broad scope information, and

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[4] Similar arguments are made also Merchant (1985a, 1998) suggesting that the overall control philosophy of a firm might be captured in a few macro-constructs and argued that one such construct is the degree of control system tightness.

[5] Following Chenhall's (2003a) control system classification interactive type use of formal controls are seen in this study as more organic form of control and diagnostic type of use as more mechanistic form of control.

information provided in a timely way (Chenhall & Morris 1986). These constructs have some elements in common, and provide the basis to theorize about the role of formal controls in the study at innovation. Further discussion of these controls is presented in later chapters.

Following Simons' broad description, project control is defined in this study as interactive when project managers actively use planning and control systems to monitor and intervene in ongoing decision activities of their project team. Diagnostic controls, on the other hand, are defined in this study as formal project control mechanism that are subject to project management attention only when important project performance targets are missed (Simons 1995: 161–162). Thus, with respect to project control, interactive and diagnostic control types differ in terms of the frequency of project management attention to project performance. That is, project control is interactive when project managers routinely discuss with project team members issues about project performance and diagnostic when managers only focus on unfavorable performance variances. Interactive controls are characterized by frequent information exchanges, analyses, debates of project plans, and a strong involvement by project management in the day-to-day activities of project sub-ordinates.

Innovations are, by definition, unique, with each being rarel commensurable with another (Damanpour 1987; Kimberly & Evanisko 1981; Van de Ven 1986). Realizing these difficulties, innovative accomplishments are defined in this study very broadly to include any policy, structure, method or process, product or market opportunity that the manager of the innovating unit perceived to be new. This definition has been employed subsequently in several studies, including the empirical work of Zaltman and colleagues (1973) and Kanter (1983). Although Daft (1982) suggested keeping technical and administrative innovations distinct, this study follows Van de Ven (1986), who argued that making such a distinction results in an unnecessarily fragmented classification of the innovation process. However, arguments of Daft were encorporated by distinguishing development projects as administrative or technical according the nature of project and their pre-set project targets. The research model includes hypotheses to test separately these two sub-groups.

Project type is defined in this study using the following definitions. Technical development projects are related to developing new products, services and production processes; that is, they are related to the primary work activity of organizations and can be either product or process innovations (Daft 1978; Damanpour & Evan 1984). Administrative development projects involve developments of organizational structure and administrative processes; that is, they are indirectly related to the primary work activity of organization and more directly related to its management (Daft 1978; Damanpour & Evan 1984; Kimberly & Evanisko 1981).

While many previous studies have provided many important insights about the effects of control system components, many of them have limited their research to one control-system component, while fewer studies have focused on multiple control system components. Because management control system has more than one component it is important to include multiple components in order to understand how and why they are used as a system and the system's effects. (Shields, Deng & Kato 2000) Results of this study will develop understanding of the effects of management control systems at the project level (diagnostic and interactive use of project feedback and measurement systems) on important organisational dependent variables (innovation and project performance) and antecedents to those control system components (task variability and task difficulty)[6] and also how managers personality variable of tolerance for ambiguity affects the use of formal control mechanisms. PLS (partial least square) is used to test the proposed research model and hypotheses.

1.2. Theoretical model and research hypotheses

The purpose of this study is to predict the effects of MCS use. Particularly, the study examines the different styles of use (interactive and diagnostic) of project feedback and measurement systems on innovation and antecedents to those control system components (task variability and task difficulty). The research also examining the moderating effect of project manager tolerance for ambiguity to relationship between

[6] Perrow (1967, 1970) described organizational technology as the actions employed to transform input into outputs. Perrow identified two dimensions-task analysability and number of exceptions- along which these transformation processes could be described. Following Van de Ven & Delbecq (1974) in this research these Perrow's two dimensions are operationalized labelling them task difficulty (analysability for Perrow) and task variability (number of exceptions for Perrow). Van de Ven & Delbecq (1974) clearly indicated that the two are independent dimensions, each with differing theoretical consequences. In addition, Van de Ven and Delbecq conceptualized the two as operating at the work-unit level of analysis as opposed to the individual level. That is, any within-work-unit variance in ratings of the two dimensions is accounted for by error in measurement as opposed to real differences at the individual level.

characteristics of project uncertainty and diagnostic and interactive styles of use project control system.

1.2.1. Level of analysis

Clearly not all individual project managers respond identically to sub-unit level variables of project uncertainty such as task variability and task difficulty. Similarly, the effects of interactive and diagnostic type project MCS on innovativeness and project performance may vary depending on project type. Because of these reasons the research model of this study is a cross-level model.[7] Cross-level theories describe "the relationship between independent and dependent variables at different levels" (Rousseau 1985: 20). Cross-level models, in which a variable at one level affects a variable at another, can be top-down or bottom-up. Top-down models are more common in the management accounting literature (Luft & Shields 2003). Valid cross-level models, unlike a multi-level model additive model where associations between variables do not cross levels, are necessarily interactive (Klein, Dansereau & Hall 1994). The interaction term expressing the combined effects of the homogeneous group characteristic and the heterogeneous or independent individual characteristic varies both within and between groups. Accordingly, it can predict within-group variability in the dependent measure. The theoretical clarity and explanatory power of the theory are thus enhanced (Klein, Dansereau & Hall 1994).[8]

Both conceptually and statistically, a homogeneous group-level characteristic cannot predict within-group variance[9]. The predictive power of a homogeneous group-level

[7] In the absence of a theory explaining differential individual responses to the same value of the independent variable, however, the individual differences are merely noise. If a theory explaining differential individual responses is available, then an interaction model with variables on multiple levels is valid. (Luft & Shields 2003)

[8] Organization-wide management accounting, for example, which provides the same information to all individual managers, can result in different individual-level performance only if there is some difference in individual managers (e.g. knowledge, preferences) that leads them to respond differently to the same information. A cross-level theoretical model reflecting such organizational and individual variables is invalid, because uniformity in the cause cannot explain variation in the effect (Luft & Shields 2003; Klein, Dansereau, & Hall 1994).

[9] If a theory argues that individual group members respond to a characteristic of the group in a comparable or homogeneous fashion, this cross-level theory predicts, within-group homogeneity. That is, the theory predicts that both the group characteristic (the independent variable) and individual behaviour (the dependent variable) are homogeneous within groups. Some cross-level theories instead predict, implicitly or explicitly, that individual group members respond to a group-level characteristic in a disparate, rather than homogeneous, fashion. Here, the theory's independent variable is homogeneous

characteristic is necessarily limited to the percentage of between-group variance in the dependent measure. Further specification and explication of the level of the theory may overcome limitations of this kind. Particularly helpful may be careful identification of the source of variability in group members' responses to the homogeneous group characteristics (Klein, Dansereau & Hall 1994). In this study it is argued that the personality characteristic of project managers' tolerance for ambiguity moderates the relationship of the sub-unit characteristic (characteristic of project uncertainty) to individual behaviour (use of interactive and diagnostic project MCS). Project managers for whom the moderator is high respond to the sub-unit characteristic in one way, whereas project managers for whom the moderator is low respond in a different fashion.

1.2.2. Controlling the effects of project type

Luft & Shields (2003) stated that much of the research evidence collected on management accounting results from the operation of causes and effects at multiple levels[10]. To deal with these issues the possible sub-unit effect of project type was controlled by analysing the research model in two sub-groups related to different technical and administrative development projects. This approach was adopted as theory suggests that project type affects the nature and characteristics of project management and thus administrative and technical type innovations and development projects characteristics may not be homogenous between these two groups[11] (e.g. Daft 1978;

within groups, but the dependent variable is not: it varies both within and between groups. (Klein, Dansereau & Hall 1994.)

[10] The observable measure that is available for "individual performance" (e.g. managers' performance as evaluated by themselves or their superiors, or as indicated by the profits of the units they manage) is an aggregate of theoretical effects at multiple levels. Subjective evaluations may attempt, with more or less success, to partial out some of these effects—for example, to eliminate industry-wide effects from an individual manager's evaluation—but available measures often include effects from levels other than the one addressed by the theory employed in the study. (Luft & Shields 2003.)

[11] In this study independent samples t-test indicated that some significant statistical differences ($p<0.05$) across technical and administrative type development projects. Specifically significant statistical differences were in variables of diagnostic style of use project feedback and measurement systems and in level of innovativeness. Independent samples t-test group statistic suggested that in administrative type development projects the diagnostic style of use project feedback and measurement systems is more intensive than in technical type development projects. Additionally, test indicated that level of innovativeness is significantly higher in technical type development projects than in administrative type development projects. The Mann-Whitney U-test (non-parametric alternative to t-test) of whether technical and administrative type development projects differ from each other based on rank scores confirmed the results of t-test. Summated scores of research variables were used to perform these tests. The significant differences across technical and administrative type development projects are reported in Appendices 1, 2 and 3.

Damanpour & Evan 1984; Kimberly & Evanisko 1981). The moderating effect of project manager tolerance for ambiguity is examined separately for technical and administrative types of projects. In statistical analysis, nested or hierarchical models including variables at multiple levels can be used to partial out additive effects at different levels—either to remove noise, if some levels are not of interest to the theory being examined, or to identify the multiple-level effects separately if the theory is intended to explain variation at multiple levels (Luft & Shields 2003).

Some previous studies have suggested that project uncertainty moderates project management-performance relationships (e.g. Eisenhardt & Tabrizi 1995; Moorman & Miner 1998; Shenhar & Dvir 1996). Similarly controlling the effects of project type by distinguishing technical vs. administrative project types and analysing the research model separately in these two sub-groups may extend this work and offer further insights into the dynamics of project management and effects of different forms and styles of control on innovation and performance. Previous research, follow a contingency approach, has also suggested that different levels of uncertainty should be examined to clarify associations between characteristics of MCS and innovation (e.g. Dewar & Dutton 1986; Keller 1994; McDonough & Leifer 1983). It has also been suggested that because of differing levels of non-routines, ambiguity, riskiness, radicalness, and different project characteristics all projects should not be managed in similar way. In this study following dual-core theory different development projects were distinguished as administrative and technical types. This includes distinguishing in focus of project development goals and expectations for innovation (Daft 1978; Damanpour 1991).

According to dual-core theory (Daft 1978) different types of innovations can be classified into technical and administrative type innovations. The dual-core theory also suggests that the appropriate organizational structure for innovation might be either mechanistic or organic depending upon the type of innovation to be adopted (Damanpour & Gopalakrishnan 1998). This distinction between administrative and technical innovations is suggested to be important because it relates to a more general distinction between social and technical systems of organization (Damanpour & Evan 1984). Technical innovations are related to products, services and production process technologies; that is, they are related to the primary work activity of organization and can be either product or process innovations (Daft 1978; Damanpour & Evan 1984). Administrative innovations involve organizational structure and administrative processes; that is, they are indirectly related to the primary work activity of organization and more directly related to its management (Daft 1978; Damanpour & Evan 1984; Kimberly & Evanisko 1981).

The dual-core theory posits that organizations have both a technical core and an administrative core (Damanpour 1992; Gopalakrishnan & Damanpour 1997; Damanpour & Gopalakrishnan, 1998). The technical core is primarily concerned with the transformation of raw materials into organizational products and services, while the administrative core's main responsibilities are the organizational structure, control systems and coordination mechanism (Daft 1978). Innovation can occur in each core, but technical and administrative innovations follow different processes. Technical innovations typically originate in the technical core and follow a bottom-up process, while administrative innovations typically originate in the administrative core and follow a top-down process (Daft 1978).

More formal and diagnostic style of use of project MCS (for extensive control system classification see Chenhall 2003a, who classifies diagnostic type controls as more mechanistic form and interactive systems as more organic form of control) may be more appropriate to administrative project as the dual-core theory also suggests the structures that facilitate innovation in each core are different and a mechanistic structure is needed when an organization must adapt to changes in goals, policies, strategies, structure, control systems and personnel (Daft 1982). Thus, for example low employee professionalism, high centralization in decision-making and high formalization of behaviour facilitate the top-down process of administrative innovations (Daft 1982).

Additionally, dual-core theory argues that an organic structure is needed when changes in organizational products, services and technology are necessary (Daft 1982). Thus, for example high professionalism, low centralization and low formalization facilitate the bottom-up process of technical innovation. Based on these arguments, this research distinguishes between administrative and technical type development projects when examining the research model.

1.2.3. Research model and hypotheses

This study develops a causal path model, which includes both antecedents and effects of project management control system mechanism. The study brings new research evidence to the unsettled phenomenon about the relevance of diagnostic and interactive use of formal project management control systems for innovativeness in different types of research and development projects. The research also attempts to deepen and extend our current knowledge about different types of project feedback and measurement systems (diagnostic and interactive styles of use) and their effects on project innovativeness.

A conceptual framework suggesting relationships among research variables is presented in Figure 1. The framework is a three-stage path model, which includes eleven hypothesized relationships, which are analyzed separately for administrative and technical type development projects to control for the possible effect of project type on the hypothesized relationships. In this study these relations are left exploratory and no definite a priori differences or separate hypotheses are developed for these two sub-groups.

In the first stage, hypotheses are developed for how task uncertainty will determine how diagnostic and interactive control mechanisms are developed. Four hypotheses are developed for the first stage relations. The first two hypotheses (H1 and H2) concern the relationships between task variability and interactive and diagnostic use of project feedback and measurement systems. The first hypothesis (H1) predicts that there is a positive relationship between project task variability and interactive use of project feedback and measurement systems. The second hypothesis (H2) predicts a negative relationship between project task variability and more diagnostic use of project feedback and measurement systems. The next two hypotheses predict that there is a negative relationship between project task difficulty and more extensive use of diagnostic project feedback and measurement system, and a positive relationship between project task difficulty and interactive use of project feedback and measurement systems (H3 and H4).

In the second stage, control mechanisms are related to project innovativeness. In administrative and technical development projects, interactive (diagnostic) controls have a positive (negative) relation to project innovativeness. The hypothesis (H5) suggests that there is a positive relationship between use of interactive use of project feedback and measurement system and project innovativeness. Hypothesis H6 argues a negative relationship between a diagnostic use of formal project feedback and measurement system and project innovativeness.

In the third stage, project innovativeness is expected to have a positive relation to project performance in both administrative and technical projects (H7. This study also controls for individual differences of project managers by including the variable of tolerance of ambiguity (TA) as a moderating construct in the research model. The style of project MCS use is seen dependent on the personality of the manager. The final set of hypotheses (H8, H9, H10, and H11) argues moderating effects of project manager tolerance for ambiguity on above mentioned four first hypotheses (H1-H4). Including the TA variable is seen as an important research choice because data collection is based on the perceptions of the project managers and their personality may affect on their perceptions on task uncertainty, control mechanisms and project performance. The administrative and technical sub-groups are split on the TA variable.

Next in this thesis, the literature on management control is examined to explore how project managers can exercise formal project control through the extensive and intensive use of controls. The structure of the discussion is to draw on control systems theory to consider fundamental dimensions of control that may assist in understanding what types of control system practices may be best suited to NPD projects. In the next section of the research drawing on the existing management accounting and control research as well as product development literatures, theoretical framework underlying the study is constructed and a number of testable hypotheses are developed. Following that the sampling procedures and measurement instruments employed in a survey of development projects from a diverse array of companies and industries. Finally, the results are reported and their implications and limitations are discussed. Results section has three parts. The first part reports descriptive statistic for the variables, the second part describes the analytic technique (PLS), which was used to test hypothesis, and the last part presents the results of hypotheses testing.

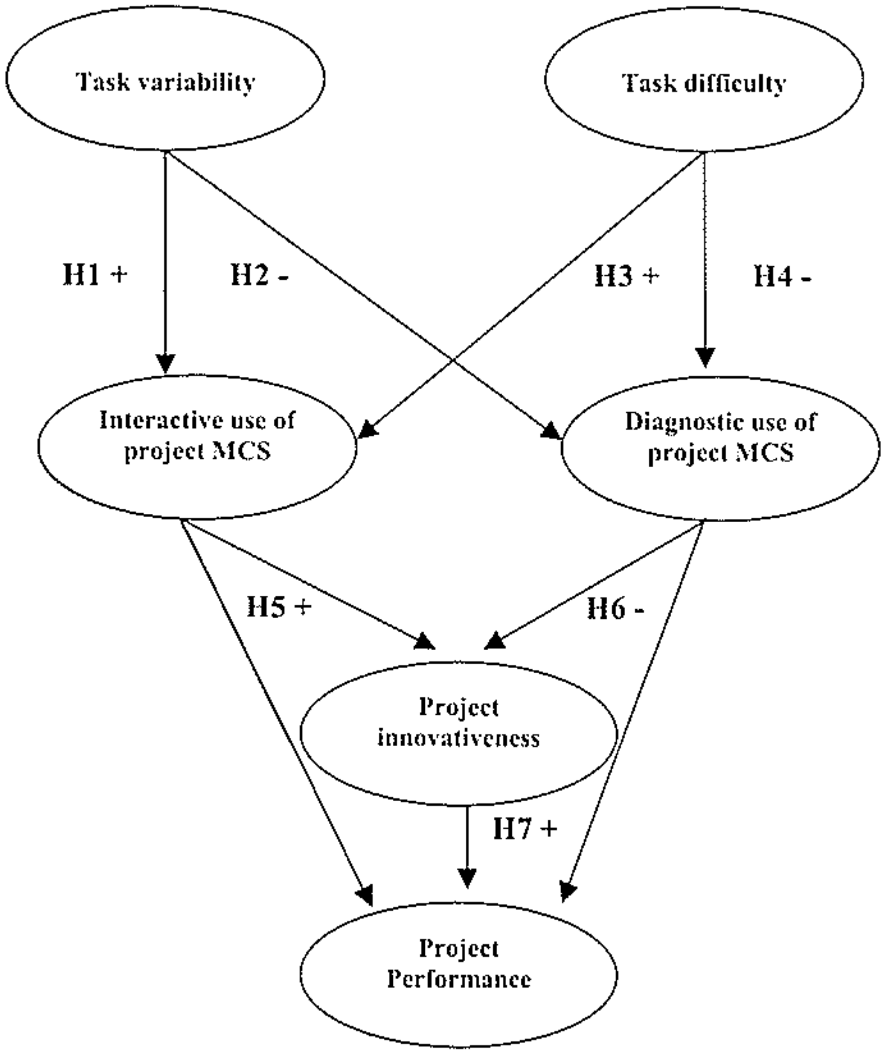

Figure 1. Research model.

2. LITERATURE REVIEW AND CONCEPTUAL BACKGROUND

The impact of management control systems on performance in new product development (NPD) situations where tasks are highly uncertain is unclear (e.g. Abernethy & Brownell 1997; Nixon 1998; Davila 2000; Hertenstein & Platt 2000). Thus far, management accounting researchers have devoted little attention to the role of management accounting in new product and service development situations. Previous studies have considered the relevance of management control systems to the process of Research and Development (R&D) and NPD (Abernethy & Brownell 1997; Birnberg 1988; Brownell 1985; Rockness & Shields 1984, 1988; Hertenstein & Platt 2000). These studies mainly characterize management control systems as hindering or, at most, being irrelevant in research and development settings. For example, Rockness and Shields (1984) study the relationship between types of control and project characteristics. Following Ouchi's framework (Ouchi 1979), they classify R&D projects according to the level of knowledge of the transformation process and the measurability of the output. Next, they predict a relationship between these characteristics and the type of control used: input, behaviour, and output control. These authors find only marginal relationships between control systems and project characteristics.

Studies by Nixon (1998), Rabino (2001), Hertenstein and Platt (2000) and Davila (2000) have examined the role of management controls in NPD and have provided important insights into the way various aspects of control systems can assist or hinder product development. Nixon (1998) and Rabino (2001) use in-depth case descriptions to show that in NPD processes financial control plays a significant role. Nixon's (1998) study identified a balancing role of the controller in assisting engineers during the development of a new copper rod production machine. In contrast to previous studies, the author reports that the ``financial component of the system serves to integrate the disparate perspectives" (Nixon 1998). Similarly, Rabino (2001) studied the utilization of emerging cost accounting practices as well as their perceived desirability. This empirical study was conducted with the collaboration of New England firms affiliated with the technology sector. Rabinos' (2001) case study suggests that accounting and marketing collaboration could substantially contribute toward a focused and effective product development effort. Rabino (2001) argues that this can be achieved by setting parameters for price, quality, and functionality, and it is, therefore, important assign accountants to enhance development projects.

In a series of case studies (Hertenstein & Platt 2000) found that it was important for managers to better understanding what type of controls, especially performance measures, were effective for NPD. Managers in Hertenstein & Platt's study often linked change with strategy. Their increasing recognition that strategy must guide NPD, and that NPD is the key to strategy implementation led to changes in management controls to increase the availability and use of strategic information during NPD. Their study indicated that changes occur as a result of responses to difficulty of controlling the creative, innovative NPD function. Often these changes may simple reflect companies conducting live experiments as they struggle with a challenging issue, especially since managers lack guidance to support choices they must make. The authors conclude that little academic research on management control of NPD has been conducted.

A study by Davila's' (2000) research suggests that cost and design information has a positive effect upon NPD project performance and, in contrast, time information hinders performance. This supports the argument that too much emphasis on formal systems limits innovation and that management control systems have, at most, a minor role in product development project environments. However, Davila concludes that if management control systems supply information relevant for coordination and learning, then a positive relationship between performance and the use of management control systems is expected.

Next in this chapter, the literature on management control is examined to explore how project managers can exercise formal project control through the extensive and intensive use of controls. The structure of the discussion is to draw on control systems theory to consider fundamental dimensions of control that may assist in understanding what types of control system practices may be best suited to NPD. First, it is noted that this study is concerned with project feedback and measurement systems practices. Next the generic classification of 'process controls' and 'results and output oriented controls' are discussed. This is followed by an examination of the benefits and costs of different controls, employing notions of tightness of controls. It argued that combinations of controls are likely to be necessary to achieve effective control of NPD. The significance of recent work by Simons (1990, 1995) of the use of controls diagnostically or interactively is discussed and presented as the taxonomy that enables combinations of controls to used. This taxonomy is used in this work.

2.1. Different forms of project control

It is important to note that this study does not address all forms of controls. For example, cultural, social, input-oriented controls are available to managers, but are not part of this study (Merchant 1998; Anthony & Govindarajan 1998). Merchant recognizes that most firms use a combination of controls (output oriented), action controls (process oriented), and personnel controls (input oriented), which may reinforce each other (Merchant 1998). Not all control alternatives are equally effective in every situation. The focus of this study is on project feedback and measurement system, which is seen as combination of process controls (action controls) and results controls (output oriented controls). These are discussed in the following sections. Cultural and social controls can clearly influence an organization's development projects performance over the long-term performance. Also personnel (input oriented controls) are an important part of project control (Merchant 1998; Abernethy & Brownell 1997). The focus of this research is limited to how project feedback and measurement systems, and more importantly the way these systems are used, effect project development and innovativeness at the project level.

The project feedback and measurement systems and the style of use of these formal control mechanisms investigated in this study are particularly important for managing development projects. Important decisions that typically are made at the very earliest stages of research and development projects concern its strategic scope and direction. These important decisions may include such things as the target market for the new product or service, its desired competitive position or fit with the firm's current product offerings, the technology platform to be employed, and the like. From these strategic decisions, formal control mechanisms for guiding and evaluating the project's progress may be developed (Wheelwright & Clark 1992).

Similarly, management might specify particular processes, procedures, or activities (e.g. stage-gate processes, etc.) for the team to follow, and subsequently monitor their adherence to those specifications over the course of the project. The setting and monitoring of such management-initiated processes and procedures is consistent with the concept of process, behavior, or action control found in the existing literature (Ouchi 1979, Merchant 1985b, 1998; Anthony & Govindarajan 1998). Alternatively management may set specific goals for the project team to attain on one or more important outcome dimensions, such as a completion deadline, an expense budget, cost or performance criteria to be met by the new product, sales objectives, or profit or ROI goals. The setting and monitoring of such management-initiated performance goals is consistent with the notion of output control as defined in the management control literatures (Merchant 1998; Anthony & Govindarajan 1998). The following section examines the notions of process controls and results or output controls.

2.1.1. Process controls

Process controls monitor project actions, which means controlling the project execution phase to ensure that the project is going to be finished by the scheduled completion date, the produced work is going to meet the stated specifications and that the project is going to be done within estimated costs. In the control process, information about actual costs, actual time, and actual accomplishment are compared with schedules estimated activity times and the control budgets estimated costs. (Anthony & Govindarajan 1998.)

Process controls in research and development projects are mechanisms used to influence the means to achieve desired ends by specifying and monitoring the behavior and activities to be followed by the team. An example related to product development is the use of a specific procedural framework such as the phase-gate process (Cooper 1993, 1998a, 1998b). These action-oriented controls are the most direct form of control because control involves taking steps to make certain that employees act in the organization's best interest. Actions are the focus of these controls ensuring that employees perform or do not perform certain actions, which are known to be beneficial or harmful to the organization (Merchant 1998: 27).

Action control are seen to provide the most direct control because the control-action link is so direct that is can guide managerial attention and focus on specific actions. Formal documented procedures and policies are also an efficient way to transfer knowledge to the people who are performing the actions, and as so act as a form of organizational memory. Finally, action controls in the form of formal procedures and policies are an efficient way to aid organizational coordination. They increase the predictability of actions and reduce the amount of inter-organizational information flows required to achieve a coordinated effort. (Merchant 1998: 255.)

However, action (process/behaviour) controls have a number of significant disadvantages, which make them useful only for highly routine tasks. First, they require extensive knowledge of what actions are desirable. This information does not usually exist in highly uncertain environments or in non-routine tasks like new product and service development. Secondly, action oriented controls may discourage creativity, innovation, and adaptation. Employees often react to action controls by becoming passive. They develop their work habits based on the work rules they are given. This adaptation may be so complete that they begin to depend on the rules, cease to think how the processes could be improved, and become resistant to change. It is also possible that action accountability can cause sloppiness. Employees start to cut corners when they are accustomed to operating with a stable set of work rules and procedures. Action controls can also cause negative attitudes, because most people are not happy operating under them. Action accountability can also lead to behavioural displacement because it is easier to focus on and monitor actions of lesser importance than actions in changing environments, which are difficult and costly to monitor. (Merchant 1998: 256.)

The previous research evidence from product development and management control literatures are somewhat at odds when it comes to predicting the likely effects of process controls on a development project team performance. This aspect of project management practice refers to the degree to which the project team adheres to formalized plans of development: a series of process tasks and decisions that are required at various stages of a well-defined process (Cooper 1993, 1998b). Examples from management practice include the so-called "stage-gate" processes popularised by Cooper and others, where the authors suggest that adherence to a formalized development plan will result in better performance of a company's research and development process.

Clark and Wheelwright (1992) and Page (1993) find that the implementation of a more formalized approach to product development process provides a solid footing on which to build a successful project. Unfortunately, there is little evidence that widely used methods such as stage-gate process (Cooper 1993) do actually improve organizational success and reduce the proportion of unsuccessful project (Sutton 2001). Much of the accepted theory and empirical evidence reported in the organizational control literature suggests that heavy reliance on formal process controls is inappropriate and are likely to be counterproductive under such circumstances (Ouchi 1979; Perrow 1970; Burns & Stalker 1961; Galbraith 1973; Tushman & Nadler 1978).

On the other hand, effective development processes have received much attention in the product development literature (Cooper & Kleinschmidt 1995, 1996; Cooper 1998a, 1999, 2000; Wheelwright & Clark 1992). The primary conclusion of much of this empirical work is that new product or service success is at least in part a function of good process management. All of this would seem to argue that effective process controls should have a positive relationship to development team's ultimate performance. However, high failure rates suggest that management's knowledge of the transformation process whereby ideas are turned into successful new products and services is far from perfect, particularly for more innovative development projects. In summary, if formal process controls become too detailed and attempt to dictate how specific activities should be carried out, the autonomy necessary for team creativity and innovation may be stifled, and, consequently, the capabilities of the product and the overall performance of the team can suffer. In addition, the over specification of procedures may hinder the team's ability to make needed adjustments early in the project leading to delays and cost overruns later in the project.

2.1.2. Results controls-output oriented controls

Results or output-oriented controls are concerned with controlling by specifying the nature of required outcomes. At the project level, output targets at the projects' planning phase, where the project plan is designed. The final project plan typically consists of three related parts: scope, schedule and costs. The scope defines the specifications of each work package and responsibilities. The schedule defines the estimated time required to complete each work package and the interrelationships among those different tasks. The final and third part of project plan is costs, which are stated in the project budget. The objective of project control is to ensure that a satisfactory product, service or process is produced within a specified time period, and at optimum cost. This usually involves trade-offs between scope, schedule, and cost. (Anthony & Govindarajan 1998: 819 –826.)

Result oriented controls at the project level has two separate aspects: an evaluation of performance in executing the project, and monitoring of the results from the project. An evaluation of project execution can be done after the project has been completed but the final performance (e.g. financial performance and market share) of project results may not be obtained until several years later. Monitoring the executing of project has also two aspects: an evaluation of project management and an evaluation of the process of managing the project. The meaning of project manager evaluation is to decide on possible rewards, promotions and to guide possible criticism. The purpose of project process monitoring is to learn from mistakes and success to find better ways in executing and managing future projects. Because many projects involving non-routine, uncertain tasks (e.g. R&D projects) are very unique by their nature, and having a high level of uncertainty and complexity, evaluation is much more subjective than in more routine activities like production. (Anthony & Govindarajan 1998: 837 –838.)

The product development literature is particularly clear about the beneficial informational and motivational effects of clearly specifying a strategic direction and clear performance goals at the earliest stage of a NPD project (e.g. Imai, Nonaka & Takeuchi 1985; Cooper 1998b). It is also important to note that the kinds of outcome standards typically specified for a new product, such as technical performance and cost parameters, completion deadlines, project budgets, and market success criteria like sales volume and market share objectives, can generally be measured with reasonable accuracy at the conclusion of the project or shortly thereafter (Bonner, Ruekert & Walker 2002). The control literature suggests that formal output control is most likely to be employed, and to be beneficial, under such circumstances (Ouchi 1979; Merchant 1998).

These output oriented result controls are an indirect form of control because they do not focus explicitly on the employees' actions. Result controls can often be effective even if it is not clear what behaviour are the most desirable. Results controls can also yield good control while allowing the people whose behaviours are being controlled high autonomy (Merchant 1998: 69 –80). This is particularly desirable where creativity is required because autonomy allows room for new and innovative ways of thinking. Beside creativity, high autonomy usually leads greater employee commitment and motivation. It allows employees learn by doing and making mistakes. It allows also room for idiosyncratic styles of behaviour, which may produce better results than standardization of one approach. Also when compared to some form of action controls, results controls are often inexpensive (Merchant 1998: 256).

Like all forms of control, project feedback and measurement systems have disadvantages. First, results measures usually provides less than a perfect indication of whether good actions have been taken because the measures fail to meet one or more of the qualities of good measure: congruence, precision, objectivity, timeliness, or understandability (Merchant 1998: 257-258). It is often difficult to correct, or even recognize, these measurement errors. Secondly, formal results controls shift risk from owners to employees because results almost always are affected by something other than employee's own skills and efforts. This risk is caused by measurement noise created by any of many uncontrollable factors, including environmental factors, organizational interdependencies, and bad luck. A majority of employees are risk averse and as such do not like to have the organizations to force them to bear even, if there is compensation to accept such a risk premium. (Merchant 1998: 257 –258.)

A third disadvantage of project feedback and measurement systems is that results targets are often focused on two important, but competing, control functions. The first is to motivate individuals to achieve the targeted results. For this function it is better for targets to be challenging but achievable. The other function is communication. Plans are often treated as commitments and passed among the various entities in an organization, so that each entity knows what to expect from other entities. For this function the targets should be a best guess, or maybe even slightly conservative, to make sure they are achieved. Obviously, one set of plans cannot serve both purposes optimally; one purpose (or both) must be sacrificed if results controls are used. (Merchant 1998: 257 – 258.)

Tightness of these results oriented controls mechanisms has an important role when considering that adequate supplies of resources such as equipment, facilities, and time are critical to innovation (Amabile 1988; Angle 1989; Taylor 1963), and the supply of such resources is another manifestation of the organizations support for innovation. A number of researchers have suggested that resource allocation to products is directly related to the projects' creativity levels (Cohen & Levinthal 1990; Damanpour 1991; Delbeck & Mills 1985; Farr & Ford 1990; Kanter 1983). Aside from the obvious practical limitations that extreme resource restrictions place on what people can accomplish in their work, perceptions of the adequacy of resources may affect people psychologically by leading to beliefs about the intrinsic value of the projects that they have undertaking.

According to Nohria & Gulati (1996) unlimited resources, including unlimited time, may not always prove beneficial to innovation since time contributes to creativity only up to a point. This kind of inverted relationship is not especially surprising when it is recognized that creative efforts are cumulative involving the pursuit of a number of requisite activities. Moreover, in creative efforts, which are inherently ambiguous, there is always the possibility that unlimited time may lead people to spend too much effort pursuing what are essentially unprofitable, ineffective approaches to the problem. This observation, in turn, suggests that the amount of time allocated to creating and the flexibility provided in time management should be guided by the nature and complexity of the task with more time and greater flexibility being called on tasks where people must work with a number of sources of information where a number of considerations must be synthesized in generating new ideas, and when a number of restrictions are imposed on idea generation and implementation. However, time buffering may prove less important after initial idea generation, when implementation plans, production plans, and testing must occur, and integration with other organizational units is at a premium (Pierce & Delbecq 1977).

In summary, the existing research on new product development and management control literatures are consistent in their predictions about the likely effects of formal results oriented control on research and development project results. The positive effects of clearly specified goals have been widely discussed under goal-setting theory. Multiple reviews and meta-analyses of the goal-setting literature have concluded that there is substantial support for the basic principles of goal-setting theory (Locke & Latham 1990a; Locke & Latham 1990b; Wofford, Goodwin & Premack 1992). First, specific difficult goals consistently lead to better performance than specific easy goals, general goals such as "do your best," or no goals. Secondly, goal-setting is most effective when there is feedback-showing progress toward the goal (Latham & Locke 1991; Locke 1996).

2.2. Benefits and costs of different control system constructs

According to Merchant (1998: 155): "The benefit of any control (or control system) is derived from the increase in the likelihood that the organizational objectives will be achieved over what could be expected if the control where not in place. This benefit can be called the amount of control achieved or the degree of certainty provided by a control system, and it can be described in terms of how tight or loose the system is". Merchant considers a control system (budgetary or other) tighter if it has a greater effect on decision-making (Merchant 1985a, 1990) or if it provides a high degree of certainty that employees act as the organization wishes (Merchant 1998).

The notion of tightness suggests that more formal or tighter controls, such as process or results controls, are likely to encourage greater congruence between employees actions and organizational objectives. However, formal control is not feasible when too little information exists as to how the object of control, processes or results, relates to the overall organizational objectives. These situations are often common in NPD settings, which are typified by high levels of uncertainty. The use of 'tight' controls under these conditions of high uncertainty can result in dysfunctional behaviour. In these situations formal controls may lead to incomplete performance measures (e.g. Hayes 1977; Hirst 1981; Govindarajan & Gupta 1985; Merchant 1990) or irrelevant performance evaluations (Govindarajan & Gupta 1985). Conversely, realizing the benefits of tight formal control is possible when there are no information asymmetries but in such situations tight systems have less potential benefit (Shields & Sprinkle 2001).

Adapting Merchants (1998) definition of tight action and results control system to the project management level provides four main components of project control system tightness: (1) Definition of targets, clear, specific, and difficult project goals (project schedule, costs, and scope). (2) Communication of those targets, which means changing communication patterns in such a way that employees will better understand and accept organizational and project objectives. This may include communicating more effectively, timely, frequently, and convincingly. (3) Performance evaluation of actions and results; more frequent, more detailed, and/or more timely monitoring of employees results, actions and behaviour. (4) Performance based rewards and punishments; tightening control means enhancing the value of rewards to the employees evaluated and the definition of stricter relationships between rewards and performance.

The ways in which project controls can be tightened suggest that tight overall control may exist with or without tight accounting-based budgetary oriented control, which deals predominantly with frequent, detailed, and timely monitoring of accounting-based results (as part of Merchant's (1998) definition item (3) of tight control in broader sense). However, Anthony has taken a narrower view of tight control that is evidenced by tight budgetary control. As such, Anthony describes a tight control system (e.g. project control system) as 'one in which a manager's performance is evaluated primarily on his ability to attain budgetary objectives during each reporting period' (Anthony & Govindarajan 1998: 436).

In a tight control philosophy, the budget target is considered to be a firm commitment against which the subordinate manager is evaluated. Each period, performance to date is compared to the budget; detailed variances identified and discussed; and corrective actions taken if it appears that the budget targets are not being met. Moreover, Anthony suggests that tight control requires a strong involvement of top management in the day-to-day activities of the business units—i.e. it requires face-to-face discussions with business managers and an intimate knowledge of the operations of the business units. (Anthony & Govindarajan 1998.)

According Merchant (1998) control to be considered tight in results control system, the results dimensions must be congruent with true organizational objectives; the performance targets must be specific, with feedback in short time increments; the desired results must be effectively communicated and internalised by those whose behaviours are being controlled; and if results controls are used exclusively in a given performance area, the measures must be complete. Completeness means that the result defined in the control system include all the areas in which organization desires good performance and for which the individual involved can have some impact. (Merchant 1998.)

Tight results controls also depend on the effectiveness of the measures of performance that are generated. Results controls rely on measures that are precise, objective, timely, and understandable. A control system that is used to apply tight control requires excellence in all of these measurement qualifications. If measures fail in any of these areas, the control system cannot be characterized as tight because behavioural problems are likely. Results control are likely to be tighter if rewards and punishments that are significant to the individuals involved are directly and definitely linked to the accomplishment (or non-accomplishment) of the desired results. A direct link means that results translate automatically into rewards or punishments with no buffers or ambiguity. A definite link between results and rewards means that no excuses are tolerated. (Merchant 1998.)

A potential cost of tight budgeting systems and other types of formal controls (e.g. formal project control) is that they provide subordinates with little opportunities and freedom to deviate from the actions and results included in budgets and other pre-set performance targets, which can hinder quick reaction to unexpected threats and opportunities and discourage spontaneous experimenting, which may have negative effects on employee innovative behaviour intended to improved organizational performance. Tight budgeting and other formal control systems (e.g. project management system) can also provide pressure (sometimes too much) to conform to budgets and other pre-set performance targets (e.g. project milestones), which can induce decisions and actions that are inconsistent with those implied by the budgets and formal project plans. Alternatively, when either the tightness of budgeting and other formal control systems is contingent on appropriate individual, organizational, and environmental factors, or subordinates have good interpersonal and organizational relations, tight budgeting and other formal control systems can have challenging effect on individuals' behaviour and be beneficial in that they can induce subordinates to make decisions and take actions that are consistent with those implied by the budget. (Shields & Sprinkle 2001.)

There is some evidence from the accounting literature that the effect of tight formal control system in more uncertain environments, such as NPD, is not well understood. For example, previous research concerning reliance on accounting performance measures (RAPM) in conditions provides support for hypotheses predicting both a positive and negative effects providing an apparent paradox (Hartmann 2000). A possible reason for this research paradox could be that contingency-based research has focused on specific elements of accounting controls, generic information dimensions of MCS, with a limited number of studies examining broader elements of control, such as clan and informal controls, or integrative mechanisms. A difficulty in studying specific elements of MCS in isolation from other organizational controls is the potential for serious model under-specification. Thus, if specific accounting controls are systematically linked with other organizational controls, studies that exclude or do not control for these elements within the research method may report spurious findings (Chenhall 2003a).

The formal budget controls are useful in assisting planning and curbing excessive innovation, while the informal communications provide broader information in flexible ways. (Chenhall 2003a.) In this research the notion of combinations of is considered to be important to the theoretical research model. This chapter has drawn on notions of process and results controls and discussed in terms of control tightness. It will know be argued that combinations of controls may be necessary to manage NPD projects. A way to research combinations of controls is to identify a variety of control taxonomies that may exist and consider how they relate to various aspects of MCS. Different control taxomonies can be classified for example as ranging from mechanistic to organic (Chenhall 2003a) and tight to loose (Merchant 1998; Anthony & Govindarajan 1998).

Mechanistic controls rely on formal rules, standardized operating procedures and routines. Organic systems are more flexible, responsive, involve fewer rules and standardized procedures and tend to be richer in data (Chenhall 2003a). This classification between organic and mechanistic forms of control is also extremely important from the point of view of innovation performance as previous research has shown that innovation requires a high degree of flexibility in the structural and communication processes within organization (Burns & Stalker 1961; Morse & Lorsch 1970; Van de Ven 1986). Organic approaches to decision making and communications provide the context whereby individuals throughout the organization can participate in formulation strategies, share ideas and information across the entity, and take advantage of opportunities or react to threats. More mechanistic approaches to structural arrangements and communication processes are considered to be less responsive and potentially inhibit innovation actions (Chenhall & Morris 1995).

Recently, Simons (1995, 2000) has introduced the idea of using formal controls more organically as interactive controls, or more mechanistically as diagnostic controls. These ideas are particularly relevant to the current research as combinations of interactive and diagnostic controls are seen to be particularly suited to the generation of innovative project development (Simons 1995). The next section considers these systems.

2.3. Diagnostic and interactive use of project MCS

Simons's framework of levers of control is particularly important from the point of view different development projects as it emphasis the tension between the need for innovation and the need for the achievement of pre-established objectives, highlighting the consequent tensions among components oh the control system. Simons (1990, 1995) defines feedback and measurement systems broadly as data-based systems that capture measurable information on either inputs, processes or outputs. As mentioned earlier the focus of this study is on project feedback and measurement systems. These were discussed in terms of their underlying control characteristics, specifically the way they relate to process and results controls. This analysis now discusses how these project control systems can be used diagnostically and interactively.

Different managers across organizations and projects may use these project feedback and measurement control systems in different ways based on different attention patterns. Based on different patterns of attention Simons distinguishes two styles of use of feedback and measurement control systems: a diagnostic and an interactive use. Similarly, project feedback and measurement systems can be subdivided in two levers of control: diagnostic project control systems and interactive project control systems. Diagnostic control systems are feedback and measurement systems that are used on an exceptions basis to monitor and reward achievement of specified project performance targets through the review of critical performance variables or key success factors. Interactive control systems are measurement systems that are used permanently focus on the constantly changing information that managers consider strategic (Simons 1991, 1995, 2000).[12]

Simons' framework proposes that the four levers of control work simultaneously even though they serve different purposes. Beliefs systems and boundary systems are used to frame the strategic domain, while diagnostic and interactive control systems are used to formulate and implement strategies. Belief systems and interactive control systems are used to encourage innovative behaviour, expand opportunity seeking, creativity and learning. In contrast, boundary systems and diagnostic control systems are used to focus

[12] In the MCS taxonomies, control normally is a question of degree from highly formal to less formal. In this study it is realized that diagnostic and interactive use of project MCS can be argued to collapse to a single construct on a continuum from formal accounting based control (diagnostic) to informal and more information intensive alternative (interactive). However, in this study these different styles of use of formal project feedback and measurement system were seen as independent control mechanisms where project manager can make the choice to use formal project MCS more interactively, diagnostically or to combine both control types depending on the level of uncertainty, project type and project manager personality. For example, the focus of study could follow previous research and study only diagnostic styles of use of project management oriented system and argue that they are unsuitable in the uncertain operating conditions found in NPD as they include incomplete information and lack flexibility. However, it may be that successful organizations rely extensively on formal project controls. This paradox could occur as a consequence of limiting the study to components of formal control systems and mainly diagnostic use of these control mechanisms without considering broader control and information networks. It may be that successful organizations operating in uncertain conditions have formal and tight project controls but they are systematically combined with open, flexible and informal communications between superiors and sub-ordinates (interactive style of use). The formal controls (diagnostic style of use) are useful in assisting planning and curbing excessive innovation, while the informal communications and more interactive style of use these formal control mechanisms provide broader information in flexible ways. (Chenhall 2003a.)

search and attention and limit the chances of deviation from preset outcomes or behaviours.

Project control implies managing the tensions between project goal achievement and creativity. Attainment of pre-set project performance targets is essential for project management to make sure that decisions are in line with organizational goals, but at the same time facilitating the emergence of new initiatives and ideas is also crucial to take advantage of new innovations. Since, some levers of control foster monitoring and others foster creativity and innovation, a crucial matter for organizations is how to deal with and how to take advantage of the tensions and balances among levers of control systems.

A goal of effective formal project MCS is to facilitate goal achievement as well as innovativeness in projects. As a consequence formal project MCS may be used not only to monitor that outcomes are in accordance with project plans (diagnostic use) but also to motivate the project team to be fully informed about current and expected state of strategic uncertainties to empower creativity and innovativeness (interactive use). Diagnostic project management systems are based more on programmed cybernetic processes such as setting standards, measuring, comparing, and taking corrective actions and on management by exception such as scanning reports for evidence of variances and following up significant detected variances. An eventual detection of unexpected events requires the manager to pay attention to the project control system.

In contrast to diagnostic project controls, what characterizes interactive type project controls is project managers strong level of involvement. Project manager pay frequent and regular attention to interactive project control and is personally involved in them. This project managers pattern of attention signals the desirability of all project team members paying frequent and regular attention to the issues addressed by the interactive project control systems. Through these attention-based processes interactive project control systems help establish and communicate the substance of the project strategies addressed by management and provide the frameworks and agendas for debate and face-to- face discussions throughout the project team.

A formal project control system can be beneficial because it has a set of components that results in a high probability that actual behaviour and performance is the same as managements' intended behaviour and performance, with loose formal control providing less assurance that actual and intended are the same. Achieving the benefits of a formal project feedback and measurement system is more difficult as information asymmetries between project superiors and subordinates increase, which occurs in projects where task uncertainty is high, projects that are larger, decentralized, or diversified in terms of products, technologies, or operating locations (static vs. dynamic project teams). The decision whether project controls should be used with more diagnostic or interactive style in any particular company, or area within company, depends on the answers to three questions: (1) what are the potential benefits of particular style of use of formal project controls? (2) What are the costs? And (3) Are any harmful side effects likely? (Merchant 1998: 258.)

In any organization, formal project control is most beneficial over the areas most critical to the organization's success. These critical success factors vary widely across businesses and projects. Some forms of control are costly to implement in interactive style of use. Interactive style of use of project action controls in the form of pre-action reviews can require considerable project management time. Similarly interactive style of use of project results control can require extensive studies to gather useful performance standards, or they might require new information system or measuring equipment. Thirdly, all the conditions necessary to make a formal project control feasible, such as knowledge about how the control object relates to the desired ends, may not be present. In those situations harmful side effects are likely if the project control is implemented, particularly if the formal project control is used in diagnostic type.

If the environment is unpredictable and the need for creativity is high, such as is the case for high-technology development projects; good knowledge may not exist about either the actions that are needed or the results that should be accomplished. (Merchant 1998: 258) Therefore neither diagnostic style of use action nor results control can be said to be clearly effective, and the implementation of either in diagnostic type is likely cause problems. Diagnostic style of use project action controls would likely to cause behavioural displacement and tent to stifle creativity. Diagnostic type project results controls would limit adaptability, as results standards are often difficult to adjust to the changing environmental conditions.

2.4. Common and distinguishing characteristics of different MCS constructs

In sum, several conclusions relevant to project control emerge from consideration of the control system literature. Interactive and diagnostic control types differ in terms of the frequency of management attention to project performance. For project control, controls are interactive when managers routinely discuss performance and diagnostic when managers only focus on unfavorable project performance target variances. Hence, interactive project controls are characterized by frequent information exchanges, analyses, debates of project plans, and a strong involvement by project management in the day-to-day activities of project team subordinates. This type of control seem to be consistent with Chenhall's (2003a) classification that interactive form of control are more organic and diagnostic control are a more mechanistic form of control. Simons (1995: 161–162) also defines interactive controls as a loose form of control because they leave a great deal of autonomy to subordinates in the way tasks are approached and provide flexibility to adjust targets based on updated information which, in the Anthony scheme, are descriptive of a relatively high degree of tolerance for performance target revisions and interim performance target deviations.

Attributes from Anthony, budgetary control tightness seem to be also partly related to diagnostic type project control: (1) Amount of emphasis on attaining budget targets; (2) Degree of budget commitment, i.e. whether budget revisions during the year are allowed; (3) Amount of detail of interim budget reviews; (4) Degree of tolerance for interim budget deviations; and, for interactive type of project control following attribute (5) Degree of involvement of top management in the subordinates' businesses.

However, Anthony does not explicitly consider budget participation as an element of tight control per se. He only argues that it might be related to control tightness as it affects budget commitment and involvement (Anthony and Govindarajan 1998: 385). Strong involvement of top management in the day-to-day activities of subordinates resembles elements of Simon's (1995) concept of interactive control. According to Simons' broad description, control is interactive when top managers actively use planning and control systems to monitor and intervene in ongoing decision activities of their business unit managers. Diagnostic controls, on the other hand, are subject to top management attention only when important targets are missed (Simons 1995: 161–162). Simons is largely concerned with the way in which senior managers utilize the various control systems of an organization, which encompass a much broader set than just budgetary controls (e.g. project management systems). Hence, Simons's control concept is also relevant here as it relates also to the use of project control system.

Merchants (1981) budget system formality captures the patterns of communication with subordinates which can be seen belonging to Chenhall (2003a) classification of mechanistic form of control or Simons (1995) definition about diagnostic type control: it includes information detail in the annual plan, frequency of updating of the annual plan, and frequency of interactions with subordinates (Merchant 1981). Merchant's definition of budget system formality matches also with three elements of Anthony's tight control concept, notably, budget detail, budget revisions during the year, and involvement (frequency of interactions) by higher-level management.

Even if common themes can be identified in these seminal publications (by Simons, Merchant, Anthony and others), they also deviate in subtle ways. Drawing common themes from the abovementioned work of Simons (1995), Merchant (1998), Anthony & Govindarajan (1998), and Chenhall (2003a) provides a basis to identify attributes of diagnostic formal project control: Diagnostic type formal project control system in this study is seen to exist if project manager: (1) Puts much emphasis on meeting the project performance targets; (2) Does not easily accept project performance target revisions during the project; (3) Has a detailed interest in specific performance line-items in evaluation (project milestones); (4) Does not lightly tolerate deviations from interim performance targets.

The notions of 'frequency of interaction' (Merchant 1981; Simons 1995) and 'involvement' (Anthony & Govindarajan 1998) and 'intensity of budget-related communication' (Van der Stede 2001) were included in this research as components of interactive type of formal project control. The formal budget-oriented accounting controls are useful in assisting planning and curbing excessive innovation, while the interactive communications provide broader information in flexible ways (Chenhall 2003a).

With respect to other relating MCS constructs it seems for example that interactive controls can be interpreted to have common characteristics with both tight and loose control mechanisms (Van der Stede 2001). Interactive project controls are descriptive to what Anthony & Govindarajan (1998) define as tight control in reference to attributes of detail of budget reviews and top management involvement. Also, in the Merchant sense, interactive controls lead to more centralization of decision-making, and hence, to tightening of the control system. However, Simons (1995: 161–162) alludes to interactive controls as loose because they leave a great deal of autonomy to subordinates in the way tasks are approached and provide flexibility to adjust targets based on updated information which, in the Anthony scheme, are descriptive of a relatively high degree of tolerance for budget revisions and interim budget deviations.

In this research, studying interactive and diagnostic use of formal project control was seen as an important research choice. For example, the focus of study could follow previous research and study only diagnostic styles of use of formal project management oriented system and argue that they are unsuitable in the uncertain operating conditions found in NPD as they include incomplete information and lack flexibility. However, it may be that successful organizations rely extensively on formal project controls. This paradox could occur as a consequence of limiting the study to components of formal control systems mechanisms without considering broader control and information networks (e.g. style of use). It may be that successful organizations operating in uncertain conditions have formal and tight project controls but the project managers are systematically combining them with open, flexible and informal communications between superiors and sub-ordinates (interactive style of use).

The focus of this study is on project feedback and measurement systems, which also has similarities to budgetary control construct (Anthony & Govindarajan 1998), but project control is seen here as a broader control mechanism as it includes also non-financial information concerning project performance targets. Accounting-based budgetary controls are an integral part of the overall management control system in most for-profit firms and are also important part of project management. Accounting-based controls have received predominant attention by management accounting researchers, especially in the reliance-on-accounting-performance-measures (RAPM) literature[13]. However, as Otley & Fakiolas (2000) have suggested it was seen in this research that the impact of performance measurement and its use by managers will need to be sensitive to discovering the frameworks used for performance measurement in target organizations, as was originally done in the Hopwood (1972, 1974) and Otley (1978) studies, rather than just assuming that budgeting and accounting data play a central role in this process. Otley & Fakiolas (2000) argue also that the previous methods used in studies on RAPM

[13] For extensive literature review see Hartmann (2000).

and evaluative styles appear to be generalizable into this arena with only relatively minor adaptation.[14]

Hereafter, in this research the terms performance target and target setting are used instead of project budget and budgeting although they have similar meanings (Atkinson 1978; Christensen 1982; Horngren, Foster & Datar 1997; Merchant 1982; Shields, Deng & Kato 2000). Results of prior research in accounting and organizational behaviour and psychology in which job or task requirements are expressed as goals, budgets, standards, or targets are qualitatively similar (see the ensuing literature review of Shields & Shields 1998). For the sample used in this study, task (project) goals are stated as targets.

In the next section of the research drawing on the existing management accounting and control research as well as product development literatures, theoretical framework underlying the study is constructed and a number of testable hypotheses are developed. Following that the sampling procedures and measurement instruments employed in a survey of development projects from a diverse array of companies and industries. Finally, the results are reported and their implications and limitations are discussed.

[14] See also Laitinen (2001) about the future of management accounting.

3. HYPOTHESES DEVELOPMENT

In this section of the research drawing on the existing management accounting and control research as well as product development literatures, the theoretical framework underlying the study is constructed and a number of testable hypotheses are developed.

3.1. Task uncertainty and interactive and diagnostic use of project MCS

From the point of view of this study uncertainty is an important antecedent to components of research and development projects management control system. The first two hypotheses of this study examine how the use the of diagnostic and interactive type project control systems are affected by the level of project task uncertainty. The major sources of uncertainty include task and external environment uncertainty. Task uncertainty is a function of the extent that an action by a manager results in an expected (predictable) outcome (Hirst 1981). Task uncertainty is similar to knowledge of the transformation process defined by Ouchi (1977). If an evaluator understands the process of transforming inputs into outputs, the evaluator can specify the actions required of the evaluated and this implies that knowledge of the transformation process is high (Fisher 1998).[15]

Task uncertainty has been shown to influence the reliance on accounting performance measures (Hirst 1983), accounting controls (Abernethy & Brownell 1997), participation in budgeting and emphasis on budget (Brownell & Dunk 1991; Lau, Low & Eggleton 1995), and flexibility in budget, and, therefore it is particularly relevant for understanding the characteristics of project control system. Most of previous RAPM studies have generally argued that uncertainty limits the feasibility of using RAPM, predicting that RAPM will be more useful under low uncertainty situations, linking task uncertainty with more informal, open MCS. (Hartmann 2000) However, some research

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[15] The choice of structure in organizational contingency research has focused on the appropriate structure to fit between the levels of uncertainty in the environment (Burns & Stalker 1961; Lawrence & Lorsch 1967; Galbraith 1973; Drazin & Van de Ven 1985), strategy (Chandler 1962) and the organization's technology (Woodward 1965; Perrow 1970; Thompson 1967; Galbraith 1973). Generally, it is believed that more organic structures are suited to uncertain environments. Contingency arguments suggest for the design and use of control systems is contingent upon the context of the organizational setting in which these controls operate. A better match between the control system and the contextual contingency variable is hypothesized to result in increased organizational (individual) performance. According to contingency theory, the appropriateness of different control systems depends on the setting of the business (Fisher 1998).

shows just opposite. For example, Brownell and Merchant (1990) found that higher (lower) standardization of products (high knowledge of input/output relations) combined with flexible (static) budgets and low (high) participation to enhance performance. More research is needed to understand the appropriateness of formal project controls under high uncertainty. Very difficult tasks require employee to be very innovative to produce novel solutions to existing problems. For that reason it is important to understand how different characteristics of project management control system lead to task difficulty and thus potentially affect project teams innovativeness and project performance.

Various levels of task-related characteristics contribute to a task's overall uncertainty level (Galbraith 1977). These characteristics include newness of the task to the organization (this includes new objectives and new technologies), higher goal difficulty, and greater interaction between and among organizational and technological elements. Tasks with high levels of uncertainty require greater and more careful pre-task planning than tasks with low levels of uncertainty. Further, to achieve effective outcomes, tasks with high uncertainty must be executed differently from tasks with low uncertainty (Daft 1986; Galbraith 1977). For example, it has been claimed that tasks with high uncertainty require 'organic' organizational approaches in order to be successful, whereas tasks with low uncertainty require 'mechanistic' organizational approaches in order to be successful (Burns & Stalker 1961; Galbraith 1973; Tushman & Nadler 1978).

Many previous studies show the link between high task uncertainty and more informal, open MCS. Technologies with high (low) task analysability are related to a high (low) reliance on standard operating procedures, programs and plans (Daft & Macintosh 1981); tasks high in difficulty and variability are associated with a low reliance on accounting performance measures (Hirst 1983). Brownell & Dunk (1991) study found that there was a fit between conditions of low task difficulty, participative budgeting and a high budget emphasis. High task difficulty suited participation with or without a strong budget emphasis. Lau, Low & Eggleton (1995) provided similar results, although they found that high participation and high task difficulty provided a fit irrespective of budget emphasis, while high participation and high budget emphasis enhanced performance in low task difficulty situations.

Perrow (1967, 1970) described organizational technology as the actions employed to transform input into outputs. Perrow identified two dimensions - task analysability and number of exceptions- along which these transformation processes could be described. These two dimensions of Perrow's framework represent basic characteristics of interest to organizational scholars. The notion of exceptions is similar to activities that have been described in terms of variability (Pugh, Hickson, Hinnigs & Turner 1969; Van de Ven & Delbecq 1974); uniformity (Mohr 1971); predictability (Galbraith 1973; March & Simon 1958); and complexity (Duncan 1972). An organization setting that has a large number of exceptions would tend to be characterized as less stable, less predictable, and more complex. Similarly, the notion of analysability is conceptually linked to other constructs. Analysability is similar what Thompson (1967) called knowledge of cause-effect relationships, the search procedures described by Cyert & March (1963), and task characteristics favouring programmed and un-programmed organizational responses (March & Simon 1958).

In this research, following Van de Ven & Delbecq (1974), these two dimensions of Perrow's framework are labelled as task difficulty (analysability for Perrow) and task variability (number of exceptions for Perrow). Van de Ven & Delbecq (1974) clearly indicated that the two are independent dimensions, each with differing theoretical consequences. In addition, Van de Ven & Delbecq (1974) conceptualized the two as operating at the work-unit level of analysis as opposed to the individual level. That is, any within-work-unit variance in ratings of the two dimensions is accounted for by error in measurement as opposed to real differences at the individual level.

Previous research has long recognized that there are major differences in levels of uncertainty and complexity between types of NPD projects (Booz, Allen, & Hamilton 1982; Griffin 1997). For example, reengineering projects or projects that make only minor modification to existing products or services are far less complex than projects that call for major modifications to existing products or projects that lead to new-to-the-world products. Reengineering projects and minor modifications (low task uncertainty development projects) face fewer design challenges, fewer difficulties in production of the final design, and less market uncertainty than do major modifications and new-to-the-world projects (high task uncertainty development projects). Because of these differences, it is reasonable to speculate that project control strategies will and should differ between simple and complex development projects.

Task variability relates to the number of exceptions, which is the frequency of unexpected and novel events that occur in the conversion process. When the number of exceptions is high, participants typically cannot predict problems in advance and many tasks are unique. When few exceptions occur, tasks have little novelty and are repetitious. The second dimension is task difficulty, which relates to the analysability in project. When the conversion process is analysable, the work often can be reduced to mechanical steps, and participants can follow an objective, computational procedure to solve problems. When work is un-analysable, there is no objective calculation or procedure to tell a person how to respond. Participants have to spend time thinking about how to solve problems, and they may actively search beyond readily available procedures. Judgements based on intuition and experience figure prominently in unanalyzable work decisions.

With little task variety and a clear view of input-output relations in task execution, the organization can justify the development and use of more formal mechanistic type of control. Perrow argued that organizations facing such tasks would be able to rely procedure guides, operating manuals, job codification and rigid lines of reporting and accountability for controlling employee behaviour. In the non-routine situation Perrow expects that formal, bureaucratic controls will not be effective for controlling performance. Tasks cannot be programmed and thus behaviour cannot be controlled by implementing procedures which pre-specify desired actions or by monitoring individual actions through the use of supervisors. Perrow argues that professional or collegial structural arrangements are required in this setting.

Perrow also proposed the existence of the combination of routine-non-routine tasks, which contains elements of both exceptions and analysability. Perrow suggested that although conceptually distinct, the two dimensions might be statistically correlated in organizations because, when problems are frequent and unexpected, they also are less analysable. A positive correlation between the two dimensions has been found in empirical studies (Daft & Macintosh 1981; Van de Ven & Delbecq 1974). Perrow (1970) argued that organizational structure and, in particular, reliance on a bureaucratic organizational form, will be dependent upon the degree of "routines" of task technology. "Routines" is unbundled by Perrow into the two dimensions, task analysability and number of exceptions. Where established techniques for handling tasks do not exists (low analysability), or where there exists substantial variety or novelty in the tasks encountered (high number of exceptions), Perrow describes the task setting as "non-routine", and conversely when tasks are analysable with few exceptions, the task setting is "routine". Perrow proceeds to describe the structural arrangements necessary to achieve effective control and co-ordination for the different task environments faced by an organization.

Thus far it has been argued that the major components of task uncertainty, variability and difficulty, have important implications for the design of MCS. Particularly, more mechanistic controls are appropriate to routine tasks and organic for non-routine tasks. In this study these arguments are related to the way in which interactive and diagnostic project controls are developed in response to elements of task uncertainty. Perrows notions of task variability and difficulty are considered as major components for project uncertainty. This uncertainty has similarities what Simons has identified as strategic uncertainties (Simons 2000: 215). Following Simons, project managers can use interactive type project control to send messages to project team in order to focus attention on strategic project uncertainties when there is unforeseen exceptions in project that could undermine the current basis of project success and competitive advantage and which also can provide opportunities for new innovations.

Strategic project uncertainties are the emerging threats and opportunities that could invalidate the assumptions upon which the current project strategy is based. They may relate to changes in competitive dynamics and internal competencies that must be understood to successfully manage development projects according pre-set project performance targets and produce innovative solutions. Strategic project uncertainties cannot be known in advance and they emerge unexpectedly over time. While high level of analysability make it possible to determine critical project performance variables and that they are embedded in project plans and performance targets, strategic project uncertainties-exceptions trigger a search for new information and meaning.

Interactive type project feedback and measurement systems motivate information gathering, dialogue and debate inside as well outside routine channels. As participants of project team respond to the perceived exceptions-threats and opportunities-organizational learning in project team is stimulated, new ideas flow and new innovations emerge. Through an interactive type project feedback and measurement self-initiative and search for opportunities are a way to boost and guide successful innovations in projects through the proactive scanning of new ideas.

As mentioned earlier (Chapter 1.2.2.) this study follows the dual-core theory and distinguishes development projects to administrative and technical types. This includes distinguishing in focus of project development goals and expectations for innovation (Daft 1978; Damanpour 1991). The research model is analysed in these two sub-groups. This approach was adopted as theory suggests that project type affects the nature and characteristics of project management and thus administrative and technical type innovations and development projects characteristics may not be homogenous between these two groups (e.g. Daft 1978; Damanpour & Evan 1984; Kimberly & Evanisko 1981).

According to dual-core theory (Daft 1978) different types of innovations can be classified into technical and administrative type innovations. The dual-core theory also suggests that the appropriate organizational structure for innovation might be either mechanistic or organic depending upon the type of innovation to be adopted (Damanpour & Gopalakrishnan 1998). This distinction between administrative and technical innovations is suggested to be important because it relates to a more general distinction between social and technical systems of organization (Damanpour & Evan 1984). Technical innovations are related to products, services and production process technologies; that is, they are related to the primary work activity of organization and can be either product or process innovations (Daft 1978; Damanpour & Evan 1984). Administrative innovations involve organizational structure and administrative processes; that is, they are indirectly related to the primary work activity of organization and more directly related to its management (Daft 1978; Damanpour & Evan 1984; Kimberly & Evanisko 1981).

More formal and diagnostic style of use of project MCS (for extensive control system classification see Chenhall 2003a, who classifies diagnostic type controls as more mechanistic form and interactive systems as more organic form of control) may be more appropriate to administrative project as the dual-core theory also suggests the structures that facilitate innovation in each core are different and a mechanistic structure is needed when an organization must adapt to changes in goals, policies, strategies, structure, control systems and personnel (Daft 1982). Thus, for example low employee professionalism, high centralization in decision-making and high formalization of behaviour facilitate the top-down process of administrative innovations (Daft 1982).

Additionally, dual-core theory argues that an organic structure is needed when changes in organizational products, services and technology are necessary (Daft 1982). Thus, for example high professionalism, low centralization and low formalization facilitate the bottom-up process of technical innovation. Based on these arguments, this research distinguishes between administrative and technical type development projects when examining the research model. Based on previous research evidence following hypotheses are tested separately in sub-groups of administrative and technical type development projects:

H1. There is a positive relationship between task variability and interactive use of project feedback and measurement system.

H2. There is a negative relationship between task variability and diagnostic use of project feedback and measurement system.

H3. There is a positive relationship between task difficulty and interactive use of project feedback and measurement system.

H4. There is a negative relationship between task difficulty and diagnostic use of project feedback and measurement system.

3.2. Diagnostic and interactive use of project MCS, project innovativeness and project performance

The effect of management control systems on performance for highly uncertainty tasks were high innovation is required is difficult to predict. If management control systems supply information relevant for coordination and learning, then a positive relationship between performance and the use of management control systems is expected. Some evidence in the product development field exists supports this proposition (Nixon 1998; Davila 2000). Davilas' (2000) research suggest that cost and design information has a positive effect upon new product development projects performance and, in contrast, time information hinders performance supporting the argument that too much emphasis on formal systems limits innovation. Formal control may not be appropriate for certain projects. Some arguments as well as evidence (Eisenhardt & Tabrizi 1995) exist suggesting that the relationship between formal MCS and improved performance does not exist or is negative. Management control systems, when used in a controlling manner by imposing rules and constraining behaviour, reduce the level of creativity required from product development and, thus, negatively affects performance (Amabile 1998; Oldham & Cummings 1996; Oldham & Cummings 1997).

However, several studies have pointed to the role of project managers or direct supervisors and characteristics of control systems, particularly in the areas of (1) goal clarity (Bailyn 1985; Locke & Latham 1990a), (2) open interactions between supervisor and subordinates (Kimberley 1981; Kimberley & Evanisko 1981; Amabile, Conti, Coon, Lazenby & Herron 1996) and (3) supervisory support of a team's work and ideas (Delbeck & Mills 1985; Scott & Bruce 1994; Oldham & Cummings 1996). The results of previous research demonstrating the critical role of problem definition in creative processes, implies the importance of goal clarity in creative behaviour. It is likely that open supervisory interactions and perceived supervisory support operate on creativity largely through the same mechanisms that are associated with fair, supportive evaluation; under these circumstances, people are less likely to experience the fear of negative criticism that can undermine the intrinsic motivation necessary for creativity (Amabile, Conti, Coon, Lazenby & Herron 1996; Amabile 1998).

Management control systems (MCS) are often an important part of organizations formal planning and control systems. (Govindarajan & Gupta 1985; Simons 1995) Typically, these control systems are highly formal, articulating action plans derived from strategies by way of detailed financial budgets. The systems require explanation of variances of actual outcomes from these plans. This type of control tends to be mechanistic and as such may be considered inconsistent with innovation. Authors who have argued that formal MCS is not sufficient for management of innovation have stated that formalized control systems may stultify creativity and thereby inhibiting the process of innovation (Galbraith 1982; Perrow 1970). However, many authors have recognized that MCS have a potentially useful role in assisting in developing and implementing innovative strategies (Thompson 1967; Simons 1987).

Previous research shows that innovation requires a high degree of flexibility in the structural and communication processes within organization (Burns & Stalker 1961; Morse & Lorsch, 1970; Van de Ven 1986). Organic approaches to decision making and communications provide the context whereby individuals throughout the organization can participate in formulation strategies, share ideas and information across the entity, and take advantage of opportunities or react to threats. More mechanistic approaches to structural arrangements and communication processes are considered to be less responsive and potentially inhibit innovation actions (Chenhall & Morris 1995).

Development and implementation of new ideas is a collective process, which requires individuals with diverse interests, skills and resources (Van de Ven 1986). Employees innovative behaviour will be encouraged by maximizing the opportunities for individuals to become involved in the process of innovation and that this is best achieved by implementing organic rather than mechanistic organizational structures and processes (Burns & Stalker 1961). More organic decision processes are participative and flexible, and opportunities for identifying problems and new ideas throughout the organization are enhanced by open and free lowing communications (Kamm 1987; Morse & Lorsch 1970).

However, formal control systems can also prevent entities that are continually seeking innovations from squandering resources on superfluous novelty (Miler & Friesen, 1982). Formal MCS can ensure that ideas are tested for the ways in which they fit within overall plans, resource constraints and capabilities of the organization (Chenhall & Morris 1995; Kanter 1983; Martin 1984; Sawyer 1978; Thompson 1967). Many authors who assert that formal MCS are inconsistent with innovation, claim that organic processes are necessary to ensure that individuals are motivated to participate in creative decision making and the free flow of ideas that are essential for developing entrepreneurial strategies (Burns & Stalker 1961; Morse & Lorsch 1970).

However, while organic processes may encourage generating ideas, they may not ensure that the ideas will be translated into effective innovations, which enhance performance. It is the potential for formal MCS to provide a discipline for resource planning and integration that assists in the translation of ideas into effective innovations. Also, it is not clear that the ideas generated from organic processes will be consistent with managerial intentions. Formal MCS ensure that management can maintain a focused view of organizational direction, capabilities and constraints. (Chenhall & Morris 1995.)

Additionally formal MCS can provide an intelligence function which indicates a need for innovative ideas by identifying the level of maturity of existing products, the degree of innovation in competitive product markets (Andrews 1980; Lorange 1992) and declining profitability due to factors such as a reduction in sales of older more obsolete products (Miller & Friesen 1982). Formal systems can also prevent entities that are continually seeking innovations from squandering resources on superfluous novelty (Miler & Friesen 1982). Formal MCS can ensure that ideas are tested for the ways in which they fit within overall plans, resource constraints and capabilities of the organization (Kanter 1983; Martin 1984; Sawyer 1978; Thompson 1967).

The previous literature suggests that there is substantial variation across NPD projects in both the types and specificity of formal controls imposed by management (Griffin 1997; Page 1993; Davila 2000). In some instances, management may outline a general direction for the project but provide few specific guidelines concerning either the processes to be followed or the goals to be accomplished. In such cases, the development team is given substantial flexibility to determine its own objectives and procedures.

Many authors have proposed that formal MCS can be amalgamated and embedded within a variety of approaches to management planning and control (e.g. Chenhall 2003a; Chenhall & Morris 1995; Daft & Macintosh 1984; Merchant 1981; Simons 1995). Combination of formal MCS and organic communication processes can generate a creative tension that helps foster organizational effectiveness (Cameron 1986; Chenhall & Morris 1995). Cameron (1986) argued that effective organizations posses mutually exclusive opposites in structures and decision processes. These opposites maintain a dynamic balance between competing values, thus avoiding potential dysfunctional effects of extremism. There is need for both 'loose-coupling' to encourage the search and initiation of innovation and for 'tight-coupling' to encourage implementation and functional reciprocity. He noted that while pro-activity and entrepreneurship are important for some organizations, too much concern with these values could create a loss of direction, wasted energy and a disruption of continuity. While control and co-ordination provide a balance to extremes of pro-activity, too much formal planning and co-ordination can produce stagnation and loss of energy and declining morale. Cameron claims that it is the presence of balanced paradoxes that energizes and empowers systems.

It is also argued that simultaneous tight-loose control can be accomplished even if a strong culture does not exist. This can be achieved by using formal controls over the few key factors, either actions or results that have the greatest potential impact on the success of the organization. More control should be exercised over strategically important areas than over minor areas, regardless of how easy it is control each. (Merchant 1998:259) As mentioned earlier, according to Merchant (1998) definition tight action and results control depends understanding and acceptance on the part of those whose behaviours and results are being controlled. If the people involved do not understand the performance targets and rules, the targets cannot affect or direct their behaviour. If they do not accept the targets or rules, they may try to find ways to avoid the whole system. Understanding and acceptance can be improved through developing effective communication processes and by allowing employees to participate in the target defining processes. Thus simultaneous tight-loose control and more effective communications in highly uncertain project environments seem to relate to Simons' framework (1995) and particularly to more interactive type use of project feedback and measurement systems.

As noted earlier in this study, previous research in the NPD literature suggests that explicit objectives should be developed and communicated by management in the very earliest stages of a NPD project in order to provide a sense of direction and challenge to members of the development team (Cooper 1993; Imai, Nonaka & Takeuchi 1985). If formal controls are seen mainly as a static process, organizational processes and/or outcomes are monitored and evaluated relative to a predetermined set of control standards that are assumed to remain constant over the course of the control period. This may be a reasonable assumption when the activities being controlled are well understood and the control period relatively short. Unfortunately, NPD projects can run for years, and involve innovative activities whose nature and consequences are hard to predict. As a result, NPD control processes can be highly dynamic and interactive between management and the NPD project team (Brown & Eisenhardt 1997; Imai, Nonaka & Takeuchi 1985; Simons 1994; Wheelwright & Clark 1992).

Based on previous findings it is suggested here that formal project MCS may present a negative or a positive effect on innovation at project level depending on style of use formal project MCS (Simons 1995; Chapman 1997, 1998). It is suggested that variety of interactive and diagnostic styles of use formal project MCS explains some of the inconsistencies of the previous studies. Simons' (1995) levers of control framework notes the tension between need for achieving pre-set project performance targets and the need for innovativeness as the role of interactive use of feedback and measurement systems is on expanding opportunity seeking, learning and enhancing innovativeness.

Simons suggests that those studies which argue that formal MCS has a negative effect on innovation are caused by the focus on diagnostic style of use formal MCS.

Important research choice of this study is that taking a more comprehensive view, which realises the presence of interactive and diagnostic styles use of formal project MCS is suggested to capture the potential role of formal project MCS to facilitate innovativeness in technical type of research and development projects. As noted earlier (see chapter 1.2.2.) this study follows the dual-core theory when distinguishing development projects to administrative and technical types. This includes distinguishing in focus of project development goals and expectations for innovation (Daft 1978; Damanpour 1991). The research model is analysed in these two sub-groups. This approach was adopted as theory suggests that project type affects the nature and characteristics of project management and thus administrative and technical type innovations and development projects characteristics may not be homogenous between these two groups (e.g. Daft 1978; Damanpour & Evan 1984; Kimberly & Evanisko 1981).

More formal and diagnostic style of use of project MCS (for extensive control system classification see Chenhall 2003a, who classifies diagnostic type controls as more mechanistic form and interactive systems as more organic form of control) may be more appropriate and useful to administrative projects than technical projects as the dual-core theory also suggests the structures that facilitate innovation in each core are different and a mechanistic structure is needed when an organization must adapt to changes in goals, policies, strategies, structure, control systems and personnel (Daft 1982). Thus, for example low employee professionalism, high centralization in decision-making and high formalization of behaviour facilitate the top-down process of administrative innovations (Daft 1982).

Additionally, dual-core theory argues that an organic structure is needed when changes in organizational products, services and technology are necessary (Daft 1982). In these technical type development projects interactive use of project MCS may be more useful style of formal control than in administrative type development projects. Thus, for example high professionalism, low centralization and low formalization facilitate the bottom-up process of technical innovation (Daft 1982). Based on these arguments, this research distinguishes between administrative and technical type development projects when examining the research model.

In this research following Simons (1995) it is believed that the relationship between interactive use of project MCS and project innovativeness is positive in both technical and administrative type projects. Similarly, it is argued a negative relationship between diagnostic use of project MCS and project innovativeness in both technical and administrative development projects. However, based on dual-core theory (Daft 1982) it is reasonable to speculate that these effects are significantly different between technical and administrative development projects. Also the effect sizes of interactive and diagnostic type project MCS on project innovativeness may be different in technical and administrative development projects.

To summarize, H5 and H6 propose that enhanced project innovation performance will be associated positively with the use of interactive type project control system and that there is an negative relationship between the use of diagnostic type project control system and innovativeness in project. Hypotheses are tested separately in administrative and technical type development projects.

H5. There is a positive relationship between interactive use of project feedback and measurement system and project innovativeness.

H6. There is a negative relationship between diagnostic use of project feedback and measurement system and project innovativeness.

The final hypothesis (H7) relates to the association between project innovativeness and project performance. Also this hypothesis is tested in technical and administrative development projects (see chapter 1.2.2 for more detailed discussion). Previous studies have shown that enhancing the creative performance of employees is a necessary step if organizations are to achieve competitive advantage (Amabile 1988; Devanna & Tichy 1990; Kanter 1983; Shalley 1995). When employees perform creatively, they suggest novel and useful products, ideas, or procedures that provide an organization with important raw material for subsequent development and possible implementation (Amabile 1988; Staw 1990; Woodman, Sawyer & Griffin 1993). The initiation and implementation of these products enhance an organization's ability to respond to opportunities and, thereby, to adapt, grow, and compete (Kanter 1983,1988; March & Simon 1958; Van de Ven 1986; Van de Ven & Angle 1989). It is suggested here that as development projects by their nature include requirement for innovations as developing incremental and radical changes and improvements to existing products, services, production processes, organizational structure, and management processes and include high level of uncertainty in development process-low analysability and high number of exceptions-innovativeness in project is necessary conditions to meet project performance targets. For these reasons the following hypothesis is presented:

H7. There is a positive relationship between project innovativeness and project performance.

3.3. Moderating effects of project manager tolerance for ambiguity

This section develops the theory by proposing that individual differences influence the nature of several of the relationships hypothezised thus far. In particular the role of individuals' tolerance for ambiguity is proposed to moderate the relationships between task uncertainty and interactive and diagnostic style of use of project MCS.[16] There is considerable support for the view that decision makers in organizations, when facing extensive uncertainty and complexity in the environment or within organization, are likely to employ information and control systems that enable them to cope better with uncertainties (Gordon & Miller 1976; Hayes 1977; Waterhouse & Tiessen 1978; Otley 1980).

Because individuals are different, they develop different cognitive strategies, which are an outcome of interactions between cognitive characteristics and the environment (Ho & Rodgers 1993). Previous research indicates that the personality of individuals affects their perceptions and responses to contextual uncertainty (Ashford & Cummings 1985; Bennet, Herold & Ashford 1990). It has been also suggested that personality has a moderating effect on the characteristics of information perceived to be useful in uncertain environments (Gul 1984, 1986; Ashford & Cummings 1985). Specifically,

[16] Most research in MCS has considered the moderating role of organizational factors. Previous empirical research has concentrated primarily on contingency factors such as environment, structure, and technology to describe the use and characteristics of MCS (Woodward 1965; Perrow 1967; Thompson 1967; Bruns & Waterhouse 1975; Khandwalla 1972, 1977; Ouchi 1979; Hirst 1981, 1983; Macintosh & Daft 1981; Rockness & Shields 1984; Brownell, 1985, 1987; Merchant 1984, 1990; Gordon & Narayanan 1984; Govindarajan 1984; Chenhall & Morris 1986; Brownell & Merchant 1990; Brownell & Dunk 1991; Dunk 1992; Mia & Chenhall 1994; Abernethy & Brownell 1997). Examples of individual level moderating and intervening models are Brownell (1981), Chenhall (1986), Chenhall & Brownell (1988), Chenhall & Morris (1991), Gul (1984, 1986), and Lal & Hassel (1998).

research evidence on tolerance for ambiguity suggests that individuals differ in how they respond to uncertain circumstances (Budner 1962; Ashford & Cummings 1985).

Previous research evidence has advocated different, and sometimes conflicting, roles for senior management in highly uncertain research and development environments. For example Clark and Wheelwright (1992) argue that senior management should endeavour to exercise more control over the NPD process via the selection of and frequent communication with a "heavyweight leader," particularly at the early stages of the development project where the NPD project is most sensitive to management's influence. On the other hand, Cooper (1993, 1998b) suggests that as new product developers move to a third generation of stage-gate systems, with self-managed teams, the role of senior management will change, with a much stronger reliance being put on the team leader.

The primary purpose of the introducing of a "heavyweight" project leader is to serve as a "linking pin" to senior management (Clark & Fujimoto 1991). This has been seen as a way in which the senior management of the firm can exercise a form of "subtle control" over the NPD project team. Eisenhardt & Tabrizi (1995) also reported that reductions in the development cycles for projects might be attributed, in part, to the use of a more experiential or participative approach to team leadership. An important role of project leaders is the provision of leadership and vision, while also allowing for sufficient autonomy to facilitate creative problem solving (Eisenhardt & Tabrizi 1995). As such the personality of project leader is an important variable when researching styles of use of project management control systems under varying project uncertainties.

It has been argued that personality traits have an important influence on the manner in which users process and use accounting information (e.g. Huysmans 1970; Dermer 1973; Faircloth & Ricchiute 1981; Gul 1984, 1986; Chenhall 1986, 2003a; Tsui 1993; Lal & Hassel 1998; Hartmann 2000). Gul (1984), for example, argues that an understanding of decision makers' personality traits 'may be able to guide the design of information systems toward more effective user decisions'. Personality factors have also been mentioned as important determinants of managerial behavioral and attitudinal reactions to budgeting (e.g. Murray 1990). In the current study important factors for investigation are personality variables related to how individuals approach situations involving risk and uncertainty (Duncan 1972; Chapman 1997). Especially the construct 'tolerance for ambiguity' is useful for this purpose (e.g. Budner 1962; Norton 1975).

Specifically tolerance for ambiguity and employee risk preferences may explain individuals preference for tight controls under uncertainty, since the clarity of targets and precision of financial and quantitative target related to performance evaluation may reduce subordinates' perceptions of ambiguity (e.g. Gupta & Govindarajan 1984; Hirst & Yetton 1984; Hartmann 2000).

Tolerance for ambiguity expresses an individual's demand for information in uncertain environments (MacDonald 1970) and seems, therefore, closely related to the conceptualization of uncertainty as a 'deficit in information' (Galbraith 1973, 1977). In related research fields (e.g. auditing, strategic management) this construct has been shown to explain personal attitudes, behaviors and information preferences under uncertainty (e.g. Downey & Slocum 1975; Duncan 1972; Dermer 1973; Gupta & Govindarajan 1984; Gul 1986).

Tolerance for ambiguity refers to the way an individual (or group) perceives and processes information about ambiguous situations or stimuli when confronted by an array of unfamiliar, complex, or incongruent clues. Tolerance for ambiguity is a variable that is often conceived on a uni-dimensional scale. The person with low tolerance of ambiguity experiences stress, reacts prematurely, and avoids ambiguous stimuli. At the other extreme of the scale, however, a person with high tolerance for ambiguity perceives ambiguous situations/stimuli as desirable, challenging, and interesting and neither denies nor distorts their complexity of incongruity. (Furnham & Ribchester 1995.) The concept of ambiguity tolerance or its many synonyms has attracted research in various branches of psychology. It has been conceived as a personality variable (Budner 1962) as well as a property of both organizations (Furnham & Gunter 1993) and national cultures (Hofstede 1984) and remains an individual difference variable of interest to clinical and organizational psychologists (Anderson & Schwartz 1992; Nutt 1993; Tsui 1993).

Tolerance for ambiguity is important to understand how individuals react to information. Tolerance for ambiguity measures the extent to which one feels threatened by ambiguity or ambiguous situations (Budner 1962; Dermer 1973). It is suggested that intolerants would show less confidence and seek more information than tolerants (Budner 1962; Norton 1975; McGhee, Shields & Birnberg 1978; Gul 1984, 1986; Pincus 1991; Tsui 1993). Ferris and Haskins (1988) suggested that an organization's information systems functions as a learning process for those individuals acting on behalf of the organization. They suggested that manager's performance is likely to be influenced by the information that they receive and use for their decisions. Tolerance for ambiguity can affect how individuals' preferences for different information and as such may influence their performance.

Results reported in the accounting literature concerning the effects of tolerance for ambiguity on decision performance are equivocal. Dermer (1973) investigated the effects of tolerance for ambiguity on the perceived importance of information. He observed a significant, positive relationship between a subject's tolerance for ambiguity and both the quantity and the perceived value of information. Dermer's study showed that tolerance for ambiguity has an impact on managers' information preferences, and managers high on tolerance for ambiguity accepted accounting information and used it more readily than managers low on tolerance for ambiguity. McGhee, Shields & Birnberg (1978) and Gul (1986) also investigated the individual's tolerance for ambiguity on subject's information processing behavior. They concluded that individuals low on tolerance for ambiguity were less confidence in their decisions than individuals high on tolerance for ambiguity.

Oliver and Flamholtz (1978), on the other hand, found that individuals low on tolerance for ambiguity accepted accounting information more readily than individuals high on tolerance for ambiguity. Similarly, more recently, Chong (1998) found that tolerance for ambiguity and the extent of use of broad scope MAS information have an interactive effect on managerial performance. Managers with low levels of tolerance for ambiguity, the use of more broad scope MAS information for decisions is associated with more positive managerial performance. On the other hand, managers with high levels of tolerance for ambiguity may prefer to use less broad scope MAS information for their managerial decisions. The use of more broad scope MAS information for managerial decisions may lead to information overload, which may be dysfunctional to their performance. (Chong 1998) Other studies (e.g. McGhee, Shields & Birnberg 1978; Faircloth & Ricchiute 1981), however, found that tolerance for ambiguity does not affect decision-making. Overall, previous studies reveal the mixed and inconclusive results of prior studies.

In summary, previous studies suggest that a potential relationship exists between tolerance for ambiguity and the desire for additional information (Budner, 1962; Norton, 1975; Asford & Cummings, 1985; Bennet, Herold & Ashford 1990; Tsui, 1993). It has been also suggested that personality has a moderating effect on the characteristics of information perceived to be useful in uncertain environments (Gul 1984, 1986; Asford & Cummings 1985; Tsui 1993; Chong 1996, 1998; Lal & Hassel 1998).

It is suggested here that the extent to which individual project managers use formal project control system more in either diagnostic or interactive manner is likely to be a function of their personality variable of tolerance for ambiguity. It is proposed that individual project managers with low tolerance for ambiguity are less confident to use formal project controls under high task uncertainty (task variability and task difficulty in project) when compared to project managers with high tolerance for ambiguity. While individuals who are high on tolerance for ambiguity are more confident in using formal project controls (interactive and diagnostic type) more intensively under task variability and task difficulty. As noted earlier (see Chapter 1.2.2 for detailed discussion) the following hypotheses suggesting monotonic relationships are proposed for administrative and technical type development projects:

H8. For project managers with high tolerance for ambiguity there is a significantly more positive relationship between task variability and interactive use of project feedback and measurement system than for project managers with low tolerance for ambiguity.

H9. For project managers with high tolerance for ambiguity there is a significantly less negative relationship between task variability and diagnostic use of project feedback and measurement system than for project managers with low tolerance for ambiguity.

H10. For project managers with high tolerance for ambiguity there is a significantly more positive relationship between task difficulty and interactive use of project feedback and measurement system than for project managers with low tolerance for ambiguity.

H11. For project managers with high tolerance for ambiguity there is a significantly less negative relationship between task difficulty and diagnosti use of project feedback and measurement system than for project managers with low tolerance for ambiguity.

The research model and hypothesized relationships among research variables are presented in Figure 2. The framework is a path model, which includes seven hypothesized relationships, which are analyzed separately for administrative and technical type development projects to control for the possible effect of project type on the hypothesized relationships. In this study the differences between administrative and technical projects are left exploratory and no definite a priori differences or separate hypotheses are developed for these two sub-groups.

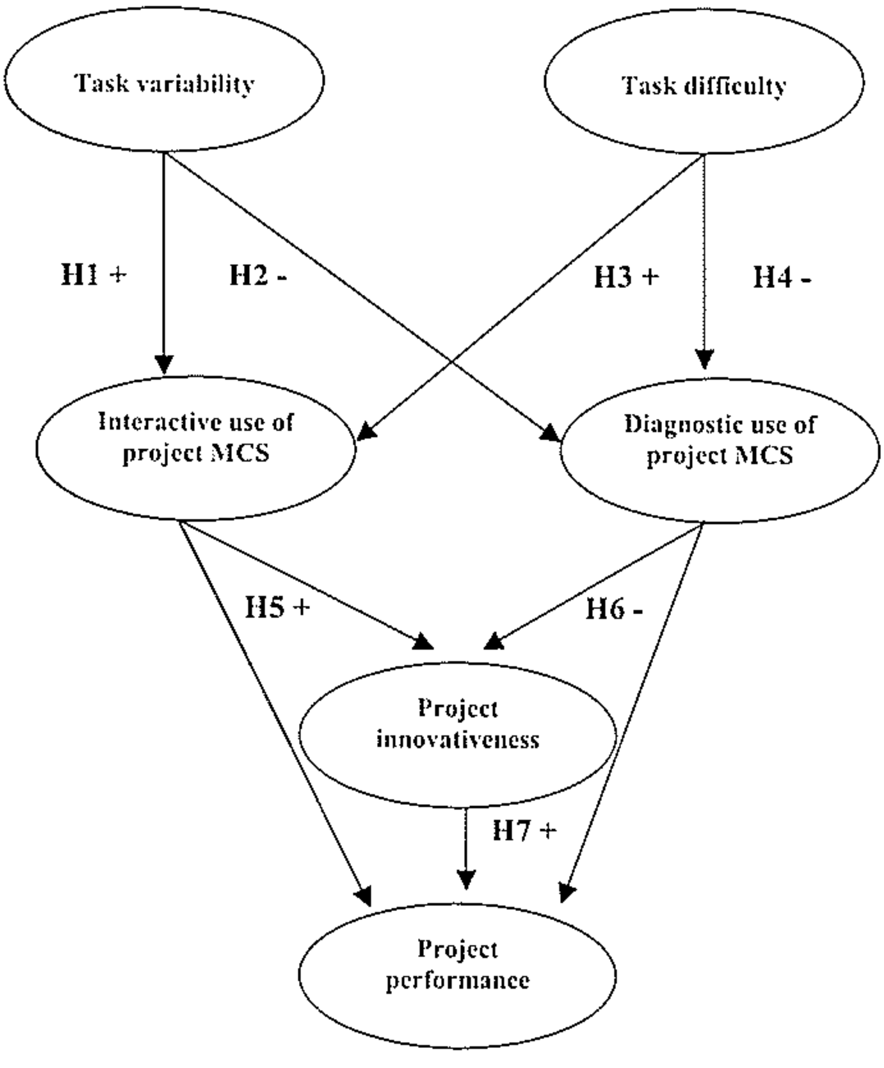

Figure 2. Research model and hypotheses.

4. HYPOTHESES TESTING METHOD

The following section has three parts. The first part further describes the sample that is used to test the hypotheses, the second part describes how the questionnaire that was used for data collection was developed, and the last part describes how the variables were measured.

4.1. Sample

The unit of analysis is the individual project. Since the study is about project control as used by the project managers in individual development projects, and accordingly with previous empirical studies in MCS and NPD literature, the research method takes project managers as key informants. As the selected population is very difficult to reach, a convenient and obtainable sample was selected by using professional association of project management in Finland. It was realized that there exists a danger that the sample will not represent the broader population of interest. However, in this case the sampling error is most likely small.

A self-administered internet-questionnaire was sent to 260 project managers from 145 differing project organizations selected from the database of Project Management Association of Finland. An initial email was sent to all officially certified (C-level) project managers in Finland (N=171) and to 109 project managers who were members of the Project Management Association of Finland and had visited the Associations internet-pages for members during the last four weeks period. From these 160 members 109 project managers were randomly chosen. An initial email was addressed personally to the project manager of each development project, explaining the goals and purpose of the study, ensuring respondents anonymity, a section where instructions about allowing respondents to provide their name and address for a copy of the survey results, and a web-link to the questionnaire and instructions how to answer the question and send the responses. Two weeks after the initial email contact, a reminder email about the web-questionnaire was sent to all project managers who had not answered the questionnaire, only four of respondents did not fill in their contact information. A total of 20 project managers who were contacted by email, indicated that they could not participate to research because they felt they did not belong to target group of the study as they have no previous experience about managing development projects.

A total of 121 responses were received. Of these, 2 were unusable, due to missing data. This resulted in 119 useable responses, a response rate of approximately 50%. These 119 usable subjects had a mean of 9.6 (SD=7.2, range=1–30) years of experience in project management. Additionally in one case of those 119 useable responses project type was not clarified, which resulted total of 70 technical type development projects and 48 administrative type development projects. Additionally, four responses were removed because of extreme low values on research variable of project innovativeness (outliers). The resulting useable sample for purposes of statistically testing the specified hypotheses was n=114.

The useable response rate of 50% was considered acceptable and higher than in most MCS surveys. It provides a sample size, which is large enough to undertake the analysis of the model (discussed in a later section), and the potential for non-response bias is limited. In order to test for potential non-response biases, comparison of means on all measured variables was undertaken. The mean responses for questionnaires (on variables) received prior to the reminder email contact were compared to those received after the reminder email, to test if responses differed between the two groups. No significant differences (two-samples t-test) were identified, providing some support for the absence of a non-response bias.

The firms in the resulting useable sample represent a variety of industries, including information technology (28 projects), telecommunications (20 projects), consulting (11 projects), automation (9 projects), electronics (9 projects), metal industry (7 projects), constructing (7 projects), engineering (6 projects), banking and financial services (6 projects) and miscellaneous (11 projects).

4.2. Survey design

A survey instrument was used to collect the data for study. The questionnaire was initially developed in English, then translated into Finnish and back-translated into English. The original and back-translated versions were compared by different individuals. The Finnish version was revised based on the small differences. A web-questionnaire was developed following the Total Design Method (TDM), the details of which are given by Dillman (2000). According to Dillmann (2000) the advantages of internet-survey are that it is relatively cheap, it avoids possible interviewer bias, it can be used to address sensitive questions, and it overcomes 'not-at-home' problem. Dillmans method was used getting people to respond and to reduce non-response rate. For example, providing rewards to respondents (research report from results), minimizing costs (time and complexity) to respondent by designing the web-questionnaire content and format so that the format of questionnaire was attractive, easy to fill out, and grouped in logic and motivating manner.

Each variable was measured using multiple indicators. Existing measures were used when possible, with modification to fit the present research context of project environment. To check on the relevance of these measures to the subjects project manager web-questionnaire was pre-tested with five academics and four project managers with expertise in the arenas of management control and project management. This resulted in changes to some of the wording and the presentation of the questionnaire. The survey instrument consisted of instructions for respondent, questions that measured each of the variables of interest, and background information from project, including project type (technical vs. administrative development), project budget, project size in terms of employees working on project, duration of project, industry, and function and previous project management experience of respondent. In most cases, the measures were adapted from prior research. All variables except project background information were measured on 7-point likert scale. Where relevant, respondents had the opportunity to indicate if the various project management practices or other questionnaire items had never been used by manager or were not relevant (indicated as 0).[17]

4.3. Definition and measurement of variables

Each research variable was measured using multiple indicators. Existing measures from previous research were used when possible, with modification to fit the present research context.

4.3.1. Task uncertainty

Perrow (1967,1970) characterized task uncertainty in terms of two attributes of the process by which inputs are transformed outputs. In this study project uncertainty is

[17] The internet-questionnaire, contact and remainder emails are presented in appendix 14.

measured using these two dimensions defined by Perrow (1967, 1970). The first dimension is number of exceptions. This refers to task variety, which is the frequency of unexpected and novel events that occur in the conversion process. When the number of exceptions is high, participants typically cannot predict problems in advance and many tasks are unique. When few exceptions occur, tasks have little novelty and are repetitious. The second dimension is analyzability, which is labeled here as task difficulty. When the conversion process is analyzable, the work often can be reduced to mechanical steps, and participants can follow an objective, computational procedure to solve problems. When work is un-analyzable (high difficulty), there is no objective calculation or procedure to tell a person how to respond. Participants have to spend time thinking about how to solve problems, and they may actively search beyond readily available procedures.

While these two dimensions are quite faithfully reproduced in the conceptualisation of task uncertainty by other researchers in the literature, the empirical counterparts of the two dimensions tend to be collapsed, in hypothesis testing, into a single construct, allegedly capturing both dimensions (e.g. Van de Ven, Delbecq & Koenig 1976; Gresov 1989). Van de Ven & Delbecq (1974) clearly indicated that these two are independent dimensions, each with differing theoretical consequences. These previous arguments were realized by examining these two dimensions as independent constructs. In addition, the level of analysis was similar to Van de Ven and Delbecq (1974) and Abernethy and Brownell (1997) who conceptualized the two dimensions as operating at the work-unit level of analysis as opposed to the individual level. While Hirst (1983) and Brownell & Hirst (1986) both treat task uncertainty as an individual level variable, both Van de Ven & Delbecq (1974) and Withey, Daft & Cooper (1983) clearly specify the work-unit as the appropriate level of analysis.

Task variability (number of exceptions) is measured in this study using the five first items of the measurement instrument developed by Whithey, Daft & Cooper (1983). Similarly task difficulty (task analyzability) is measured using remaining five items from Withey, Daft & Cooper (1983). Whithey, Daft & Cooper (1983) have shown the scale to be reliable and capable of differentiating work units with varying tasks.

Task uncertainty (modified to suite project environment from Withey, Daft and Cooper, 1983)

1. How repetitious were the duties of those in your project? (Very little...very much)
2. To what extent would you say the work of your project was routine?
3. Basically, project members performed repetitive activities in doing their jobs.
4. How many of the tasks in your project were the same from day to day? (Very few...most of them)
5. People in my project did about the same job in the same way most of the time.
6. To what extent was there an understandable sequence of steps that can be followed in doing the work of your project?
7. To what extent was there an understandable sequence of steps that can be followed in carrying out the work in your project?
8. To what extent was there a clearly known way to do the major types of work normally encountered in your project?
9. To what extent was there a clearly defined body of knowledge of subject matter, which can guide the work done in your project?
10. To do the work of your project, to what extent could personnel actually rely on established procedures and practises?

Items are coded 1 = to a small extent, 7 = to a great extent scale unless otherwise noted.

4.3.2. Interactive and diagnostic use of project MCS

Diagnostic and interactive styles of use of project related controls were developed from the literature using the Simons (1995) framework of levers of control. These characteristics have some common elements with Anthony's description of tight budgetary control and to Van der Stede (2001) measurement instrument of budget tightness. They also correspond to the control elements used by Merchant (1981, 1998). Previous measurement instruments of Van der Stede (2000, 2001), Otley & Fakiolas (2000) and Shields, Deng & Kato (2000) and Chenhall & Morris (1995) were considered when developing measures for interactive and diagnostic use of project control systems. After a review of these instruments, items and validation during the pilot study, the following items were used to measure interactive and diagnostic use of project MCS.

Diagnostic use of project feedback and measurement system

1. I judged my project team performance with performance measures that explain in detail project performance variances on a line- by- line basis.
2. I was not only interested how well my project team achieves overall project performance target but I also evaluated how well my project team was on target on each of the project performance line items.
3. I attached a great deal of importance to interim project performance target deviations.
4. I used performance target variances as a pressure device for my project team to emphasize the need to meet targets.
5. I required my project team sub-ordinates to report the actions taken to correct causes of interim project performance target variances.

These items are scored on a seven-point Likert scale from strongly agree to strongly disagree.

Interactive use of project feedback and measurement system

1. I called my project team sub-ordinates in to discuss project performance target deviations in face-to-face meetings.
2. Myself, and my own project team subordinates often discussed informally and solved project performance target matters together.
3. Project performance target matters were discussed regularly with my project team sub-ordinates even if there were no negative performance target deviations to report.

These items are scored on a seven-point Likert scale from Strongly Agree to Strongly Disagree.

4.3.3. Tolerance for ambiguity

Tolerance for ambiguity refers to the way an individual (or group) perceives and processes information about ambiguous situations or stimuli when confronted by an array of unfamiliar, complex, or incongruent clues. Tolerance for ambiguity is a variable that is often conceived on a uni-dimensional scale. The person with low tolerance of ambiguity experiences stress, reacts prematurely, and avoids ambiguous stimuli. At the other extreme of the scale, however, a person with high tolerance for ambiguity perceives ambiguous situations/stimuli as desirable, challenging, and interesting and neither denies nor distorts their complexity of incongruity (Furnham & Ribchester 1995).

Furnham (1994) provides a comprehensive content, correlational, and factor analytic study of four tolerance for ambiguity questionnaires. The correlational analysis results show that the Norton (1975) and Rydell & Rosen (1966) scales appeared to have the best, internal reliability (0.89 and 0.78). The two shorter scales of Budner (1962) and Walk (O'Connor 1952) had reliabilities just under 0.60, which is regarded by many as the barely acceptable minimum for short scales. Based on the above mentioned research results of Furnham (1994) and the relevance for the present research context personality variable of tolerance for ambiguity is measured in this study using the job-related and problem solving components of the tolerance for ambiguity instrument from the Norton (1975) 50-item scale (MAT-50). This instrument was modified to fit the context of the present research, including only job-related and problem-solving items from MAT-50.

Measurement items are from the Measure of Ambiguity Tolerance (adapted from MAT-50 Norton, 1975)

Job-related

1. I function very poorly whenever there is a serious lack of communication in a job situation.
2. In a situation in which other people evaluate me, I feel a great need for clear and explicit evaluations.
3. If I am uncertain about the responsibilities of a job, I get very anxious.
4. If I were a scientist, I might become frustrated because my work would never be completed (because science will always make new discoveries).
5. If I were a doctor, I would prefer the uncertainties of a psychiatrist to the clear and definite work of someone like a surgeon or X-ray specialist.

Problem-solving

6. Once I start a task, I don't like to start another task until I finish the first one.
7. Before any important job, I must know how long it will take.

8. In a problem-solving group it is always best to systemically attack the problem.
9. A problem has little attraction for me if I don't think it has a solution.
10. I do not like to get started in group projects unless I feel assured that the project will be successful.
11. In a decision-making situation in which there is not enough information to process the problem, I feel very uncomfortable.
12. I don't like to work on a problem unless there is a possibility of coming out with a clear-cut and unambiguous answer.
13. Complex problems appeal to me only if I have a clear idea of the total scope of the problem.
14. A group meeting functions best with a definite agenda.

A seven-point scale is used to measure AT. The scale ranges from "very strong agreement" with the statement to "very strong disagreement".

4.4.4. Project innovativeness and project performance

Innovative accomplishments are defined in this study very broadly to include any policy, structure, method or process, product or market opportunity that the manager of the innovating unit perceived to be new. This definition has been employed in several studies, including the empirical work of Zaltman, Duncan & Holbek (1973) and Kanter (1983). Although Daft (1982) suggested keeping technical and administrative innovations distinct, this study follows Van de Ven (1986) who argued that making such a distinction results in an unnecessarily fragmented classification of the innovation process. However, as mentioned earlier the suggestions of dual-core theory were used to distinguish the different development projects as administrative and technical, based on nature of projects and their project goals. The studies of creativity and innovation have generated a wide-ranging variety of definitions of the concept, some of which define it as a characteristic of a person and others as a process (Amabile 1988). The terms creativity and innovation are often used interchangeably in research studies, and the distinction between the two concepts may be more one of emphasis than of substance (West & Farr 1990).

Following the conceptualisation of Amabile (1988) and Staw (1990), in this study the distinction between creative performance and organizational innovation is recognized. That is, creative performance refers to production of novel and useful products, ideas, and so forth produced at the individual level, whereas innovation refers to the production or adoption of useful ideas and successful implementation of these products at the organizational level (Kanter 1988; Van de Ven 1986). Although creativity is often framed as "doing something for the first time anywhere or creating new knowledge" (Woodman, Sawyer & Griffin 1993: 293), innovation also encompasses the adaptation of products or processes from outside an organization. Researchers exploring innovation have explicitly recognized that idea generation is only one stage of a multistage process on which many social factors impinge (Kanter 1988). Most contemporary researchers and theorists have adopted a definition that focuses on the product or outcome of a product development process (Amabile1983, 1988; Shalley 1991; Woodman, Sawyer & Griffin 1993; Zaltman, Duncan & Holbek 1973). Three items were developed to measure innovativeness and project performance. These items are a modification of the job-performance instrument of Shields, Deng & Kato (2000).

Respondents were given the following definition for innovation performance: *"Innovative accomplishments are defined here very broadly to include any policy, structure, method or process, product or market opportunity that you as the manager of the project perceived to be new."* They were then asked to answer the following questions, using this definition of innovation as basis.

Project innovativeness

1. The level of my project team innovation performance (number of innovations) measured relative to project performance targets (standards).
2. The level of my project team measured innovation performance (number of innovations) relative to other project teams measured performance working in the same type of projects.
3. The overall level of my project team measured innovation performance.

(Anchored by 1 = Extremely low, and 7 = Extremely high)

Project performance

1. The level of my project team performance measured relative to project performance targets (standards).
2. The level of my project team measured performance relative to other project teams measured performance working in the same type of projects.

3. The overall level of my project team measured performance.

(Anchored by 1 = Extremely low, and 7 = Extremely high)

4.4.5. Project type

Project type is measured using a dichotomous measurement scale where administrative development project is defined as involving development of organizational structure and administrative processes; that is, they are indirectly related to the primary work activity of organization and are more directly related to its management (Daft 1978; Damanpour & Evan 1984; Kimberly & Evanisko 1981). Similarly, technical development projects are defined in this study as projects where the main goal is to develop new products, services, or production process technology; that is the project is related to the basic work activity of the organization and can involve either product or process innovations (Daft 1978; Damanpour & Evan 1984).

5. RESULTS

This section has three parts. The first part reports descriptive statistic for the variables, the second part describes the analytic technique (PLS), which was used to test hypothesis, and the last part presents the results of hypotheses testing.

5.1. Descriptive statistics

Table 1 reports the research variables means, standard deviations, and theoretical and actual ranges. The variables' actual ranges were almost as large as their theoretical ranges and their means were approximately in the middle of these ranges. The actual range of interactive use of project MCS, when compare to its theoretical range, appears skewed toward the direction of highly interactive style of use formal project MCS. This was expected as the nature of development project require intensive and interactive communication processes between project manager and sub-ordinates. Similarly, the task variability skewed toward the direction of highly variable tasks, which was expected in the case of technical and administrative development projects.

The mean of project manager personality variable of tolerance for ambiguity was almost in the middle of the theoretical range. It was expected that these project managers would have used to and selected to an uncertain and ambiguous work settings, which would imply that their tolerance for ambiguity mean would be greater than the middle of the theoretical range. Additionally, in the case of task difficulty, it was expected that the actual range would skewed toward the direction of highly difficult tasks. It could be that these project managers were providing relative, not absolute, assessments of their project environment. That is, if they had become accustomed to high levels of project task difficulty, they could have responded that they had average level of task difficulty meaning that they had experienced a typical level of task difficulty for the kind of project they have. The key, however, is not their reported level of uncertainty but how it is associated with the other variables.[18]

[18] Appendix 4 reports the tests of normality.

Table 1. Descriptive statistics on research variables.

	Ranges		Mean		Std. Deviation
	Theoretical	Actual			
	Statistic	Statistic	Statistic	Std. Error	Statistic
Project task variability	5 - 35	12 - 35	25,3070	,5304	5,6633
Project task difficulty	5 - 35	8 - 33	17,4951	,4347	4,6411
Diagnostic use of project MCS	5 - 35	6 - 34	21,2470	,5531	5,9056
Interactive use of project MCS	3 - 21	12 - 21	15,6100	,3002	3,2055
Project innovativeness	3 -21	6 - 21	13,5944	,2691	2,8727
Project performance	3 - 21	7 - 21	15,2505	,2699	2,8815
Tolerance for ambiguity	13 - 91	16 - 70	47,5902	,9662	10,3165

Descriptive statistics for project budget, project duration, number of employees working on project, and project manager experience are presented in Table 2. The average previous project management experience of respondents was 10 years. The average project duration was 14 months and project budget range was from 6000 euros to 23 million euros. Number of people working in project was averagely 12,5. To test for significant differences between technical and administrative type development projects independent sample t-tests were used. As predicted, based on dual-core theory, there were significant differences between these two groups of projects, which supports the research choice of analysing the research model separately in administrative and technical development projects to control for effect of project type. Results of these tests are presented in Appendices 1, 2 and 3.

Table 2. Descriptive statistics on project background characteristics.

	N	Minimum	Maximum	Mean		Std.
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Project budget (in euros)	99	6000,00	23000000	1519434	347910,9	3461670
Project duration (in months)	116	2,00	50,00	13,5560	,9108	9,8097
Project managers previous management experience (in years)	108	1,00	30,00	9,5880	,6972	7,2460
Average number of people working in project	116	2,00	80,00	12,5043	1,2551	13,5180

Table 3 reports Pearson correlations for the variables (N=114). The signs of the correlations were consistent with four of the seven hypotheses ($p<0.05$). The correlations between Task variability and diagnostic use of project MCS and both diagnostic use of project MCS and project innovativeness standard-based incentives not significant. Additionally, the significant correlation between task difficulty and interactive use of project MCS was not consisted with the hypothesis as the sign was negative.

Table 3. Pearson correlations among variables in study.

	Intolerance for ambiguity	Project task variability	Project task difficulty	Diagnostic use of project MCS	Interactive use of project MCS	Project innovativeness	Project performance
Intolerance for ambiguity	1,000	-,036	-,176*	,225**	,064	-,089	-,161*
	.	,353	,030	,008	,251	,174	,043
Project task variabilit	-,036	1,000	,301**	-,080	,156*	,095	,002
	,353	.	,001	,198	,049	,157	,493
Project task difficulty	-,176*	,301**	1,000	-,285**	-,182*	-,070	-,304**
	,030	,001	.	,001	,027	,229	,001
Diagnostic use of project MCS	,225**	-,080	-,285**	1,000	,429**	-,043	,117
	,008	,198	,001	.	,000	,323	,108
Interactive use of project MCS	,064	,156*	-,182*	,429**	1,000	,242**	,238**
	,251	,049	,027	,000	.	,005	,005
Project innovativene:	-,089	,095	-,070	-,043	,242**	1,000	,403**
	,174	,157	,229	,323	,005	.	,000
Project performance	-,161*	,002	-,304**	,117	,238**	,403**	1,000
	,043	,493	,001	,108	,005	,000	.

*. Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.01 level (1-tailed).

5.2. Partial Least Squares

To test the hypotheses, the technique of Partial Least Square (PLS) was used. PLS provides a way in which statistical modelling in management accounting can move forward as the assumptions underlying PLS are less strict than in more traditional covariance-based Structural Equation Modelling (SEM) (Smith & Langfield-Smith 2002). PLS was chosen instead of using covariance-based SEM because the sample size of this study is relatively small and PLS is said to be particularly suitable to small sample size studies[19] (Wold 1985). Also, it overcomes some theoretical and estimation problems in the use of more well known covariance-based SEM approaches. The

[19] PLS is said to be a powerful of analysis because of the minimal demands on measurement scales, sample size, and residual distributions (Wold, 1985). Tests of normality are presented in appendix 4.

technique of PLS comprises a structural model that specifies the relationships among constructs and a measurement model that specifies the relations between the manifest items and the constructs that they represent. PLS enables an overall assessment of the validity of constructs within the total model (Chin 1998a).

PLS is said to be a particularly useful approach in situations where the objective is prediction, and/or the phenomenon in question is relatively new or changing and the theoretical model or measures are not well formed. Additionally, when the model is relatively complex with large number of indicators and/or latent variables (LV), and/or there exists an epistemic need to model the relationships between LVs and indicators in different modes using formative and reflective indicators PLS is a particularly useful approach. PLS can be used if the data conditions relating to normal distribution, independence, and/or sample size are not met. (Chin 1998a; Chin & Newsted 1999.)

It is argued that PLS is more deeply rooted in the observed data sets. As opposed to the covariance-based approach, it does not rigidly adhere to an underlying theoretical model (i.e., to the extent of explaining all observed correlations). Rather, the objective of PLS is to aggregate indicators within blocks in a predictive sense. The extent to which the theoretical model is true is determined partly by the strength of the path relations among LV components scores and loadings for reflective indicators as estimated by the procedure (Chin 1998a). However, despite the popularity of PLS in other disciplines and its clear advantages of using small sample sizes and to model non-normal data, PLS has had only limited use in management accounting. Smith & Langfield-Smith (2002) survey of published management accounting research in ten leading journals during years 1980 to 2001 found only one study (Ittner, Larcker & Rajan, 1997) that has used PLS. Beside that at least more recent study of Chenhall (2003b) also uses PLS as analytical technique. Because it seems that management accounting researchers are not as yet familiar with partial least squares, the main principles of this approach are presented shortly in next section.

SEM-based approaches provide the researcher with the flexibility to perform the following: (a) identify model relationship among multiple predictor and criterion variables, (b) construct unobservable latent variables, (c) model errors in measurements for observed variables, and (d) statistically test a priori substantive/theoretical and measurement assumptions against empirical data (i.e., confirmatory analyses). Typically using a maximum likelihood (ML) function, covariance-based SEM attempts to minimize the difference between the sample covariances and those predicted by the theoretical model. Therefore, the parameters that are estimated by this procedure attempt to reproduce the covariance matrix of the observed measures. But such an attempt makes the underlying assumptions that the observed variables follow a specific multivariate distribution (normality in the case of the ML function) and that the observations are independent of one another. This is not always the care in management accounting research. Similarly, sample size requirements are often out of reach for MCS researchers and because small samples that are not asymptotic in characteristics SEM can lead to poor parameter estimates and model test statistics. In addition, inadmissible solutions in the form of negative variances and out-of range-covariances often occur as the sample size decreases. Beside these problems relating to small sample size in covariance-based SEM a poor model can still falsely achieve adequate model fit leading to type II error. (Chin 1998a; Chin & Newsted 1999.)

The objective of PLS is to help the researcher obtain determinate values of latent variables for prediction. Instead of using the model for explaining the covariation of all the indicators, PLS minimizes the variance of all dependent variables. Thus, parameter estimates are obtained based on the ability to minimize the residual variances of dependent variables (both latent and observed). Each latent variable is approximated by its respective block of indicators. Latent variable component scores are created based on a weighted sum of their indicators. The best weighting scheme for each block of indicators depends on the model being estimated. To obtain the weights and subsequent loading and path estimates, the PLS approach uses a three-stage estimation algorithm. The first stage provides the weight estimates. The second stage provides estimates for the inner model (structural relations among latent variables) and outer model (reflective of formative measurement paths). The third stage yields the means and location estimates. In the first two stages, the indicators and LVs are treated as deviations from their means and in the third stage the weight and path estimates from the previous two stages are used for calculating the means and location parameters. (Chin1998a; Chin & Newsted 1999.)

Stage 1 is the heart of the PLS algorithm. In the first stage, an iterative scheme of simple and/or multiple regressions, contingent on the particular model, is performed until a solution converges on a set of weights used for estimating the latent variables (LV) scores. Once the LV estimates are obtained, stages 2 and 3 are simple non-iterative applications of OLS regression for obtaining loadings, path coefficients, and mean scores and location parameters for the LV and observed variables. Until stage 3, the LV and indicators are treated as deviations from their means. (Chin 1998a; Chin & Newsted 1999.)

The algorithm does an initial outside approximation estimation of the LVs by summing the indicators in each block with equal weights. The weights, in each iteration, are scaled to obtain unit variance for the latent variable scores over the N cases in sample. This step is known as the outside approximation. Once this is done, proxies are created for each LV variable based on its association with other LVs. In other words combining the component scores for all LVs associated (i.e., having path relations) with each specific LV to obtain a proxy estimate. In the case of a simple two-block model, PLS uses the component score for the other LV as the proxy. But in the multiblock case, a particular LV may have more than one LV connected to it at the structural level. Under these conditions, different procedures for combining more than one component score to obtain the best proxy for the LV under consideration is needed. This is called the inside approximation and there have been three primary inside approximation weighting schemes developed thus far for combining neighboring LVs to obtain the proxy for a specific LV: centroid weighting, factor weighting, and path weighting. Althought each weighting scheme follows a particular logic, Noonan & Wold (1982) have noted that its choice tends to have little influence on the results: .005 or less for structural paths and .05 or less for measurement paths. (Chin 1998a; Chin & Newsted 1999.) In this study the path weighting scheme (a default setting of PLS-Graph 3.00) was used.

The path weighting scheme is the only procedure among the above mentioned three that takes into account the directionality of the structural model and it is often used for models with hypoyhesized causal relations. Path weighting scheme differentially weights neighboring LVs depending on whether they are antecedents or consequents of the focal LV. This scheme, thus, attempts to produce a component that can both ideally be predicted (as a predictant) and at the same time be a good predictor for subsequent dependent variables. To do this, all independendent variables impacting the target LV are weighted by the multiple regression coefficients, whereas all dependent LVs are weighted by the correlation coefficients. In a sense, the focal LV becomes a best mediating LV between the source and target LVs. (Chin 1998a.)

Thus, the PLS procedure iterates back and forth between two ways of estimating a LV. The outside approximation attempts to provide an estimate of the LV via an aggregation of its indicators whereas the inside approximation yields an estimate by combining neighboring LVs. The first approach (i.e. outside approximation) occurs under situations where the researcher is handed a set of measures supposedly capturing a particular construct. Without additional information, the best initial estimate of the construct would be a summation of the measures. The second approach represents the situation where a researcher is not provided with the outer set of measures, but instead scores of LVs that are considered to be most closely related with the construct in question. If asked to give the best initial estimate of that construct, also the scores given are aggregated. The PLS procedure, thus, utilizes information at both levels in estimating a component score for each LV. (Chin 1998a.)

In the PLS approach a graphical model, arrow scheme, is used quite differently from that of a covariance analysis. For the covariance approach the arrow scheme is a rigid constraint on how parameters are estimated, because it dictates the paths by which indicators are associated in a correlational sense. In the PLS approach, the parameters appear as a result of the attempt to minimize the variances as outline by the scheme. The arrow scheme, therefore, is used to determine which set of residuals are to be minimized (i.e., which LV components and indicators) in order to come up with the set of weights necessary to create the LV components. (Chin 1998a.)

Formative vs. reflective indicators

An underlying assumption for SEM analysis is that the items or indicators used to measure an LV are reflective in nature. Such items are viewed as affected by the same underlying concept (i.e., the LV). Yet a common and serious mistake often committed by researchers is to inadvertently apply formative indicators (also known as cause measures) in an SEM analysis. Formative indicators, first introduced by Blalock (1964), are measures that form or cause the creation or change in an LV. An example is socio-economic status (SES), where indicators such as education, income, and occupational prestige are items that cause or form the LV SES. If an individual loses his or her job, the SES would be negatively affected. But to say that a negative change has occurred in an individual's SES does not imply that there was a job loss. Furthermore, a change in an indicator does not necessarily imply a similar directional change for the other indicators. (Chin 1998b.)

The PLS approach provides a means for directly estimating LV component scores. The procedure is partial in a least squares sense because each step of the procedure minimizes a residual variance with respect to a subset of the parameters being estimated given proxies or fixed estimates for the other parameters. It is coherent in a predictive sense where its objective is to minimize the variances of the dependent variables (observed or latent). Because LV scores are determinate, also indicators where the observed indicators are assumed to cause or form the LV can be modelled (termed cause or formative indicators). In this situation, with arrows directed toward the construct from their indicators, the PLS algorithm provides LV weight estimates such that the LV score is maximally predicted by its block of indicators. Furthermore, the determinate nature of the PLS approach avoids parameter identification problems that can occur under covariance-based analysis. (Chin 1998a.)

Because the arrows relating to indicators to their LVs can go in either direction, various combinations (reflective, formative or formative and reflective) or modes (mode A, mode B, and mode C) can be formed. In this study all LVs consisted of indicators in a reflective mode (called also mode A among PLS users). Reflective indicators are typical for the classical true score test theory and factor analysis models. These indicators are created under the perspective that they all measure the same underlying phenomenon (i.e., LV). If the actual level of the phenomenon change, then all the indicators should also change in the same direction. The magnitude in which each indicator shifts relative to the shift in the underlying phenomenon is based on how well the indicator reflects or taps into the LV. This, in turn can be determined by the loading, which is proportional to the amount of variance in that indicator that the LV is able to account. For LVs with reflective indicators, the loadings should be inspected for determining the appropriateness of the indicators. (Chin 1998a.)

Essentially, each loading represents the correlation between the indicator and the component score. Indicators with low loadings essentially imply that they have little relationship in terms of shared variance with the LV component score. Because in this study all the blocks of indicators are modelled in mode A with arrows directed toward the indicators, each indicator in each block is individually regressed on its respective proxy (i.e., inside approximation score). In the case of mode B (formative) with arrows derected inward, PLS would perform a multiple regression of the proxy estimate of LV on its indicators. The simple or multiple regressions coefficients are then used as new weights for an outside approximation of each LV. (Chin 1998a.)

Sample size requirements

As mentioned earlier, PLS performs either simple or multiple regressions depending on the mode for each block of indicators and the inner weighting scheme. Due to the partial nature of estimation procedure where only a portion of the model is involved, the part, which requires the largest multiple regression must be found. In general, it means inspecting the arrow scheme for the largest of two following possibilities: (a) the block with the largest number of formative indicators (i.e., largest measurement equation), or (b) the dependent LV with the largest number of independent LVs impacting it (i.e., the largest structural equation). In the case of using a regression heuristic of 10 cases per predictor, the sample size requirement would be 10 times either (a) or (b), whichever is greater. Because in this study only reflective indicators are used and the dependent LV (project performance) has the largest number of independent LVs affecting it, which in this case is three (interactive type MCS, diagnostic type MCS, and innovativeness), the sample size requirement would be approximately 30 under regression heuristic of 10 cases per predictor. (Chin 1998a; Chin & Newsted 1999.) The smallest sub-group analysis in this study is done with 22 cases.

Model evaluation

Three general sets of methodological considerations, which are relevant to the application of PLS are: (1) assessing the reliability and validity of measures; (2) determining the appropriate nature of the relationships between measures and constructs; and (3) interpreting path coefficients, determining model adequacy, and selecting a final model from the available set of alternatives (Hulland 1999). Because PLS makes no distributional assumptions, other than predictor specification, in its procedure for estimating parameters, traditional parametric-based techniques for significance testing/evaluation would not be appropriate. Rather than based on covariance fit, evaluation of PLS models should apply prediction-oriented measures that are also nonparametric. R-square for dependent LVs, the Stone-Geisser (Geisser 1975; Stone 1974) test for predictive relevance, and Fornell and Larcker's (1981) average variance extracted measures are used to asses predictiveness, whereas resampling procedures such as jacknifing and bootstrapping are used to examine the stability of estimates (Chin 1998a; Chin & Newsted 1999). In the next sections' those methodological considerations are presented from the point of this particular study.

5.2.1. Reliability and validity

PLS estimates parameters for both the loadings between measures and constructs and the path coefficients between different constructs at the same time. In this study the PLS model was analyzed and interpreted sequentially in two stages: first assessing the reliability and validity of the measurement model, followed by the assessment of the structural model. This sequence ensures that the reliably and validy measures of constructs is assessed before attempting to draw conclusions about the nature of the construct relationships (Hulland 1999). The adequacy of the measurement model was assessed by looking at individual item reliabilities, the convergent validity of the measures which are associated with individual constructs, and the discriminant validity.

To assess individual item reliability in PLS, the loadings of the measurement items with their respective construct were examined. Results indicate acceptable levels of item reliability as most of the items loadings are near 0.7 - the suggested required rule of thumb employed by many researchers. This implies that there is more shared variance between the construct and its measure than error variance (e.g. Carmines & Zeller 1979). Since loadings are correlations, this implies that more than 50 percent of the variance in the observed variable (i.e. the square of the loading) is due to the construct (Hulland 1999). [20]

However, it is common to find that at least several measurement items in an estimated model have loadings below the 0.7 threshold, as was in the case of this study, it is not surprising as in this study new items for interactive and diagnostic type use of project MCS are employed. A low loading may be the result of: (1) a poorly worded item, (2) an inappropriate item, or (3) an improper transfer of an item from one context to another. The first problem leads to low reliability, the second to poor content (and construct) validity, and the last to non-generalizability of the item across contexts and/or settings (Chin 199a; Hulland 1999). Even when the researcher has a strong theoretical rationale for including such items in his or her model, items with extremely low loadings should be carefully reviewed, since they will add very little explanatory power

[20] When considering individual item reliability each indicator should share more variance with the component score than with error variance. This implies that standardized loadings should be greater than .707 but it should also be noted that this rule of thumb should not be as rigid at early stages of scale development. Loadings of .5 or .6 may still be acceptable if there exist additional indicators in the block for comparison basis. (Chin 1998a.)

to the model while attenuating (and therefore biasing) the estimates of the parameters linking constructs (Nunnally 1978). In this study PLS model loadings in Table 4 show that only two items have loading under 0.6 and even the lowest loading of 0.42 exceed a threshold commonly used for factor analysis, that items with loadings of less than 0.4 or 0.5 should be dropped.[21]

5.2.2.Convergent validity

Because multiple measures were used to measure all individual constructs, beside individual measurement item reliability, also the extent to which the measures demonstrate convergent validity was examined. Traditionally, researchers using PLS have generally reported one or both of two measures of convergent validity (also referred to as composite reliability): Cronbach's alpha and the internal consistency measure developed by Fornell & Larcker (1981). The interpretation of the values obtained is similar, and the guidelines offered by Nunnally (1978) can be adopted for both (Chin 199a; Hulland 1999). Specifically, Nunnally suggests 0.7 as a benchmark for 'modest' composite reliability, applicable in the early stages of research. PLS estimates for Composite Reliability measures presented in Table 4 show that all individual constructs exceed value of 0.7 demonstrating at least modest convergent validity.[22]

Composite reliability

In assessing the internal consistency for a given block of indicators the composite reliability developed by Werts, Linn, and Jöreskog (1974) can be used. Using the normal PLS output, which standardizes the indicators and LV, the composite reliability is:

$$\rho_c = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum_i \operatorname{var}(\varepsilon_i)}$$

Where λ_i is the component loading to an indicator and $var(\varepsilon_i) = 1 - \lambda_i^2$.

[21] Appendices 6 and 7 present the individual item reliability and the composite reliability of the individual measurement constructs separately for technical and administrative type development projects. These results demonstrate at least modest item reliability and convergent validity of constructs.

[22] In comparison to Cronbach's alpha, this measure does not assume tau equivalency among the measures with its assumptions that all indicators are equally weighted. Therefore, alpha tends to be a lower bound estimate of reliability, whereas composite reliability is a closer approximation under the assumption that the parameter estimates are accurate. (Chin 1998a.) Cronbach alpha for research variable of tolerance for ambiguity is presented in appendix 5. Cronbach alpha of .75 indicates at least modest convergent validity. Item 5 was removed because it did not correlate with other items of the measurement instrument.

Table 4. Outer model loadings: Reliability of independent measurement items and convergent validity of measurement constructs.

	Original sample estimate	Mean of subsamples	Standard error	T-Statistic
Task variability: (Composite Reliability = 0.893 , AVE = 0.629)				
TU1_1	0.6520	0.5454	0.2585	2.5221
TU2_1	0.6956	0.6318	0.1818	3.8263
TU3_1	0.7803	0.7508	0.1413	5.5210
TU4_1	0.9011	0.8430	0.1510	5.9664
TU5_1	0.9034	0.8331	0.1595	5.6636
Task difficulty: (Composite Reliability = 0.818 , AVE = 0.476)				
TU6_1	0.7331	0.7069	0.0935	7.8406
TU7_1	0.7208	0.7034	0.1256	5.7377
TU8_1	0.7575	0.7601	0.0621	12.2050
TU9_1	0.6393	0.6318	0.1072	5.9614
TU10_1	0.5823	0.5619	0.1187	4.9066
Interactive use of project MCS: (Composite Reliability = 0.726 , AVE = 0.482)				
INT1_1	0.7997	0.7610	0.1289	6.2037
INT2_1	0.7725	0.7420	0.1622	4.7640
INT3_1	0.4569	0.4320	0.2014	2.2689
Diagnostic use of project MCS: (Composite Reliability = 0.809 , AVE = 0.468)				
DIAG1_1	0.7037	0.6732	0.1204	5.8440
DIAG2_1	0.7883	0.7558	0.0851	9.2605
DIAG3_1	0.7697	0.7818	0.0636	12.1103
DIAG4_1	0.4189	0.4782	0.1713	2.4457
DIAG5_1	0.6754	0.6839	0.0836	8.0768
Project innovativeness: (Composite Reliability = 0.880 , AVE = 0.710)				
INN1_1	0.8275	0.8195	0.0574	14.4065
INN2_1	0.7667	0.7643	0.0627	12.2236
INN3_1	0.9261	0.9267	0.0139	66.5974
Project performance: (Composite Reliability = 0.897 , AVE = 0.744)				
PERF1_1	0.8616	0.8637	0.0277	31.0630
PERF2_1	0.8393	0.8381	0.0378	22.2094
PERF3_1	0.8861	0.8803	0.0594	14.9292

PLS estimates for composite reliability (see Table 4) show good internal consistency indicating good construct definition and that all individual constructs are unidimensional as modeled. Low internal consistency can result from poor construct definition and/or construct multidimensionality. In the first case, the faulty construct definition severely impairs the determination of relevant and appropriate measures for the construct. In the latter case, if the underlying construct is actually multidimensional, but it is measured using items, which are assumed to be linked to an unidimensional construct, the measures as a group will demonstrate poor internal consistency. Furthermore, while some of the individual measurement items will have strong loadings linking them closely with the construct, others will have loadings, which are close to zero, or even negative in sign. In such instances, the researcher should consider either splitting the original construct into new constructs (each with its own set of measures), or eliminating items until only a unidimensional construct remains (Hulland 1999).

5.2.3. Discriminant validity

Discriminant validity represents the extent to which measures of a given construct differ from measures of other constructs in the same model. In a PLS context, one criterion for adequate discriminant validity is that a construct should share more variance with its measures than it shares with other constructs in a given model. (Chin 1998a; Hulland 1999) To assess discriminant validity, Fornell and Larcker (1981) suggest the use of Average Variance Extracted (i.e. the average variance shared between a construct and its measures). This measure should be greater than the variance shared between the construct and other constructs in the model (i.e., the squared correlation between two constructs), which indicates that more variance is shared between the LV component and its block of indicators than with another component representing a different block of indicators (Chin 1998a). Alternatively, square roots of AVEs can be compared with the correlations. This is demonstrated in Table 5 correlation matrix, which includes the correlations between different constructs, average variance extracted values (AVE), and the square roots of the average variance extracted values (Root AVE) calculated for each of the constructs. Results indicate adequate discriminant validity as the Root AVEs are significantly greater than the correlations between constructs.[23]

[23] When all the indicators are standardized, this measure would be the same as the average of the communalities in the block. Fornell and Larcker (1981) suggested that this measure can also be interpreted as a measure of reliability for the LV component score and tends to be more conservative than composite reliability. It is recommend that AVE should be greater than .50 meaning that 50% or more variance of the indicators should be accounted for.

Average variance extracted (AVE)

Average variance extracted (AVE) created by Fornell and Larcker (1981) attempts to measure the amount of variance that an LV component captures from its indicators relative to the amount due to measurement error. Assuming standardized indicators and LV estimates, the AVE is calculated as follows (Chin 1998a):

$$AVE = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 + \sum_i \text{var}(\varepsilon_i)}$$

Where λ_I is the component loading to an indicator and $var(\varepsilon_I) = 1 - \lambda_I^2$.

Table 5. Correlations of latent variables from PLS, Average variance extracted (AVE), and the square roots of the average variance extracted (Root AVE).

All development projects (N=114)

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact	AVE	Root AVE
Difficul	1.000						0.476	0.690
Variabil	0.271	1.000					0.629	0.793
Diagnost	-0.338	-0.120	1.000				0.468	0.684
Innovati	-0.112	0.109	-0.018	1.000			0.710	0.843
Performa	-0.303	0.024	0.180	0.430	1.000		0.744	0.863
Interact	-0.184	0.176	0.441	0.285	0.273	1.000	0.482	0.694

Bootstrapping

To examine the structural model, PLS generates standardized β that are used as path coefficients within the structural model and are interpreted as OLS regression. Bootstrapping provides a basis to evaluate parameter estimates and their confidence intervals based on multiple estimations. The bootstrap represents yet another nonparametric approach for estimating the precision of the PLS estimates. N samples sets are created in order to obtain N estimates for each parameter in the PLS model. Each sample is obtained by sampling with replacement from the original data set (typically until the number of cases is identical to the original sample set).

Bootstrapping was chosen in this study instead of jackknife, as jackknife is viewed as less efficient than bootstrap because it can be considered as an approximation to the bootstrap. (Chin 1998a.) Bootstrapping using 200 samples with replacement was used to assess the significance of the path coefficients. Figures 3, 4 and 5 present the results related to the structural models for technical type development projects (N=69) and administrative type development projects (N=45). This includes the path coefficients and their t-test.

R-square

Assessing R-square for each dependent variable can be obtained because the case values of the LVs are determined by the weight relations. The interpretation is identical to that of traditional regression. The corresponding standardized path estimates can also be examined and interpreted in the same manner. The change in R-squares can be explored to see whether the impact of a particular independent LV on a dependent LV has substantive impact. Specifically, the effect size f^2 can be calculated as (Chin 1998a.):

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$$

Where *R-square$_{included}$ and R-square$_{excluded}$* are the *R-squares* provided on the dependent LV when the predictor LV is used or omitted in the structural equation respectively. Similar to J. Cohen's (1988) operational definitions for multiple regressions f^2 of .02, .15, and .35 can be viewed as a gauge for whether a predictor LV has a small, medium, or large effect at the structural level (Chin 1998a). Table 6 presents the f^2 values for all sub-group analysis.

Table 6. Effect sizes *(f^2)*

F^2-values (effect size)	Technical projects			Administrative projects		
Path from→Path to	All	High_at	Low_at	All	High_at	Low_at
Task variability→Interactive type MCS	.04	.06	.23	.10	.22	.00
Task variability→Diagnostic type MCS	.02	.05	.36	.01	.01	.31
Task difficulty→Interactive type MCS	.10	.13	.41	.10	.03	.27
Task difficulty→Diagnostic type MCS	.13	.09	.42	.11	.22	.36
Interactive type MCS→Innovativeness	.20	.37	.07	.03	.10	.16
Diagnostic type MCS→Innovativeness	.01	.02	.06	.01	.08	.01
Interactive type MCS→Performance	.01	.00	.08	.01	.00	.05
Diagnostic type MCS→Performance	.01	.00	.06	.15	.24	.46
Innovativeness→Performance	.16	.12	.03	.20	.42	.11

Table 6 shows that the impacts of task variability and task difficulty on the interactive and diagnostic use of project MCS have large effect sizes ($f^2 > .35$) when the level of project manager tolerance for ambiguity is low but not when the project manager has a high level of tolerance for ambiguity. Also, in the technical type projects in the sub-group of project managers with high tolerance for ambiguity the impact of interactive use of project MCS on project innovativeness has a large effect size but only a small ($f^2 = .07$) effect size in the sub-group of low tolerance for ambiguity. Similarly, the impact of project innovativeness on project performance has a large effect size in administrative type development projects in the sub-group of project managers with high tolerance for ambiguity but only a small effect size in the low tolerance for ambiguity sub-group. Additionally, in administrative projects the effect of diagnostic use of project MCS on project performance has a large effect size in the sub-group of project managers with low tolerance for ambiguity and only medium effect size in the high tolerance for ambiguity sub-group.

5.2.4. Analysis for moderating effects of tolerance for ambiguity

In order to determine whether the form of the relationship is conditional upon a moderator variable Z, it is necessary to determine whether changes in Z are in fact associated with changes in β. In this study it was necessary to test hypotheses about the moderating effects of project manager tolerance for ambiguity on relationships between a) task variability in project and interactive use of project MCS (H8), b) task variability and diagnostic use of project MCS (H9), c) task difficulty and interactive use of project MCS (H10), and finally d) the relationship between task difficulty and diagnostic use of project MCS (H11). PLS analyses were done in high and low tolerance for ambiguity sub-groups separately for the administrative and technical type development projects. The moderator variable, tolerance for ambiguity, was transformed to a dichotomy variable by splitting the sample to two sub-groups of high and low tolerance for ambiguity according to median score. Project type did not require any transformation as administrative and technical project development type was measured with dichotomy scale in questionnaire.

This form of analysis often uses a special form of moderated regression analysis (MRA) meaning that the moderator variable is a dummy variable, taking only discrete values (e.g. 0 and 1). In this case, analysis is done for two sub-groups and therefore the MRA with a dummy variable is sometimes called sub-group regression analysis in which the sub-groups are distinguished based on extreme (e.g. high and low) values of the moderator variable. Sub-group regression analysis is commonly performed based on a categorization of the variable scores that have an underlying continuous scale. Such categorization has been argued to be unadvisable as it implies a loss of information (e.g. Cohen & Cohen 1983: 310; Russel & Bobko 1992). However, it has substantial advantages relating to the understandability of the MRA outcomes and the statistical power of the MRA technique (Arnold 1984: 221-222).[24]

The split group technique was used to test the moderating effects of tolerance for ambiguity. This involved comparing raw score β weights estimated separately for two sub-groups defined by their tolerance for ambiguity values (Z). When the third variable Z, upon which the form of the relationship between X and Y is hypothesized to be conditional, takes only two values, the analysis is straightforward. In testing hypotheses the slopes of the Y on X regressions (i.e., the β weights) were examined for the two values of Z (sub-groups of project managers with high and low levels of tolerance for ambiguity) estimating two PLS models separately for those two groups. (Arnold 1982) The significance of the difference of the coefficients between sub-groups was tested by (Arnold 1982):

$$t = \frac{\beta_{21} - \beta_{11}}{SE_{\beta_{21} - \beta_{11}}} = \frac{\beta_{21} - \beta_{11}}{(SE_{\beta_{21}}^{2} + SE_{\beta_{11}}^{2})^{1/2}}$$

With $n_1 + n_2 - 4$ df, where

β_{11} = slope of the Y on X regression line for those cases having one value of Z,
β_{21} = slope of the Y on X regression line for those cases having other value of Z,
$SE_{\beta_{11}}$ = standard error of estimate for β_{11}
$SE_{\beta_{21}}$ = standard error of estimate for β_{21}
n_1 = number of cases taking the first value of Z,
n_2 = number of cases taking the second value of Z

24 For extensive review about moderating regression analysis in management accounting see Hartmann & Moers (1999).

PLS estimates for path coefficients and standards errors in technical and administrative type development projects are presented in Appendices 8 and 9. Table 7 presents the t-statistics for the significance of the difference of the coefficients between sub-groups of technical and administrative development projects. PLS sub-group estimates of path coefficients and standards errors for project managers with high and low tolerance for ambiguity in administrative type development projects are presented in Appendices 10 and 11 and for technical type development projects in Appendices 12 and 13. Table 10 reports the multiple R squares for administrative and technical project type and Table 11 presents multiple R squares for low and high tolerance for ambiguity sub-groups in technical and administrative type development projects. Tables 8 and 9 presents the t-statistics for the significance of the difference of the coefficients between sub-groups of project managers with high and low tolerance for ambiguity in administrative and technical type development projects.

5.3. Hypothesis test

5.3.1. Hypothesis test for the technical and administrative type projects

The research model considering the sub-group analysis separately for technical and administrative development projects without, the moderating effects of project manager personality variable of tolerance for ambiguity, comprised seven hypotheses for each sub-groups (Figure 3). The signs and significance levels (t-statistics in parentheses, **, and * = statistically significant at 1%, and 5% levels, one-tailed) of the PLS estimates for administrative projects provide support for two of the seven hypotheses. In particular, the significant results were a negative relationship between task difficulty in project and interactive use of project control system (H3: -0.31), a negative relationship between task difficulty and diagnostic use of project MCS (H4: -0.32), and a positive relationship between innovativeness and project performance (H7: 0.40).

Administrative development projects (N=45) Technical development projects (N=69)

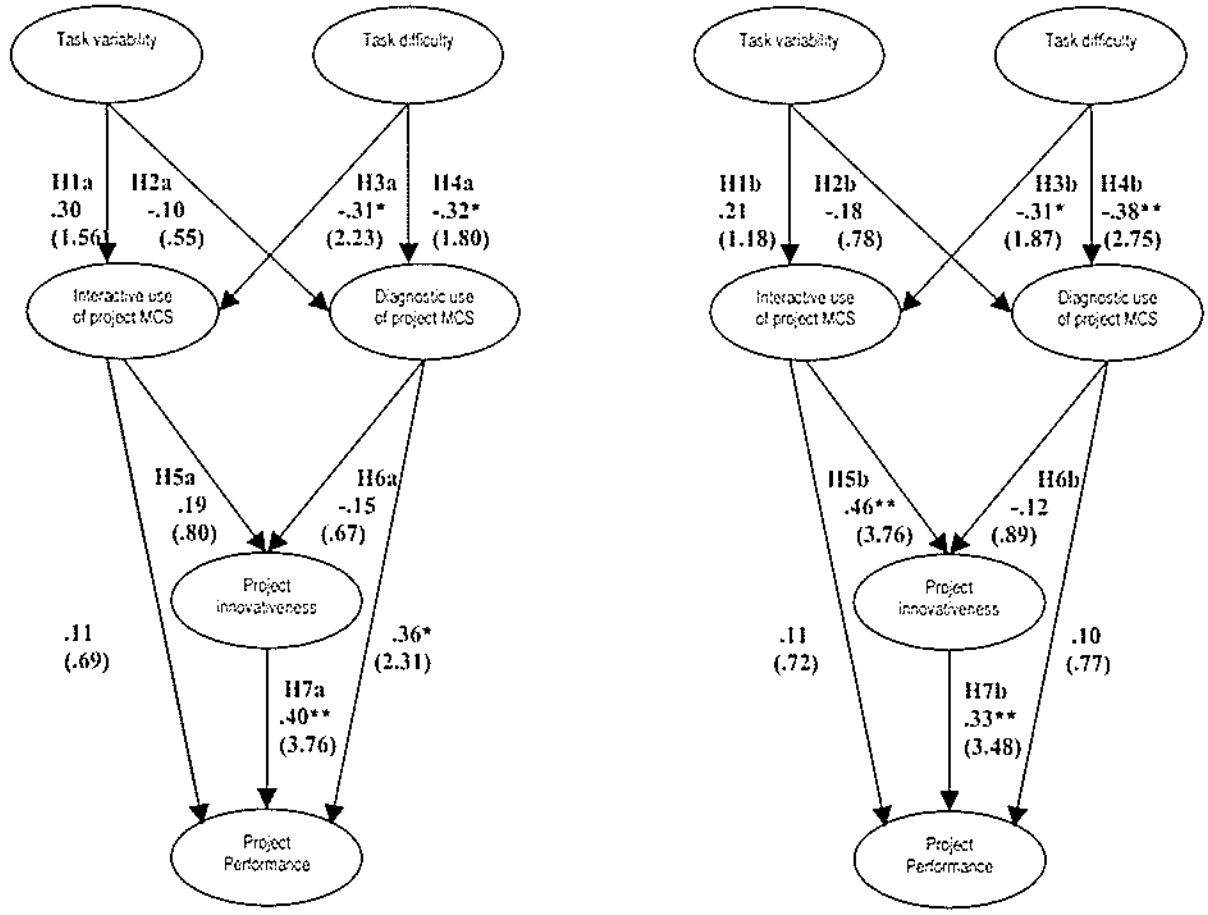

Figure 3. Path coefficients and t-statistics of research models for sub-group analysis of administrative and technical projects.

However, the PLS estimates for the positive relationship between task variability and interactive use of project control system (H1: 0.30), a negative relationship between task variability and diagnostic use of project control system (H2: -0.10), a positive relationship between interactive use of project control system and project innovativeness (H5: 0.19), and a negative relationship between diagnostic use of project control system and project innovativeness (H6: -0.15) were not significant (Figure 3). A negative and significant relationship between task difficulty and use of interactive type project control system (H3: -0.31) did not provide support for hypothesized relationship as the hypothesis suggested a positive relationship between task difficulty and interactive use of project control system.[25]

[25] The PLS estimates also indicated a significant positive relationship between diagnostic use of project MCS and project performance (0.36, $p < 0.05$). This relationship was not hypothesized.

The signs and significance levels of the PLS estimates for the sub-group of technical type development projects provide support for four of the seven hypotheses (Figure 3). In particular, the significant results were a negative relationship between task difficulty in project and diagnostic use project control system (H4: -0.38), a positive relationship between interactive use of project control system and project innovativeness (H5: 0.46), and a positive relationship between project innovativeness and project performance (H7: 0.33).[26]

However, the PLS estimates related to the proposed positive relationship between task variability and interactive use of project control system (H1: 0.21), and the negative relationship between task variability in project and diagnostic use of project control system (H2: -0.18), and the negative relationship between diagnostic use of project control system and project innovativeness (H6: -0.12) were not significant (Figure 3). A negative and significant relationship between task difficulty and interactive use of project control system (H3: -0.31) did not provide support for hypothesized relationship as this suggested a positive relationship between task difficulty and interactive use of formal project control system.

The results for the tests significance of the differences of the coefficients between technical and administrative type projects sub-groups provided evidence that five path coefficients for the seven hypothesized relationship were significantly different between technical and administrative type developments projects. This result supports the reseach choice to analyze administrative and technical development projects separately. Table 7 reports t-statistics for the significance of the difference of the coefficients between sub-groups of technical and administrative development projects. Results indicate significant differences in path coefficients between technical and administrative development projects in four of seven hypothesized relationships.

[26] **, and * = statistically significant at 1%, and 5% levels (one-tailed).

Table 7. T-statistics for the significance of the difference of the coefficients between sub-groups of technical and administrative development projects.

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.00	0.00	0.00	0.00	0.00	0.00
Variabil	0.00	0.00	0.00	0.00	0.00	0.00
Diagnost	-2.29	-1.65	0.00	0.00	0.00	0.00
Innovati	0.00	0.00	0.87	0.00	0.00	8.02
Performa	0.00	0.00	-12.98	-0.92	0.00	0.21
Interact	-0.17	-2.82	0.00	0.00	0.00	0.00

5.3.2. Hypothesis test for moderating effects of tolerance for ambiguity

The analysis of the moderating effect of the project manager personality variable of tolerance for ambiguity was undertaken separately in sub-groups of technical and administrative type development projects, comprised four hypotheses in both groups (Figures 4 and 5). Tables 8 and 9 report the test for significance of the differences of the coefficients between high and low tolerance for ambiguity sub-groups, which provides evidence that path coefficients are significantly different from each other. Three of the four hypothesized relationships between high and low tolerance for ambiguity sub-groups were significantly different in administrative type development projects (Table 8) and all four relationships in technical type development projects (Table 9). This provides support the proposed moderating effect of project manager tolerance for ambiguity to relationships between components of project uncertainty and different styles of use (interactive and diagnostic type) formal project control systems. Additionally, the research analysis shows that in administrative type development projects, besides these three proposed relationships, the difference between three other coefficients is significantly different. Specifically, these other significantly different relationships were between diagnostic use of project MCS and project performance, interactive use of project MCS and project performance and project innovativeness and project performance. In technical type development projects all relationships in research model were significantly different. Tables 8 and 9 present t-statistics for the significance of the difference of the coefficients between sub-groups of project managers with high and low tolerance for ambiguity in administrative and technical type development projects.

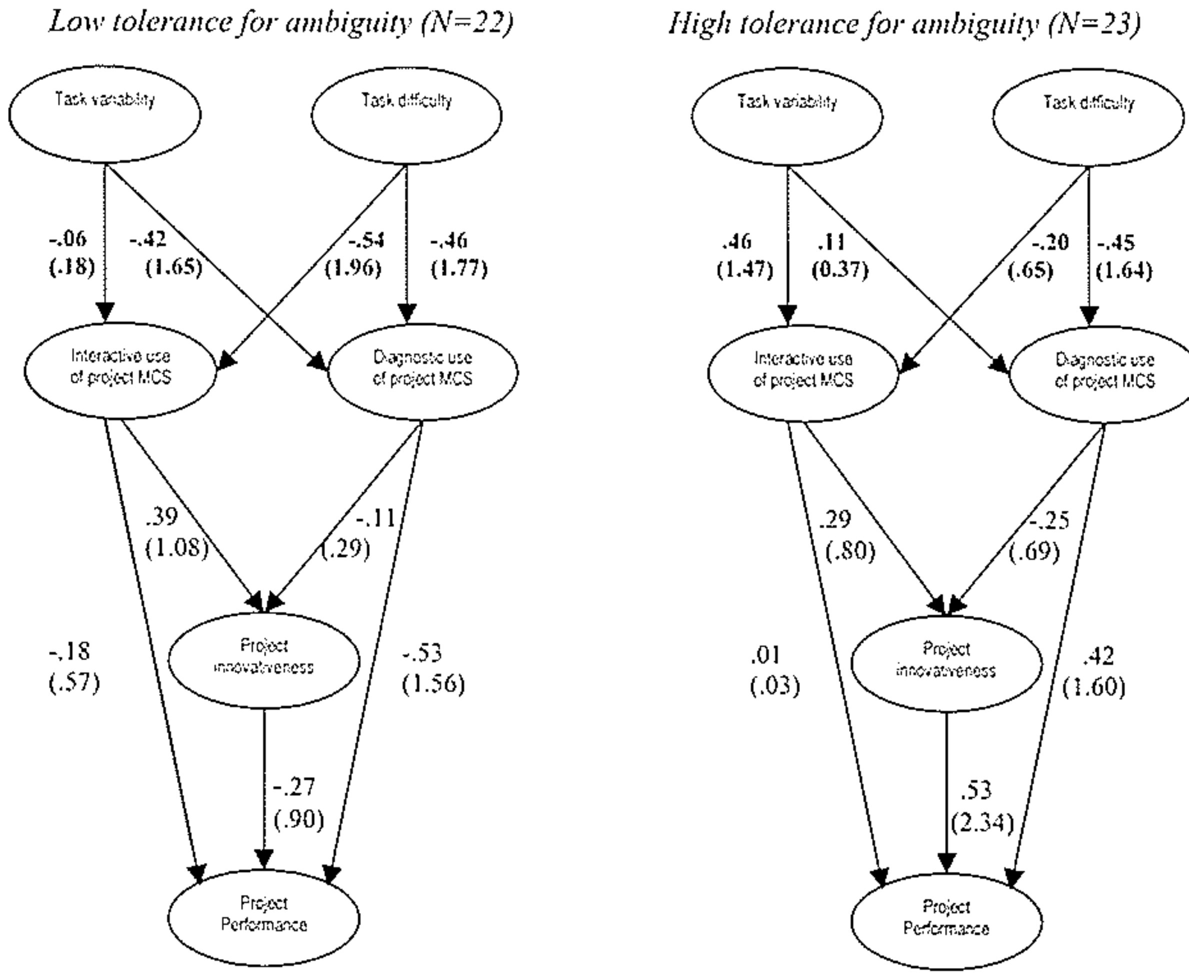

Figure 4. Path coefficients and t-statistics for sub-group analysis of project managers with low and high tolerance for ambiguity in administrative type development projects.

All of the hypothesized relationships were predicted to be monotonic. However, the signs of the PLS estimates provide support that in administrative type development project sub-group two of the three significantly different relationships actually are non-monotonic, the non-monotonic relationship are between task variability and interactive use of project MCS and between task variability and diagnostic use of project MCS. In particular non-monotonic significantly different relationships were in hypothesis H8, where it was hypothesized that in sub-group of project managers with high tolerance for ambiguity there is a significantly more positive relationship between task variability and interactive type project MCS than in sub-group of project managers with low tolerance for ambiguity (H8: low at sub-group -0.06; high at sub-group 0.46; t-statistic for difference 4.66). Similarly in the sub-sample of administrative type development projects the relationship between task variability and diagnostic use of project MCS

(H9) was also non-monotonic (H9: low at sub-group -0.42; high at sub-group 0.11; t-statistic for difference 6.93).

Table 8. T-statistics for the significance of the difference of the coefficients between sub-groups of project managers with high and low tolerance for ambiguity in administrative type development projects.

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.00	0.00	0.00	0.00	0.00	0.00
Variabil	0.00	0.00	0.00	0.00	0.00	0.00
Diagnost	0.21	6.93	0.00	0.00	0.00	0.00
Innovati	0.00	0.00	-1.02	0.00	0.00	-0.83
Performa	0.00	0.00	10.38	11.29	0.00	2.00
Interact	4.08	4.66	0.00	0.00	0.00	0.00

As mentioned earlier, in technical type development projects the analysis shows that all path coefficients in the research model are significantly different between high and low tolerance for ambiguity sub-groups. Table 9 present t-statistics for the significance of the difference of the coefficients between sub-groups of project managers with high and low tolerance for ambiguity in technical type development projects and Figure 5 path coefficients and their t-statistics (in parentheses) for low and high tolerance for ambiguity sub-groups in technical type development projects.

Table 9. T-statistics for the significance of the difference of the coefficients between sub-groups of project managers with high and low tolerance for ambiguity in technical type development projects.

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.00	0.00	0.00	0.00	0.00	0.00
Variabil	0.00	0.00	0.00	0.00	0.00	0.00
Diagnost	4.23	2.56	0.00	0.00	0.00	0.00
Innovati	0.00	0.00	4.20	0.00	0.00	15.73
Performa	0.00	0.00	-7.43	16.54	0.00	-2.45
Interact	2.70	8.93	0.00	0.00	0.00	0.00

As noted earlier, all of the hypothesized relationships were predicted to be monotonic. However, the signs of the PLS estimates provide support that also in technical type development project sub-group one of the four hypothesized and significantly different relationships actually is non-monotonic. The non-monotonic relationship is between task variability and interactive use of project MCS and between task variability (H8). In particular non-monotonic significantly different relationship (H8) predicted that in sub-group of project managers with high tolerance for ambiguity there is a significantly less negative relationship between task variability and diagnostic type project control than in sub-group of project managers with low tolerance for ambiguity (low at sub-group -0.44; high at sub-group 0.23; t-statistic for difference 8.93).

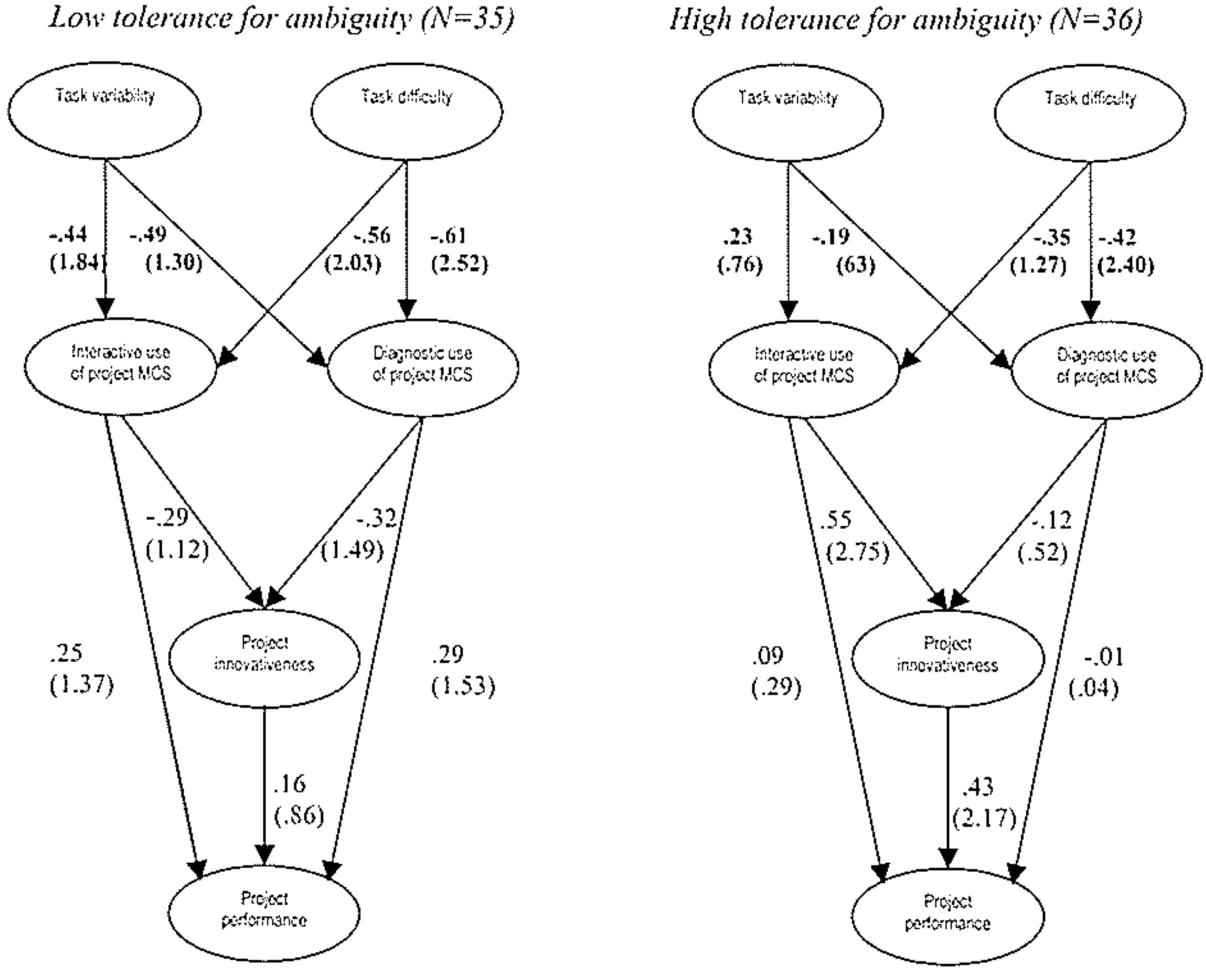

Figure 5. Path coefficients and t-statistics for sub-group analysis of project managers with low and high tolerance for ambiguity in technical type development projects.

It is inappropriate in PLS to use any goodness of fit measures, as used in covariance structure analysis modelling such as LISREL, because PLS makes no distributional assumptions (Chin 1998a). Rather, fit is evaluated by the overall incidence of significant relationships between constructs and the explained variance of the endogenous variables. To determine the best model the technique recommended by Jöreskog and Sörbom (1989) can be used where the values of the squared multiple correlations of the dependent variables for each model is summed. The best model is the one with greatest sum. Multiple R square values are reported in Tables 10 and 11. These summed values indicate that the research model explains more variance of the endogenous variables in sub-groups of project managers with low tolerance for ambiguity than in sub-groups of high tolerance for ambiguity. Similarly, Tables 10 and 11 show that the multiple R square value for project innovativeness is higher in technical type development projects than in administrative projects. However, more variance of project performance is explained in administrative projects than in technical projects.

Table 10. Multiple R squares for all development, technical type development projects, and administrative type development projects.

Block	All	Technical	Administrative
Variability	0.000	0.000	0.000
Difficulty	0.000	0.000	0.000
Interactive	0.089	0.101	0.128
Diagnostic	0.115	0.218	0.136
Innovativeness	0.107	0.178	0.038
Performance	0.227	0.226	0.313
SUM:	0.538	0.723	0.615

Table 11. Multiple R squares for low and high tolerance for ambiguity sub-groups in technical and administrative type development projects.

Block	Technical		Administrative	
	AT-low	AT-high	AT-low	AT-high
Variability	0.000	0.000	0.000	0.000
Difficulty	0.000	0.000	0.000	0.000
Interactive	0.338	0.134	0.317	0.199
Diagnostic	0.413	0.258	0.505	0.183
Innovativeness	0.277	0.277	0.140	0.096
Performance	0.323	0.215	0.486	0.391
SUM:	1.351	0.884	1.448	0.869

6. DISCUSSION

This research study aimed to improve understanding of how interactive and diagnostic use of formal project control systems can assist organizations to enhance their innovativeness in technical and administrative type development projects. This was approached by clarifying, that task variability (number of exceptions) and task difficulty (analyzability) are differing characteristics of project uncertainty and are modeled separately here. Additionally, project manager tolerance for ambiguity is seen an important personality variable, which affects how project management systems are used and their impact on project innovativeness and performance.

While accounting research has studied formal control mechanisms in other contexts[27], these mechanisms have received less attention in management accounting research from the point of view of research and development environments.[28] More importantly, the specific types and characteristics of formal controls and their influence on research and development project performance have been largely unexplored. The current study contributes by showing, empirically, how characteristics of use of formal project management control systems (interactive and diagnostic style) are associated with innovativeness in technical type of research and development project environments.

This study also clarifies the components of interactive and diagnostic type control systems, which has been identified an important area for further academic research but has received little attention in management accounting research. Results of this study clarify previous inconclusive results about effects of formal control system on innovation. Also these results could help managers to choose the most appropriate type of formal project control.

It should also be noticed that while many previous studies have provided important insights about the effects of control system components, many of them have limited their research to one control-system component, while fewer studies have focused on multiple control system components. Because management control systems usually have more than one component it is important to include multiple components in order

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[27] For extensive literature reviews see Shields & Shields (1998), Hartmann (2000) and Chenhall (2003a).

[28] See Rockness & Shields (1984), Abernethy & Brownell (1997), Nixon (1998), Davila (2000) and Hertenstein & Platt (2000) for exceptions.

to understand how and why they are used as a system and the system's effects (Shields, Deng & Kato 2000).

In summary, the purpose of this study was to test a research model, which predicts the effects of management control systems (diagnostic and interactive type project control) on important organisational outcomes (innovativeness) and to examine antecedents to those control system components (task variability and task difficulty). The model also shows how project type affects the usefulness of different styles of use of project control systems, and how project manager's tolerance for ambiguity affects the use of different types of project control mechanisms. Summaries of results are presented in Table 12 for administrative development projects and in Table 13 for technical type development projects.

6.1. Interactive and diagnostic use of project MCS and project innovativeness

As mentioned earlier in this study the NPD literature suggests that explicit objectives should be developed and communicated by management in the very earliest stages of a NPD project in order to provide a sense of direction and challenge to members of the development team (Cooper 1993; Imai, Nonaka & Takeuchi 1985). If formal controls are used in a diagnostic manner and seen mainly as a static process, organizational processes and/or outcomes are monitored and evaluated relative to a predetermined set of control standards that are assumed to remain constant over the course of the control period. This may be a reasonable assumption when the activities being controlled are well understood and the control period relatively short. However, development projects can run for years, and involve innovative activities whose nature and consequences are hard to predict. As a result, project control processes can be highly dynamic and interactive between management and the project team (Brown & Eisenhardt 1997; Imai, Nonaka & Takeuchi 1985; Simons 1994; Wheelwright & Clark 1992).

Table 12. Summary of findings in sub-group of administrative type development projects.

	Hypothesis Verbalization	Supported	Comments
H1	*There is a positive relationship between task variability and interactive use of project feedback and measurement system.*	Non-supported	
H2	*There is a negative relationship between task variability and diagnostic use of project feedback and measurement system.*	Non-supported	
H3	*There is a positive relationship between task difficulty and interactive use of project feedback and measurement system.*	Non-Supported	Significant negative relationship
H4	*There is a negative relationship between task difficulty and diagnostic use of project feedback and measurement system.*	Supported	
H5	*There is a positive relationship between interactive use of project feedback and measurement system and project innovativeness.*	Non-supported	
H6	*There is a negative relationship between diagnostic use of project feedback and measurement system and project innovativeness.*	Non-supported	Significant positive relationship between diagnostic style of use project MCS and project performance
H7	*There is a positive relationship between project innovativeness and project performance.*	Supported	
H8	*For project managers with high tolerance for ambiguity there is a significantly more positive relationship between task variability and interactive use of project feedback and measurement system than for project managers with low tolerance for ambiguity.*	Supported	It was predicted monotonic relationship but the results indicate that the relationship is actually non-monotonic (low at sub-group -0.06; high at sub-group 0.46; t-statistic for difference 4.66).
H9	*For project managers with high tolerance for ambiguity there is a significantly less negative relationship between task variability and diagnostic use of project feedback and measurement system than for project managers with low tolerance for ambiguity.*	Supported	It was predicted monotonic relationship but the results indicate that the relationship is actually non-monotonic (low at sub-group -0.42; high at sub-group 0.11; t-statistic for difference 6.93).
H10	*For project managers with high tolerance for ambiguity there is a significantly more positive relationship between task difficulty and interactive use of project feedback and measurement system than for project managers with low tolerance for ambiguity.*	Partly supported	Relationship between two sub-groups is significantly different but not as it was predicted. Results indicate that the relationship is monotonic but the signs of coefficients are different what predicted (low at sub-group -0.54; high at sub-group -0.20; t-statistic for difference 4.08).
H11	*For project managers with high tolerance for ambiguity there is a significantly less negative relationship between task difficulty and diagnostic use of project feedback and measurement system than for project managers with low tolerance for ambiguity.*	Non-supported	

Table 13. Summary of findings in sub-group of technical type development projects.

	Hypothesis Verbalization	Supported	Comments
H1	*There is a positive relationship between task variability and interactive use of project feedback and measurement system.*	Non-supported	
H2	*There is a negative relationship between task variability and diagnostic use of project feedback and measurement system.*	Non-supported	
H3	*There is a positive relationship between task difficulty and interactive use of project feedback and measurement system.*	Non-Supported	Significant negative relationship
H4	*There is a negative relationship between task difficulty and diagnostic use of project feedback and measurement system.*	Supported	
H5	*There is a positive relationship between interactive use of project feedback and measurement system and project innovativeness.*	Supported	
H6	*There is a negative relationship between diagnostic use of project feedback and measurement system and project innovativeness.*	Non-supported	
H7	*There is a positive relationship between project innovativeness and project performance.*	Supported	
H8	*For project managers with high tolerance for ambiguity there is a significantly more positive relationship between task variability and interactive use of project feedback and measurement system than for project managers with low tolerance for ambiguity.*	Supported	It was predicted monotonic relationship but the results indicate that the relationship is actually non-monotonic (low at sub-group -0.44; high at sub-group 0.23; t-statistic for difference 8.93).
H9	*For project managers with high tolerance for ambiguity there is a significantly less negative relationship between task variability and diagnostic use of project feedback and measurement system than for project managers with low tolerance for ambiguity.*	Supported	
H10	*For project managers with high tolerance for ambiguity there is a significantly more positive relationship between task difficulty and interactive use of project feedback and measurement system than for project managers with low tolerance for ambiguity.*	Partly supported	Relationship between two sub-groups is significantly different but not as it was predicted. Results indicate that the relationship is monotonic but the signs of coefficients are different what predicted (low at sub-group -0.56; high at sub-group -0.35; t-statistic for difference 2.70).
H11	*For project managers with high tolerance for ambiguity there is a significantly less negative relationship between task difficulty and diagnostic use of project feedback and measurement system than for project managers with low tolerance for ambiguity.*	Supported	

Based on previous findings it was suggested in this study that formal project MCS may present a negative or a positive effect on innovation at the project level, depending on the style of use of formal project MCS (Simons 1995; Chapman 1997, 1998; Chenhall 1995). It was argued that variety of interactive and diagnostic styles of use formal project MCS explains some of the inconsistencies of the previous studies. Simons' (1995) levers of control framework notes the tension between a need for achieving pre-set project performance targets and the need for innovativeness as the role of interactive use of feedback and measurement systems is on expanding opportunity seeking, learning and enhancing innovativeness. This suggestion of Simons was confirmed in the case of technical type development projects as results indicate a significant positive relationship between interactive use of project MCS and project innovativeness (H5). However, the results of this study did not find a significant negative relationship between diagnostic use of formal project MCS and project innovativeness (H6) in administrative or technical type development projects. These results do not support previous arguments based on Simons that formal diagnostic use of project MCS will have a negative effect on innovation. The important research finding of this study is that taking a more comprehensive view, which includes both interactive and diagnostic styles of use of formal project MCS interactive facilitates innovativeness in development projects.

Previous research has stated that success in development projects requires both innovation and efficiency. Thus, a significant challenge for managers is how to ensure efficiency by exercising adequate control over project teams, while at the same time encouraging flexibility, creative freedom and participative decision processes (Imai, Nonaka, and Takeuchi 1985; Jelinek & Schoonhoven 1990). However, only a few studies have investigated the effects of different project management styles on efficiency and innovation (Brown & Eisenhardt 1995; Jelinek & Schoonhoven 1990). Existing research in product development has stressed divergence between emergent and planned styles in project management (e.g. Lewis, Welsh, Dehler & Green 2002). Emergent styles use more informal and more organic controls, a fluid style of project management, which is seen as a means to foster creativity and improvisation (e.g., Doughtery 1992; Moorman & Miner 1998). Others prescribe a disciplined planning style as a way to focus and speed project efforts (e.g. Wheelwright & Clark 1992; Zirger & Maidique 1990). However, proponents of both emergent and planned styles also recognize the need for balance.

Emergent and planned styles share similar characteristics with organic vs. mechanistic control and diagnostic vs. interactive style of use of formal control systems, which are the central constructs of this study. Following Chenhall's (2003a) control system classification, an interactive use of formal controls was seen in this study as a more organic form of control and diagnostic use as more mechanistic. An emergent style is related more to the organic form and the interactive style of formal project control systems, whereas the planned style involves more mechanistic and diagnostic style of formal project management control systems. As such, emergent and planned styles reflect varied managerial assumptions and goals.

In this light, in emergent styles of project management project managers seek to facilitate team members' improvisation and experiential learning, helping innovation emerge from the bottom up. Hence, monitoring, evaluation, and control are loosely coupled activities (Lewis, Welsh, Dehler & Green 2002). In the current study, for the sub-sample of technical type development projects, a significant positive relationship between interactive style of use project control systems and innovativeness in project (H5b) supports previous arguments that more organic form controls foster a participative approach to project management and offer teams the freedom to challenge existing ideas and solve problems regarding product design and their own tasks (Burns & Stalker 1961; Morse & Lorsch 1970; Van de Ven 1986; McDonough & Barczak 1991).

In comparison, proponents of a planned style presume that product development is more predictable and rational, best managed as a top-down process. Successful senior executives and project managers provide discipline and structure, striving to direct team efforts and link project and organizational goals (Wheelwright & Clark 1992). From this perspective, monitoring, evaluation, and control activities appear tightly coupled, interwoven within a systematic cycle (Lewis, Welsh, Dehler & Green 2002). Project milestones help a team methodically track a project; formal reviews enable critical assessments that inform major decisions (for instance, continue/terminate project; resource allocation); and directive control allows managers to adjust project resources and objectives as necessary (Rosenau & Moran 1993).

A diagnostic style of use promotes monitoring explicit milestones. According to Jelinek and Schoonhoven (1990), milestones ideally convert a project strategy into analyzable technical, budgetary, and time-related objectives. Interim goals, schedules, and tests offer managers clear indications of a project's progress and a common frame of reference, but also serve as guides for team members (Eisenhardt & Tabrizi 1995; Wheelwright & Clark 1992). Such predetermined standards may aid team coordination and ensure that projects do not absorb unnecessary resources. Results from the current study provide support for these arguments. This study provides support for the abovementioned arguments in that they show a significant positive relationship between diagnostic use of project MCS and project performance in administrative type development projects.

A significant positive relationship between interactive type project MCS and innovativeness (H5) in technical type development projects but which was not found in administrative type development projects supports also some arguments of dual-core theory (Daft 1978), which classifies different type of innovations into technical and administrative type innovations. The dual-core theory also suggests that the appropriate organizational structure for innovation might be either mechanistic or organic depending upon the type of innovation to be adopted (Damanpour & Gopalakrishnan 1998). This distinction between administrative and technical innovations is suggested to be important because it relates to a more general distinction between social and technical systems of organization (Damanpour & Evan 1984). Technical innovations are related to products, services and production process technologies; that is, they are related to the primary work activity of organization and can be either product or process innovations (Daft 1978; Damanpour & Evan 1984). Administrative innovations involve organizational structure and administrative processes; that is, they are indirectly related to the primary work activity of organization and more directly related to its management (Daft 1978; Damanpour & Evan 1984; Kimberly & Evanisko 1981).

The dual-core theory posits that organizations have both a technical core and an administrative core (Damanpour 1992; Damanpour & Gopalakrishnan 1998). The technical core is primarily concerned with the transformation of raw materials into organizational products and services, while the administrative core's main responsibilities are the organizational structure, control systems and coordination mechanism (Daft 1978). Innovation can occur in each core, but technical and administrative innovations follow different processes. Technical innovations typically originate in the technical core and follow a bottom-up process, while administrative innovations typically originate in the administrative core and follow a top-down process (Daft 1978).

Additionally, the dual-core theory argues that an organic structure is needed when changes in organizational products, services and technology are necessary (Daft 1982). Thus, high professionalism, low centralization and low formalization facilitate the bottom-up process of technical innovation. In this study it was suggested that a more interactive style of use of formal project MCS may be needed to drive innovations. Results (H5) indicate that in sub-groups of technical projects there is a significant positive relationship between interactive use of project control systems and innovativeness but in a sub-group of administrative projects this relationships was not significant (see Figure 3). PLS estimates provided some support for the dual-core theory in that the positive effect of interactive use of formal project control systems on innovation is more important in technical projects than in administrative type projects.

However, the results did not support the arguments of the dual-core theory that more formal and diagnostic style of use of project MCS may be more appropriate to facilitate innovation in administrative projects. The dual-core theory suggests that the structures that facilitate innovation in each core are different and a mechanistic structure is needed when an organization must adapt to changes in goals, policies, strategies, structure, control systems and personnel (Daft 1982). Thus low employee professionalism, high centralization in decision-making and high formalization of behaviour facilitate the top-down process of administrative innovations. Results from the current did not provide evidence that a diagnostic style of use of formal project control is more useful to administrative than technical type project innovation (H6). The relationship between diagnostic use of formal project MCS and innovation (H6) was negative and insignificant in both types of development projects and tests for significant differences in path coefficients did not indicated significant differences in path coefficients (see Table 7).

However, results indicated that in administrative type development projects formal project MCS has an important role in achieving and keeping projects on track with project performance targets. Whereas in technical type development projects performance is achieved mainly through innovative accomplishments where interactive use of project MCS is an important mechanism directing and coordinating this innovativeness to successful innovations, which provides the basis for project performance.

Specifically, this study provides support for the abovementioned arguments in that they show a positive relationship between diagnostic use of project control systems and project performance in administrative type development projects. This suggests that diagnostic type project management controls enhances project efficiency, which it is claimed is the principle objective (Shenhar & Dvir 1996). The effects of interactive and diagnostic styles of project feedback and measurement system on project performance were not hypothesized. The theoretical arguments of Simons (1995) about different control system constructs within the levers of control do not make specific suggestions about the direct effects of diagnostic and interactive controls on performance. However, it seems that in administrative type of development projects diagnostic type project controls are more useful in driving project performance than in technical projects (path coefficients: administrative 0.36*; technical 0.10, t-statistic for significant difference –12.98). [29]

Similarly interactive styles of formal project control systems seem to be more useful in driving project innovativeness in technical type development projects than in administrative projects (path coefficients: administrative 0.19; technical 0.46**, t-statistic for significant difference 8.02). There are also significant positive relationships between innovation and project performance (H7) in both technical and administrative type development projects (path coefficients: administrative 0.40**; technical 0.33**). These results suggest that in technical projects performance may be enhanced more by innovation, and interactive type formal project control systems are used to boost innovativeness in those projects. In administrative projects it seems that formal controls are used differently as innovativeness did not have such an important role in achieving project performance targets. Rather formal project control appear to be used more diagnostic style for project performance related matters (e.g. project budgets, schedules, resources).

It seems that by using diagnostic type formal controls project managers seek to ensure that teams have sufficient support and remain targeted on project goals. These findings support arguments of Wheelwright and Clark (1992), that schedule- and budget-based milestones keep teams aware of their scarce resources. Likewise, formal reviews guide decision making regarding resource allocation. Formal controls may also function as directive control defining project boundaries, reducing the likelihood of wasteful explorations and costly errors (Chenhall & Morris 1995; McDonough & Barczak 1991).

[29] **, and * = statistically significant at 1%, and 5% levels (one-tailed).

This suggests that tight formal controls provide discipline that may motivate action and drive efficiency.

These results also support the previous findings of meta-analysis reported by Damanpour (1991) who concluded that preponderance of evidence pointed to a positive, not negative, correlation between formalization and innovation in manufacturing and for-profit organizations and for both product and process innovations. The commonly hypothesized negative relationship between innovation and formalization in Damanpour's study held only for studies of service and not-for-profit organizations and for innovations of higher scope. Formal procedures appear to facilitate innovation when they capture lessons of prior experience and when they help coordinate larger-scale projects (e.g. Craig 1995). Scientists and engineers might prefer less formalization ceteris paribus, but if the use of such procedures to formalize the more routine parts of their tasks enhances their effectiveness and their subjective self-efficacy (Bandura 1977), they could be expected to embrace formalization.

These abovementioned results also support previous arguments that while organic processes may encourage generating ideas they may not ensure that the ideas will be translated into effective innovations, which enhance performance. It is the potential for formal MCS to provide a discipline for resource planning and integration that assists in the translation of ideas into effective innovations. Also, it is not clear that the ideas generated from organic processes will be consistent with managerial intentions. Formal MCS ensure that management can maintain a focused view of organizational direction, capabilities and constraints (Chenhall & Morris 1995).

These different styles of use of project management system, interactive and diagnostic, also mirror tensions between freedom and structure. Project managers need to encourage commitment and creativity and to ensure timely and appropriate action (Benghozi 1990). Researchers suggest that "subtle control" is the blend of participative and directive control apparent in "heavyweight" teams, which provide members discretion and the support of a powerful leader (e.g. Wheelwright & Clark 1992). As Dougherty further explained, "It is desirable that people feel free to generate ideas, create possible solutions to problems, and experiment with various courses of action. It is also desirable that people feel responsible to work toward common goals" (1996: 430). Positive relationships between interactive type project control and innovativeness in technical type development projects (H5) and diagnostic type control systems and project performance in administrative type development projects support recent arguments of many authors who have proposed that formal MCS can be amalgamated and embedded within a variety of approaches to management planning and control (e.g. Chenhall 2003a; Chenhall & Morris 1995; Daft & Macintosh 1984; Merchant 1981; Simons 1995). Combination of diagnostic type formal MCS and more organic form interactive style of use can generate a creative tension that helps foster organizational effectiveness (Cameron 1986; Chenhall & Morris 1995).

6.2. Task uncertainty and interactive and diagnostic use of project MCS

Characteristics of project uncertainty - task variability and task difficulty - are important antecedents to the studied components of formal project control systems. In this research characteristics of project uncertainty were measured using two dimensions based on Perrow's (1967, 1970) organizational technology as the actions employed to transform input into outputs.

Perrow (1970) identified two dimensions of task uncertainty along which these transformation processes could be described. The first dimension is number of exceptions. This refers to task variety, which is the frequency of unexpected and novel events that occur in the conversion process. When the number of exceptions is high, participants typically cannot predict problems in advance and many tasks are unique. When few exceptions occur, tasks have little novelty and are repetitious. The second dimension of task uncertainty is analyzability. When the conversion process is analyzable, the work often can be reduced to mechanical steps, and participants can follow an objective, computational procedure to solve problems. When work is un-analyzable, there is no objective calculation or procedure to tell a person how to respond. Participants have to spend time thinking about how to solve problems, and they may actively search beyond readily available procedures.

While these two dimensions are quite faithfully reproduced in the conceptualization of task uncertainty by other researchers in the literature, the empirical counterparts of the two dimensions tend to be collapsed, in hypothesis testing, into a single construct, allegedly capturing both dimensions (e.g. Van de Ven et al., 1976; Gresov et al., 1989). Van de Ven & Delbecq (1974) clearly indicated that these two are independent dimensions, each with differing theoretical consequences. These previous arguments were realized by examining these two dimensions as independent constructs. In addition, the level of analysis was similar to Van de Ven and Delbecq and Abernethy and Brownell (1997) who conceptualized the two dimensions as operating at the work-unit level of analysis as opposed to the individual level.

Previous research has argued that with little task variety and a clear view of input-output relations in task execution, the organization can justify the development and use of more formal mechanistic types of controls. Perrow (1970) argued that organizations facing such tasks would be able to rely procedure guides, operating manuals, job codification and rigid lines of reporting and accountability for controlling employee behaviour. In this study a significant negative relationships was found in both technical and administrative development projects sub-samples between task difficulty and the diagnostic use of formal project control system (H4), and also a significant negative relationship between task difficulty and interactive use of formal project control system (H3) in administrative and technical type development projects. This supports Perrow's (1970) arguments that organizational structure and, in particular, reliance on a bureaucratic organizational form, will be dependent upon the degree of high task analysability (task difficulty) and low number of exceptions (task variability).

Where established techniques for handling tasks do not exists (low analysability), or where there exists substantial variety or novelty in the tasks encountered (high number of exceptions) Perrow expects that formal, bureaucratic controls will not be effective for controlling performance. Tasks cannot be programmed and thus behaviour cannot be controlled by implementing procedures which pre-specify desired actions or by monitoring individual actions through the use of supervisors. Perrow argues that professional or collegial structural arrangements are required in this setting. Drawing on these ideas this study also suggested a negative relationship between task variability and diagnostic type use of project MCS. However, results of this study show only insignificant negative relationship between task variability in project and diagnostic type formal project MCS (H2) in administrative and technical type development projects.

Results of this study provide some support previous studies, which show the link between high task uncertainty and more interactive style of use formal project control system. In this study only a slightly significant positive relationship between task variability (number of exceptions in task) and interactive type use of project MCS (H1) was found for administrative type development projects (.30, t-statistic 1.56). These findings are consistent with previous arguments that to achieve effective outcomes, tasks with high uncertainty must be executed differently from tasks with low uncertainty (Daft 1986; Galbraith 1977).

Previous research has stated that tasks with high numbers of exceptions requires more organic form of control system in order to be successful, whereas tasks with high analyzability require a more mechanistic form control system in order to be successful (Burns & Stalker 1961; Galbraith 1973; Tushman & Nadler 1978). As mentioned earlier results, of this study show a slightly significant positive relationship between task variability and interactive type use of project controls (H1). However, the hypothesized negative relationship between task variability and diagnostic type of project controls was insignificant. Also, contrary to expectations this study shows a negative relationships between task difficulty and interactive type use of formal project MCS (H2) in both administrative and technical type development projects, suggesting that formal project MCS is not being used intensively under high task difficulty (low analyzability).

6.3. Moderating effect of tolerance for ambiguity

Tolerance for ambiguity was considered in this research as a personality variable, which explains individual project managers differing needs to use interactive and diagnostic type project controls under different levels of analyzability and exceptions in technical type development project. It has been argued that personality traits have an important influence on the manner in which users process and use accounting information (e.g. Huysmans 1970; Dermer 1973; Faircloth & Ricchiute 1981; Gul 1984, 1986; Chenhall 1986, 2003; Tsui 1993). Gul (1984), for example, argues that an understanding of decision makers' personality traits 'may be able to guide the design of information systems toward more effective user decisions'.

Because individuals are different, they develop different cognitive strategies, which are an outcome of interactions between cognitive characteristics and the environment (Ho & Rodgers 1993). Previous research indicates that the personality of individuals affects their perceptions and responses to contextual uncertainty (Ashford & Cummings 1985; Bennet, Herold & Ashford 1990). Moderating effects of project manager personality, specifically tolerance for ambiguity, was considered as important to the research as it has been also suggested that personality has a moderating effect on the characteristics of information perceived to be useful in uncertain environments (Gul 1984, 1986; Ashford & Cummings 1985). More specifically, research evidence on tolerance for ambiguity suggests that individuals differ in how they respond to uncertain circumstances (Budner 1962; Ashford & Cummings 1985).

Tolerance for ambiguity expresses an individual's demand for information in uncertain environments (Budner 1962; MacDonald 1970) and seems, therefore, closely related to the conceptualization of uncertainty as a 'deficit in information' (Galbraith 1973, 1977). Tolerance for ambiguity measures the extent to which one feels threatened by ambiguity or ambiguous situations (Budner 1962; Dermer 1973). It is suggested that 'intolerants' would show less confidence and seek more information than 'tolerants' (Budner 1962; Norton 1975; McGhee, Shields & Birnberg 1978; Gul 1984, 1986; Pincus 1991; Tsui 1993). In previous research this construct has been shown to explain personal attitudes, behaviors and information preferences under uncertainty (e.g. Downey & Slocum 1975; Duncan 1972; Dermer 1973; Gupta & Govindarajan 1984; Gul 1986). Based on previous research evidence a potential relationship exists between tolerance for ambiguity and the desire for additional information (Budner 1962; Norton 1975; Asford & Cummings 1985; Bennet, Herold & Ashford 1990; Tsui 1993).

The analysis of the moderating effect of the project manager personality variable of tolerance for ambiguity was undertaken separately in sub-groups of technical and administrative type development projects, comprised four hypotheses in both groups (Figures 4 and 5). The test for significance of the differences of the coefficients between high and low tolerance for ambiguity sub-groups provides evidence that path coefficients are significantly different from each other. Three of the four hypothesized relationships between high and low tolerance for ambiguity sub-groups were significantly different in administrative type development projects and all four relationships in technical type development projects. The results provide support for the previous research evidence that tolerance for ambiguity has found to have a moderating effect on the characteristics of information perceived to be useful in uncertain environments (Gul 1984, 1986; Asford & Cummings 1985; Tsui 1993, Chong 1998; Lal & Hassel 1998).

The results of this study showed a significantly different non-monotonic relationship between task variability in project and interactive use of project control system (H8) in administrative and technical type development projects. However, in both groups of administrative and technical type development projects the sign of the coefficient is positive for sub-group of project managers with high tolerance for ambiguity and negative for project managers with low tolerance for ambiguity (see Figures 4 and 5 and Appendices 10, 11, 12 and 13.). This finding provides some support for the propositions that the extent to which individual project manager use interactive or diagnostic type formal project controls under highly uncertain conditions is function of their personality variable of tolerance for ambiguity. Individuals high on tolerance for ambiguity were argued to be more confident and the results indicated that in administrative and technical type development projects these project managers are using project MCS more interactively when facing high task variability (H8) when compared to project managers with low tolerance for ambiguity (see Tables 8 and 9).

In this situation it seems that tolerance for ambiguity is the ability to respond positively to ambiguous situations. This means that an individual high on tolerance for ambiguity can still be confident about decisions made in an ambiguous environment without attempting to seek more information (MacDonald 1970). This also provides support to the previous research evidence that personality has found to have a moderating effect on the characteristics of information perceived to be useful in uncertain environments (Gul 1984, 1986; Asford & Cummings 1985; Tsui 1993; Chong 1998; Lal & Hassel 1998).

Additionally, in sub-samples of administrative and technical development projects results show significantly different monotonic relationships between task difficulty and interactive use of project MCS (H10) where the path coefficient is less negative for the sub-group of project managers with high-tolerance for ambiguity. Similarly, relationship between task variability and diagnostic use of project MCS (H9) is significantly different (non-monotonic and less negative in the high tolerance for ambiguity sub-group) in administrative development projects and also significantly different (monotonic and less negative in the high tolerance for ambiguity sub-group) in technical development projects. These findings provide support for the arguments made in this study that project managers with low tolerance for ambiguity are less confident to use formal project control system under high project task uncertainty. The results provide also some support for the previous arguments that intolerants for ambiguity would show less confidence and seek more information than tolerants (Budner 1962;

Norton 1975; McGhee, Shields & Birnberg 1978; Gul 1984, 1986; Pincus 1991; Tsui 1993). However, in the sub-sample of administrative development projects, task difficulty has a negative effect on diagnostic use project MCS (H11) for project managers with high and low tolerance for ambiguity but the path coefficients are not significantly different from each other (see Table 8 and Figure 4).

Additionally, interesting research findings, which were not hypothesized, are that it seems that in administrative and technical type development projects the relationships between project innovativeness and project performance is significantly more positive in sub-group of project managers with high tolerance for ambiguity than low tolerance for ambiguity. This relationship was also significant and highly positive for the sub-group of project managers with high tolerance for ambiguity in both technical (high tolerance for ambiguity 0.43*, low tolerance for ambiguity 0.16, t-statistic for the difference 16.54) and administrative (high tolerance for ambiguity 0.53**, low tolerance for ambiguity –0.27, t-statistic for the difference 11.29) type development projects, but not for the sub-groups of project managers with low tolerance for ambiguity. Similarly, non-monotonic relationship between interactive use of project MCS and project innovativeness was significantly different and more positive for the project managers with high tolerance for ambiguity in technical type development projects (high tolerance for ambiguity 0.55**, low tolerance for ambiguity –0.29, t-statistic for the difference 15.73). Also in the sub-sample of administrative type development projects, significantly different non-monotonic relationship (t-statistic for the difference 10.38) were found between diagnostic use of project MCS and project performance. This relationship was significant and positive (0.42*) for the project managers with high tolerance for ambiguity and significant and negative (- 0.53*) for the project managers with low tolerance for ambiguity. Appendices 8, 9, 10 and 11 present detailed results. [30]

6.4. Limitations of study and implications for future research

Limitations of this research study should be considered when interpreting its results. Measurement of the research variables, while demonstrating satisfactory measurement reliability, could be improved. For example, project innovativeness and project performance could be measured by reference to objective measures (e.g. patent counts

[30] **, and * = statistically significant at 1%, and 5% levels (one-tailed).

and audited project budget, schedule and quality data) or, if subjective measurement is relied on, then multiple raters of project innovativeness and performance could be used (e.g. superior, peers). The question can be raised about the degree to which such subjective self-ratings of project innovativeness and performance correspond to objective performance measures and/or project managers superiors' ratings. However, previous research results have found a significant positive correlation between superiors' subjective rating and objective measures of subordinate performance. Similarly, several studies have reported positive correlations between superiors' and subordinates' subjective ratings of subordinate performance (see Shield, Deng & Kato 2000). Thus, while objective measures or superiors' ratings of project innovativeness and project performance would have been preferred, prior research has shown that subjective self-ratings of performance are highly correlated with them.

Additionally, the scales that were developed to measure diagnostic and interactive project MCS could have been more widely pre-tested to improve construct validity. Also, the sample is a potential limitation in terms of direct comparability to the samples used in related research. However, since tests of predictions that are based on those previous related studies yielded similar results, this should reduce concerns about generalizability or comparability. Also, reliance on non-experimental data to test causal relationships can be seen as a one limitation of the study.

This study provided additional information concerning relationship between task uncertainty, informal and formal MCS and project innovativeness and performance. Previous research evidence does not display strong results that the effects of uncertainty on MCS are well understood (Hartmann 2000). It has also been argued that a possible reason for unclear research findings is that contingency-based research has focused only on specific elements of accounting controls, generic information dimensions of MCS, with a limited number of studies examining broader elements of control, such as clan and informal controls, or integrative mechanisms (Chenhall 2003a).

The aim of this research was to study specific elements of different styles of use of formal project MCS. It should also be noticed that this study did not address all forms of formal controls. For example, cultural, social, and input controls are available to managers, but were not part of this study (Merchant 1998; Anthony & Govindarajan 1998). Merchant recognizes that there are many ways to affect tight formal control. Most firms use a combination of results controls (output oriented), action controls (process oriented), and personnel controls (input oriented), which may reinforce each other (Merchant 1998). All types of control can be more or less tight, and not all control alternatives are equally effective in every situation. The focus of this study was on project feedback and measurement systems. Future research could examine cultural and social controls, which can clearly influence an organization's development projects performance over the long-term performance. Also behavior (process oriented) and personnel (input oriented controls) are important part of project control and different characteristics of these constructs could also provide important research area for future studies.

Previous research evidence has also suggested that project management styles and controls are dynamic, evolving to meet fluctuating demands (e.g. Ancona & Caldwell 1992a, 1992b). Similarly, there may not be one absolute standard for evaluating creative work and, different evaluation standards may be needed for different types of work at different points in the development cycle (Brophy 1998). Early in the development cycle evaluation is more subjective and qualitative (Nixon 1998; Hauser & Zettelmeyer 1997). Perceived impact, conceptual elegance, and the potential for developing useful applications may be appropriate evaluation criteria, while later in development cycle measurement can be more quantitative and focus is on issues like product refinement, production design, and cost control (Nixon 1998; Werner & Souder 1997). In addition managers may alter their approaches to project management and use of different forms of control in response to new resource allocations, changes in market demand, progress by competitors on similar projects, or novel scientific discoveries (Van de Ven & Polley 1992).

Future studies should pay close attention to abovementioned issues when analyzing project management and control styles as they may fluctuate over time and project type. Studies using cross-sectional or retrospective data may provide only partial or even inaccurate views of relationships between project management and performance (McDonough & Barczak 1991). In contrast, longitudinal data might reveal whether--or how--managers adjust their actions to contextual changes (Pennings 1992; Lewis, Welsh, Dehler & Green 2002).

Interactive type project control may be more crucial when a team is entering the unknown (Barrett 1998) and at the beginning of a project, when teams seek to cultivate new ideas (Van de Ven & Polley 1992) Then, as the product development process moves toward transforming ideas into an implemented reality, emphasis on experiential learning declines. Efforts to foster improvisation may wane as a project shifts from idea generation to manufacturing and eventual product launch (Lewis, Welsh, Dehler & Green 2002).

The role of formal project MCS is likely to be more stable, but its role may change over time. Diagnostic style of formal MCS may help project in reducing uncertainty in the early stages of project, then pushing a project to completion by serving to clarify project details. Interactive style of use formal MCS is vital, because the earlier a product is conceptualized, the faster its development (Clark & Fujimoto 1991). Over time, these managerial activities evolve into reliable routines, such as the use of systematic project milestones and formal reviews. Coupled with directive control, these activities provide a consistent course of action for project teams (Lewis, Welsh, Dehler & Green 2002).

Some studies have also suggested that project uncertainty moderates project management-performance relationships (e.g. Eisenhardt & Tabrizi 1995; Moorman & Miner 1998; Shenhar & Dvir 1996). Similarly examining the moderating effect of project novelty by distinguishing radical vs. incremental innovations may extend this work and offer further insights into the dynamics of project management and effects of different forms and styles of control on innovation and performance.

As mentioned earlier the dual-core theory proposes that the appropriate organizational structure for innovation might be either mechanistic or organic depending upon the type of innovation to be adopted (Damanpour & Gopalakrishnan 1998). Similarly like the dual-core theory, the theory of innovation radicalness refines innovation by dividing it to two groups. Radical innovations produce fundamental changes in the activities of organization and represent clear departure from existing practises, whereas incremental innovations result lesser departure (Dewar & Dutton 1986; Ettlie, Bridges & O'Keefe 1984). Empirical research that distinguishes between predictors of radical and incremental innovations is scarce and a dominant theory has not yet emerged (Damanpour & Gopalakrishnan 1998).

Hage (1980) suggested that innovative organizations with organic structures would innovate incrementally because they have more democratic values and power is shared, whereas organizations with more mechanistic structure may be a fertile ground for radical innovations (Nord & Tucker 1987). Similarly Ettlie et al. (1984) found that radical innovations are more likely to occur in organizations with centralized and informal structures, while incremental innovations are more likely in those with complex and decentralized structures. It has also been suggested that radical innovations are facilitated more than incremental innovations by organizational complexity, while incremental innovations are hindered less than radical innovations by bureaucratic control (Gopalakrishnan & Damanpour 1997; Damanpour & Gopalakrishnan 1998).

7. CONCLUSIONS

The purpose of this study has been to examine the role of project management control systems (MCS) in development project environment where innovativeness is important for organizational success. While previous research has shown that enhancing the creative performance of employees is a necessary step if organizations are to achieve competitive advantage and that creativity and innovation can be fostered by allowing a considerable degree of freedom or autonomy in the conduct of individuals work. However, previous research has also suggested that several aspects of project supervision are important, starting with an ability to clearly set overall project goals while allowing procedural autonomy to have choice in how to go about accomplishing the tasks that they are given. In addition, project supervision is likely to foster creativity when it is characterized by clear planning and feedback, good communications between the supervisor and the work group, and enthusiastic support for the work of individuals as well as the entire group.

However, while some degree of freedom and flexibility seems to be an essential condition to the relative success of cross-functional development project teams, it may also be essential to combine this with more formal types of control mechanisms. These teams must also consider that those choices and actions, which they make during the project, fit to changing customer needs and desires and that they fit with the firm's strategies, competencies and resources, and that projects are on schedule and budget. At an individual project level, traditional formal controls may play a role in management's attempts to keep project teams on an appropriate strategic track and to avoid unwelcome surprises. But too much, or the wrong type of formal control, may decrease the team's creativity, impede their progress, and injure their ultimate performance. Therefore, an important and interesting research question, which has been the main issue of this study, is how do different styles of use of formal project control system impact on project teams' innovativeness.

The main focus of this study has been on formal project management control systems and draws on Simon's (1995) definition of management control systems as the formal, information-based routines and procedures managers use to maintain or alter patterns in organizational activities (Simons 1995: 5). Simons' management control framework is particularly important from the point of view of this study as it relates also to project management systems and more importantly because it distinguishes different styles of use of those control mechanisms. Simons suggests that in order to characterize management control systems in organizations it is necessary not only to identify design features of MCS, but also to examine how management attention is distributed among the various formal control subsystems and what are the patterns or styles of use of MCS by management (Simons 1990, 1994, 1995). Simons identified two different styles of use of formal feedback and measurement control systems: a diagnostic style and an interactive style. These two styles of use, diagnostic and interactive type project feedback and measurement systems, were the central research variables of this study as it suggested that different styles of use have an important role in development project management.

According to Simons' broad description, project control can be defined in this study as interactive when project managers actively use planning and control systems to monitor and intervene in ongoing decision activities of their project team. Diagnostic controls, on the other hand, are defined in this study as formal project control mechanism, which are the subject of project management attention only when important project performance targets are missed (Simons 1995: 161–162). Indicating that, with respect to project control, interactive and diagnostic control types differ in terms of the frequency of project management attention to project performance. That is, project control is interactive when project managers routinely discuss with project team members about project performance and diagnostic when managers only focus on unfavorable performance variances. Hence, diagnostic and interactive use of controls is characterized by frequency of information exchanges, analyses, debates of project plans, and the extent of involvement by project management in the day-to-day activities of project sub-ordinates.

While accounting research has studied formal control mechanisms in other contexts, these mechanisms have received less attention in management accounting research from the point of view of research and development environments. More importantly, the specific types and characteristics of formal controls and their influence on research and development project performance have been largely unexplored. So far, management accounting literature has devoted scant attention the role of management accounting in highly uncertain task environments like new product and service development. Most previous studies have looked at the relevance of management control systems to the broader process of R&D. These studies mainly characterize management control systems as hindering or, at most, being irrelevant in research and development settings.

Similarly, much of the accepted theory and empirical evidence reported in the organizational control literature suggests that heavy reliance on formal process controls is inappropriate and likely counterproductive under such circumstances.

On other hand, the study of effective development processes has received much attention in the product development literature. The primary conclusion of much of this empirical work is that new product or service success is at least, in part, a function of good process management. Similarly, formal control systems can prevent entities that are continually seeking innovations from squandering resources on superfluous novelty. Formal MCS can ensure that ideas are tested for the ways in which they fit within overall plans, resource constraints and capabilities of the organization. Many authors who assert that formal MCS are inconsistent with innovation, claim that organic processes are necessary to ensure that individuals are motivated to participate in creative decision making and the free flow of ideas that are essential for developing entrepreneurial strategies. However, while organic processes may encourage generating ideas, they may not ensure that the ideas will be translated into effective innovations, which enhance performance. It is the potential for formal MCS to provide a discipline for resource planning and integration that assists in the translation of ideas into effective innovations. Also, it is not clear that the ideas generated from organic processes will be consistent with managerial intentions. Formal MCS ensure that management can maintain a focused view of organizational direction, capabilities and constraints.

The existing research in NPD and management control literatures is consistent in their predictions about the likely effects of formal output control on research and development project results. The positive effects of clearly specified goals have been widely discussed under goal-setting theory. Specific, difficult goals consistently lead to better performance than specific easy goals, general goals such as "do your best," or no goals. In addition, goal-setting is most effective when there is feedback-showing progress toward the goal (Latham & Locke 1991; Locke 1996). Similarly, the product development literature is particularly insistent about the beneficial informational and motivational effects of clearly specifying a strategic direction and clear performance goals at the earliest stage of a NPD project. However, if formal process controls become too detailed and attempt to dictate how specific activities should be carried out, the autonomy necessary for team creativity and innovation may be stifled, and, consequently, the capabilities of the product and the overall performance of the team can suffer. In addition, the over specification of procedures may hinder the team's ability to make needed adjustments early in the project leading to delays and cost overruns later in the project.

Based on previous findings it has been suggested in this study that formal project MCS may present a negative or a positive effect on innovation at the project level depending on style of use of formal project MCS. It was argued that variety in the use of interactive and diagnostic styles of formal project MCS explains some of the inconsistencies of the previous studies. Simons' (1995) levers of control framework notes the tension between the need for achieving pre-set project performance targets and the need for innovativeness. Interactive use of feedback and measurement systems has an important role on expanding opportunity seeking, learning and enhancing innovativeness. This suggestion of Simons was confirmed in technical type development projects, as results indicate a significant positive relationship between interactive style of use project MCS and innovativeness in project. However, results of this study did not find a significant negative relationship between diagnostic use of formal project MCS and innovativeness in administrative or technical type development projects. This is inconsistent with previous arguments of Simons who argued that a negative effect of formal MCS on innovation is caused by the narrow focus of a diagnostic use of formal MCS

These findings supported, also, some arguments from the dual-core theory, which claims that an organic structure is needed when changes in organizational products, services and technology are necessary and thus, high professionalism, low centralization and low formalization facilitate the bottom-up process of technical innovation. Results of this study indicated that there is significant positive effect of interactive use of formal project MCS on innovation in technical type development projects but not in administrative type projects.

However, the results did not support the arguments of the dual-core theory that more formal and diagnostic use of project MCS may be more appropriate to drive innovativeness in administrative type development projects. The dual-core theory suggests that the structures that facilitate innovation in each core are different and a mechanistic structure is needed when an organization must adapt to changes in goals, policies, strategies, structure, control systems and personnel (Daft, 1982). Thus low employee professionalism, high centralization in decision-making and high formalization of behaviour facilitate the top-down process of administrative innovations. Results of PLS analysis did not provide evidence that diagnostic use of formal project MCS is more useful in administrative than in technical type project innovation. The relationship between diagnostic use of formal project MCS and innovation was negative and insignificant in both types of development projects. Tests for significant differences in path coefficients did not indicate significant differences in path coefficients.

However, the results indicated that in administrative type development projects diagnostic use of formal project MCS has an important role in achieving and keeping projects on track with project performance targets. It seems that in administrative type of development projects diagnostic type project controls are more useful in driving project performance than in technical projects. Whereas in technical type development projects performance is achieved mainly through innovative accomplishments where interactive use of project MCS is an important mechanism directing and coordinating this innovativeness to successful innovations, which functions as the base for project performance.

These results suggest that in technical projects performance is enhanced more by innovation and the interactive use of formal project MCS is used to boost innovativeness in projects. In administrative projects it seems that formal controls are used differently as innovativeness does not have such an important role in achieving project performance targets, but also formal MCS are used more for project performance related matters (e.g. project budget, schedule, resources). It seems that by using diagnostic type formal project MCS project managers seek to ensure that teams have sufficient support and remain targeted on project goals. In administrative type development projects diagnostic use of formal project controls may also function as directive controls, defining project boundaries, reducing the likelihood of wasteful explorations and costly errors. This suggests that diagnostic use of formal project controls provide discipline that may motivate action and drive efficiency.

The findings of this study are consistent with previous arguments that to achieve effective outcomes, tasks with high uncertainty must be executed differently from tasks with low uncertainty. Previous research has stated that tasks with high number of exceptions require more organic forms of control systems in order to be successful, whereas tasks with high analyzability require more mechanistic forms of control systems in order to be successful. This study found a slightly significant positive relationship between task variability and interactive use of project MCS in administrative type development projects. Also, this study found a significant negative relationship between task difficulty and diagnostic use of project MCS in both administrative and technical type development projects. The hypothesized negative relationship between task variability and diagnostic type project controls was not found. Also, the study did not support the hypothesized positive relationships between task difficulty and interactive use of project MCS, rather a significant negative relationship was identified in both administrative and technical types of development projects. This suggests that formal project MCS can not be used intensively under high task difficulty (low analyzability).

The results also provide support for previous research evidence that personality has a moderating effect on the characteristics of information perceived to be useful in uncertain environments. Specifically, this study found a significantly different non-monotonic relationship, for sub-groups of project managers with high and low tolerance for ambiguity, between task variability in project and interactive use of project control systems in both administrative and technical type development projects. This result provides some support for the proposition that the extent to which individual project manager use interactive or diagnostic type formal project controls under highly uncertain conditions is a function of their personality variable of tolerance for ambiguity. Individuals high on tolerance for ambiguity were seen as more confident and hence used project MCS more interactively when facing high task variability in managing administrative and technical type development projects.

Also, this study found a significantly different monotonic less negative relationship between task difficulty and interactive use of project MCS in the sub-group of project managers with high-tolerance for ambiguity than in the sub-group of managers with low tolerance for ambiguity in the both sub-samples of administrative and technical type development projects. Similarly, this study found a significantly different less negative relationship between project task variability and use of diagnostic project MCS for project managers with high tolerance for ambiguity than for project managers with low tolerance for ambiguity in both administrative and technical type development projects. These results also support the argument that project managers with low tolerance for ambiguity are less confident in using formal project MCS under highly uncertain situation. Additionally, in the sub-sample of administrative type development projects task difficulty has a negative effect on diagnostic use of project MCS for project managers with high and low tolerance for ambiguity and the path coefficients are not significantly different from each other. However, this relationship was significantly different between high and low tolerance for ambiguity sub-groups in technical type development projects.

In summary, these results suggest that while innovation requires a high degree of flexibility in the structural and communication processes, formal project MCS also has an important role in project management. Project type, also, affects how different control strategies to manage development projects are best achieved when facing uncertain conditions. Additionally, the project manager's personality characteristic of tolerance for ambiguity seems to play an important role in determining the use of interactive and diagnostic type project controls under task uncertainty.

REFERENCES

Abernethy, M.A. & P. Brownell (1997). Management control systems in research and development organizations: the role of accounting, behavior and personnel controls. *Accounting, Organizations and Society* 22, 223–248.

Amabile, T. M. (1983). *The Social Psychology of Creativity*. New York: Springer-Verlag.

Amabile, T. M. (1988). A model of creativity and innovation in organizations. In B. M. Staw & L. L. Cummings (eds), *Research in Organizational Behaviour* 10, 123–167. Greenwich, CT: JAI Press.

Amabile, T. M., R. Conti, H. Coon, J. Lazenby & M. Herron (1996). Assessing the work environment for creativity. *Academy of Management Journal* 39, 1154–1184.

Amabile, T.M. (1997) Motivating creativity in organizations: on doing what you love and loving what you do. *California Management Review* 40, 39–58.

Amabile, T. M. (1998). How to kill creativity. *Harvard Business Review* 76, 77–87.

Ancona, D. & D. Caldwell (1992a). Demography and design: Predictors of new product team performance. *Organization Science* 3, 321–341.

Ancona, D. & D. Caldwell (1992b). Bridging the boundary: External activity and performance in organizational teams. *Administrative Science Quarterly* 37, 634–665.

Anderson, S. & Schwartz, A. (1992). Intolerance of ambiguity and depression. *Social Cognition* 10, 271–298.

Andrews, K.R. (1980). *The Concept of Corporate Strategy*. Irwin, Homewood, Ill.

Angle, H. 1989. Psychology and organizational innovation. In A. Van de Ven, H. Angle & M. Poole (eds), *Research on the Management of Innovation*: The Minnesota studies: 135 – 170. New York: Harper & Row.

Anthony, R. N. & V. Govindarajan (1998). *Management Control Systems*, 9th edition, Irwin-McGraw- Hill.

Arnold, H. J. (1982). Moderator variables: A clarification of conceptual, analytic, and psychometric issues. *Organizational Behavior and Human Performance* 29, 143–174.

Arnold, H. J. (1984). Testing moderator variables hypotheses: A reply to Stone and Hollenbeck. *Organizational Behavior and Human Performance* 34, 214–224.

Atkinson, A. (1978). Standard setting in agency. *Management Science* 24, 1351–1361.

Ashford, S. J. & L. L. Cummings (1985). Proactive feedback seeking: The instrumental use of information environment. *Journal of Occupational Psychology* 58, 67–79.

Bailyn, L. 1985. Autonomy in the industrial R & D laboratory. *Human Resource Management* 24, 129–146.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioural change. *Psychology Review* 54, 191–215.

Barrett, F. J. (1998). Creativity and improvisation in jazz and organizations: Implications for organizational learning. *Organization Science* 9, 605–622.

Bartlett, C. A. & S. Ghoshal (1989). *Managing Across Borders: The Transnational Solution*. Boston: Harvard Business School Press.

Benghozi, P. (1990). Managing innovation: From ad hoc to routine in French Telecom. *Organization Studies* 11, 531–554.

Bennett, N., D. M. Herold & S. J. Ashford (1990). The effects of tolerance for ambiguity and feedback seeking behaviour. *Journal of Occupational Psychology* 63, 343–348.

Birnberg, J. G. (1988). Discussion of an empirical analysis of the expenditure budget in research and development. *Contemporary Accounting Research* 4, 582 –587.

Bonner, J. M., R. W. Ruekert & O. C. Walker (2002). Upper management control of new product development projects and project performance. *The Journal of Product Innovation Management* 19, 233–245.

Booz, Allen & Hamilton, Inc. (1982). *New Product Management for the 1980's*. New York: Booz, Allen and Hamilton, Inc.

Brophy, D. R. (1998). Understanding, measuring, and enhancing individual creative problem solving efforts. *Creativity Research Journal* 11, 123–150.

Brown, S. L. & K. M. Eisenhardt (1995). Product development: past research, present findings, and future directions. *Academy of Management Review* 20, 343–378.

Brown, S. L. & K. M. Eisenhardt (1997). The art of continuous change: linking complexity theory and time-based evolution relentlessly shifting organizations. *Administrative Science Quarterly* 42, 1–34.

Brownell, P. (1981). Participation in budgeting, locus of control and organizational performance. *The Accounting Review* October, 844–860.

Brownell, P. (1985). Budgetary systems and the control of functionally differentiated organizational activities. *Journal of Accounting Research* 23, 502–512.

Brownell, P. (1987). The role of accounting information, environment and management control in multi-national organisations. *Accounting and Finance* 27, 1–16.

Brownell, P. & M. K. Hirst (1986). Reliance on accounting information, budgetary participation, and task uncertainty: Tests of a three-way interaction. *Journal of Accounting Research* 24, 241–249.

Brownell, P. & K. Merchant (1990). The budgetary and performance influences of product standardisation and manufacturing process automation. *Journal of Accounting Research* 28, 388–397.

Brownell, P. & A. S. Dunk (1991). Task uncertainty and its interaction with budgetary participation and budget emphasis: Some methodological issues and empirical investigation. *Accounting, Organizations and Society* 16, 693–703.

Bruns, W. J. & J. H. Waterhouse (1975). Budgeting control and organizational structure. *Journal of Accounting Research* 13, 177–203.

Budner, S. (1962). Intolerance of ambiguity as a personality variable. *Journal of Personality* 30, 29–59.

Burns, T. & G. M. Stalker (1961). *The Management of Innovation*. London: Tavistock Publishers.

Cameron, K. S. (1986). Effectiveness paradox: Consensus and conflict in conceptions of organizational effectiveness. *Management Science* 32, 539–553.

Carmines, E. G. & Zeller, R. A. (1979). Reliability and validity assessment. *Sage University Paper Series on Quantitative Applications in the Social Sciences*, No. 07–017, Beverly Hills, CA: Sage.

Chandler, A. D. (1962) *Strategy and Structure – Chapters in the History of American Industrial Enterprise*. Cambridge: MIT Press.

Chapman, C. S. (1997). Reflections on a contingent view of accounting. *Accounting, Organizations and Society* 22, 189–205.

Chapman, C. S. (1998). Accountants in organizational networks. *Accounting, Organizations and Society*. 23, 737–766.

Chenhall, R. H. (1986). Authoritarianism and participative budgeting: A dyadic analysis. *The Accounting Review* 61, 263–272.

Chenhall, R. H. (2003a). Management control systems design within its organizational context: Findings from contingency-based research and directions for the future. *Accounting, Organizations and Society* 28, 127–168.

Chenhall, R. H. (2003b). Integrative strategic performance measurement systems: strategy, strategic alignment of manufacturing, learning and organizational performance. Working paper. Fortcoming.

Chenhall, R. H. & P. Brownell (1988). The effect of participation on job satisfaction and performance: role of ambiguity as an intervening variables. *Accounting, Organizations and Society* 13, 225–233.

Chenhall, R. H. & K. Langfield-Smith (1998). The relationship between strategic priorities, management techniques and management accounting: an empirical investigation using a systems approach. *Accounting, Organizations and Society* 23, 243–264.

Chenhall, R. H. & D. Morris (1986). The impact of structure, environment, and interdependence on the perceived usefulness of management accounting systems. *The Accounting Review* 61, 58–75.

Chenhall, R. H. & D. Morris (1991). The effect of cognitive style and sponsorship bias on the treatment of opportunity costs in resource allocation decisions. *Accounting, Organizations and Society* 16, 27–46.

Chenhall, R. H. & D. Morris (1995). Organic decision and communication processes and management accounting systems in entrepreneurial and conservative business organizations. *Omega, International Journal of Management Science* 23, 485–497.

Chin, W. W. (1998a). The partial least squares approach for structural equation modelling. In G. A. Marcoulides (ed.), *Modern Methods for Business Research*, 295–336. Mahwah, NJ: Lawrence Erlbaum.

Chin, W. W. (1998b). Issues and opinion on structural equation modelling. *MIS Quarterly* 22, VII (10 pages)

Chin, W. W. & P. Newsted (1999). Structural equation modelling analysis with small samples using partial least squares. In R.H. Hoyle (ed.), *Statistical Strategies for Small Sample Research* 307–341. Thousand Oaks: Sage publications.

Christensen, J. (1982). The determination of performance standards and participation. *Journal of Accounting Research* 20, 589–603.

Chong, V. K. (1996). Management accounting systems, task uncertainty and managerial performance: a research note. *Accounting, Organizations and Society* 22 415–421.

Chong, V. K. (1998) Testing the contingency 'fit' between management accounting systems and managerial performance: a research note on the moderating role of tolerance for ambiguity. *British Accounting Review* 30, 331–342.

Chow, C. W., Y. Kato & K. A. Merchant (1996). The use of organizational controls and their effects on data manipulation and management myopia: A Japan v. U.S. comparison. *Accounting, Organizations and Society* 21, 175–192.

Clark, K. B. & T. Fujimoto (1991). *Product Development Performance.* Boston, MA: Harvard Business School Press.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Hillsdale, NJ: Lawrence Elrbaum Associates.

Cohen, J. & P. Cohen (1983). *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences.* Hillsdale: Erlbaum.

Cohen, W. M. & D. A. Levinthal (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* 35, 128–152.

Cooper, R. G. (1993). *Winning at New Products: Accelerating the Process from Idea to Launch.* Reading, MA: Perseus Books.

Cooper, R. G. (1998a). Benchmarking new product performance: results of the best practices study. *European Management Journal* 16, 1–17.

Cooper, R. G. (1998b). *Product Leadership: Creating and Launching Superior New Products*. Reading, MA: Perseus Books.

Cooper, R. G. (1999). From experience: The invisible success factors in product innovation. *Journal of Product Innovation Management* 16, 115–133.

Cooper, R. G. (2000). Product innovation and technology strategy. *Research Technology Management* Jan.-Feb, 38–40.

Cooper, R. G. & E. J. Kleinschmidt (1995). Benchmarking firms' new product performance and practices. *Engineering Management Review* 23, 112–120.

Cooper, R. G. & Kleinschmidt, E. J. (1996) Winning businesses in product development: critical success factors. *Research Technology Management* 39, 18–29.

Craig, T. (1995). Achieving innovation through bureaucracy: Lessons from the Japanese brewing industry. *California Management Review* 38, 8–36.

Cummings, L. L. (1965). Organizational climates for creativity. *Academy of Management Journal* 3, 220–227.

Cyert, R. M. & J. G. March (1963). *A Behavioural Theory of the Firm*. Englewood Cliffs, N.J: Prentice-Hall.

Daft, R. L. (1978). A dual-core model of organizational innovation. *Academy of Management Journal* 21, 193–210.

Daft, R. L. (1982). Bureaucratic versus nonbureaucratic structure and the process of innovation and change. In S.B. Bacharach (ed.). *Research in the Sociology of Organizations* 1, 129–166. Greenwich, CT: JAI Press.

Daft, R. L. (1986). *Organization Theory and Design*. St. Paul: West Publishing.

Daft, R. L. & N. B. Macintosh (1981). A tentative exploration into the amount and equivocality of information processing in organisational work units. *Administrative Science Quarterly* 26, 207–224.

Daft, R. L. & N. B. Macintosh (1984). The nature and use of formal control systems for management control and strategy implementation. *Journal of Management* 43–66.

Damanpour, F. (1987). The adoption of technological, administrative, and ancillary innovations: impact of organizational factors. *Journal of Management* 13, 675–688.

Damanpour, F. (1991). Organizational innovation: A meta-analysis of effects of determinants and moderators. *Academy of Management Journal* 34, 555–590.

Damanpour, F. (1992). Organizational size and innovation. *Organization Studies* 13, 375–402.

Damanpour, F. & W. M. Evan (1984). Organizational innovation and performance: the problem of organizational lag. *Administrative Science Quarterly* 29, 392–409.

Damanpour, F. & S. Gopalakrishnan (1998). Theories of organizational structure and innovation adoption: the role of environmental change. *Journal of Engineering and Technology Management* 15, 1–24.

Davila, A. (2000). An empirical study on the drivers of management control systems design in new product development. *Accounting, Organizations and Society* 25, 383–409.

Delbecq, A. L. & P. K. Mills (1985). Managerial practices that enhance innovation. *Organizational Dynamics* 14, 24–34.

Dermer, J. (1973). Cognitive characteristics and the perceived importance of information. *The Accounting Review* 73, 551–519.

Devanna, M. A. & N. Tichy (1990). Creating the competitive organization of the 21st century: The boundaryless corporation. *Human Resource Management* 29, 445–471.

Dewar, R. D. & J. E. Dutton (1986). The adoption of radical and incremental innovations: an empirical analysis. *Management Science* 32, 1422–1433.

Dillman, D. A. (2000). *Mail and Internet Surveys*. New York: John Wiley and Sons.

Dougherty, D. (1992). Interpretive barriers to successful product innovation in large firms. *Organization Science* 3, 179–202.

Downey, H. K. & J. W. Slocum (1975). Uncertainty: measures, research and sources of variation. *Academy of Management Journal* 18, 562–578.

Drazin, R. & A. H. Van de Ven (1985). Alternative forms of fit in contingency theory. *Administrative Science Quarterly* 30, 514–539.

Duncan, R. (1972). Characteristics of organizational environments and perceived environmental uncertainty. *Administrative Science Quarterly* 17, 313–327.

Dunk, A. S. (1992). Reliance on budgetary control, manufacturing process automation and production sub-unit performance: a research note. *Accounting, Organizations and Society* 17, 185–239.

Eisenhardt, K. M. & B. N. Tabrizi (1995). Accelerating adaptive processes: product innovation in the global computer industry. *Administrative Science Quarterly* 40, 84–110.

Ettlie, J. E. (1983). Organizational policy and innovation among suppliers to the food processing sector. *Academy of Management Journal* 26, 27–44.

Ettlie, J. E., W. P. Bridges & R. D. O'Keefe (1984). Organization strategy and structural differences for radical versus incremental innovations. *Management Science* 30, 682–695.

Faircloth, A. W. & D. N. Ricchiute (1981). Ambiguity intolerance and financial reporting alternatives. *Accounting, Organizations and Society* 6, 53–67.

Farr, J. L. & C. M. Ford (1990). Individual innovation. In M. A. West & J. L. Farr (eds), *Innovation and Creativity at Work*: 63-80. Chichester, England: Wiley.

Ferris, K. R. & M. E. Haskins (1988). Perspectives on accounting systems and human behavior. *Accounting, Auditing and Accountability Journal*, 3–18.

Fisher, J. G. (1998). Contingency theory, management control systems and firm outcomes: past results and future directions. *Behavioural Research in Accounting* 10, 47–64.

Fornell, C. & D. F. Larcker (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research* 18, 39–50.

Furnham, A. (1994). A content, correlational and factor analytic study of four tolerance of ambiguity questionnaires. *Personality and Individual Differences* 16, 403–410.

Furnham, A. & B. Gunter (1993). *Corporate Assessment*. London: Routledge.

Furnham, A. & T. Ribchester (1995). Tolerance of ambiguity: a review of the concept, its measurement and applications. *Current Psychology* 14, 179–200.

Galbraith, J. R. (1973). *Designing Complex Organizations*. Reading, MA: Addison-Wesley.

Galbraith, J. R. (1977). *Organization Design*. Reading, MA: Addison-Wesley.

Galbraith, J. R. (1982). Designing the innovating organization. *Organizational Dynamics* 10, 5–25.

Geisser, S. (1975) The predictive sample reuse method with applications. *Journal of American Statistical Association* 70, 320–328.

Gopalakrishnan, S. & F. Damanpour (1997). A review of innovation research in economics, sociology and technology management. *Omega* 25, 15–28.

Gordon, L. & D. Miller (1976). A contingency framework for the design of accounting information systems. *Accounting, Organizations and Society* 1, 59–69.

Gordon, L. A. & V. K. Narayanan (1984). Management accounting systems, perceived environmental uncertainty and organizational structure: an empirical investigation. *Accounting, Organizations and Society* 9, 33–47.

Govindarajan, V. (1984). Appropriateness of accounting data in performance evaluation: An empirical examination of environmental uncertainty as an intervening variable. *Accounting, Organizations and Society* 9, 125–135.

Govindarajan, V. & A. K. Gupta (1985). Linking control systems to business strategy: impact on performance. *Accounting, Organizations and Society* 10, 51–66.

Gresov, C. (1989). Exploring fit and misfit with multiple contingencies. *Administrative Science Quarterly* 34, 431–453.

Griffin, A. (1997). PDMA research on new product development practices: Updating trends and benchmarking best practices. *Journal of Product Innovation Management* 14, 429–458.

Gul, F. A. (1984). The joint and moderating role of personality and cognitive style on decision making. *The Accounting Review* 59, 264–277.

Gul, F. A. (1986). Tolerance for ambiguity, auditors' opinions and their effects on decision making. *Accounting and Business Research* 16, 99–105.

Gupta, A. K. & V. Govindarajan (1984). Business unit strategy, managerial characteristics, and business unit effectiveness at strategy implementation. *Academy of Management Journal* 27, 25–41.

Gupta, A. K. & D. L. Wilemon (1990). Accelerating the development of technology-based new products. *California Management Review* 32, 24–44.

Hage, J. & R. Dewar (1973). Elite values versus organizational structure in predicting innovation. *Administrative Science* 18, 279–290.

Hartmann, F. G. (2000). The appropriateness of RAPM: toward the further development of theory. *Accounting, Organizations and Society* 25, 451–482.

Hayes, D. D. (1977). The contingency theory of managerial accounting. *The Accounting Review* 52, 22–39.

Hertenstein, J. & M. Platt (2000). Performance measures and management control in new product development. *Accounting Horizons* 14, 303–324.

Hirst, M. K. (1981). Accounting information and the evaluation of subordinate performance: a situational approach. *The Accounting Review* 56, 771–784.

Hirst, M. K. (1983). Reliance on accounting performance measures, task uncertainty and dysfunctional behavior: Some extensions. *Journal of Accounting Research* 21, 596–605.

Hirst, M. K. & P. Yetton (1984). Influence of reliance on accounting performance measures and job structure on role ambiguity for production and non-production jobs. *Australian Journal of Management* 9, 53–62.

Ho, J. L. & W. Rodgers (1993). A review of accounting research on cognitive characteristics. *Journal of Accounting Literature* 12, 101–130.

Hofstede, G. (1984). *Cultures' Consequences*. Beverly Hills, California: Sage.

Hopwood, A. (1972). An empirical study of the role of accounting data in performance evaluation. *Journal of Accounting Research* 10, 156–182.

Hopwood, A. (1974) Leadership climate and the use of accounting data in performance evaluation. *The Accounting Review* 49, 485–495.

Horngren, C., G. Foster & S. Datar (1997). *Cost Accounting: a Managerial Emphasis*. Upper Saddle River: Prentice Hall.

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal* 20, 195–204.

Huysmans, J. H. B. M. (1970). The effectiveness of the cognitive style constraint in implementing operations research proposals. *Management Science* 16, 92–104.

Imai, K., I. Nonaka & H. Takeuchi (1985). Managing the new product development process: how Japanese companies learn and unlearn. In R.H. Hayes, K.B. Clark, & C. Lorenz (eds), *The Uneasy Alliance: Managing the Productivity-Technology Dilemma*, 337 –375. Boston, Harvard Business School Press.

Ittner, C. D., D. F. Lacker & M. V. Rajan (1997). The choice of performance measures in annual bonus contracts. *The Accounting Review* 72, 231–255.

Jelinek, M. & C. B. Schoonhoven (1990). *The Innovation Marathon: Lessons from high Technology Firms.* San Fransisco: Jossey-Bass.

Jöreskog, K. G. & D. Sörbom. (1989). *LISREL 7: A Guide to the Program and Applications.* Chicago: SPSS.

Kamm, J. B. (1987). *An Integrative Approach to Managing Innovation.* Lexington: Lexington Books.

Kanter, R. (1983). *The Changemasters.* New York: Simon & Schuster.

Kanter, R. (1988). When a thousand flowers bloom: Structural, collective, and social conditions for innovation in organizations. In B. M. Staw & L. L. Cummings (eds), *Research in Organizational Behavior* 10, 169–211. Greenwich, CT: JAI Press.

Keller, R. T. (1994). Technology – information processing fit and the performance of R&D project groups: A test of contingency theory. *Academy of Management Journal* 37, 167–179.

Khandwalla, P. (1972). The effect of different types of competition on the use of management controls. *Journal of Accounting Research* 10, 275–285.

Khandwalla, P. (1977). *Design of Organizations.* New York: Harcourt Brace Jovanovich.

Kimberly, J. R. (1981). Managerial Innovation. In P.C. Nystrom & W.H. Starbuck (eds). *Handbook of Organizational Design*, 84–104. New York: Oxford University Press.

Kimberly, J. R. & M. Evanisko (1981). Organizational innovation: the influence of individual, organizational and contextual factors on hospital adoption of technological and administrative innovations. *Academy of Management Journal* 24, 689–713.

Klein, K. J., F. Dansereau & R. J. Hall (1994). Levels issues in theory development, data collection and analysis. *Academy of Management Review* 19, 195–229.

Laitinen, E. K. (2001). *Future Management Accounting: Preliminary Propositions with Survey Evidence.* Levon Institute publication No. 92. Strategic Management Accounting Research Unit. University of Vaasa. Vaasa.

Lal, M. & L. Hassel (1998). The joint impact of environmental uncertainty and tolerance of ambiguity on managers perceptions of the usefulness of non-conventional management accounting information. *Scandinavian Journal of Management* 14, 259–271.

Lau, C. M., L. C. Low & I. R. C. Eggleton (1995). The impact of reliance on accounting performance measures on job-related tension and managerial performance, additional evidence. *Accounting, Organizations and Society* 20, 359–381.

Latham, G. P. & E. A. Locke (1991). Self-regulation through goal-setting. *Organizational Behavior and Human Decision Processes* 50, 212–247.

Lawrence, P. & J. Lorsch (1967). *Organization and Environment*. Homewood, Ill: Irwin.

Lewis, M. W., M. A. Welsh, G. E. Dehler & S. G. Green (2002). Product development tensions: Exploring contrasting styles of project management. *Academy of Management Journal* 45, 546–564.

Locke, E. A. (1996). Motivation through conscious goal setting. *Applied and Preventive Psychology* 5,117–124.

Locke, E. A. & P. G. Latham (1990a). *A Theory of Goal Setting and Task Performance.* Englewood Cliffs, NJ: Prentice-Hall.

Locke, E. A. & P. G. Latham (1990b). Work motivation and satisfaction: Light at the end of the tunnel. *Psychological Science* 1, 240–246.

Lorange. P. (1992). *Implementation of Strategic Planning.* Englewood Cliffs, N.J: Precentice-Hall.

Luft, J. & M. D. Shields (2003). Mapping management accounting: Making structural models from theory-based empirical research. *Accounting, Organizations and Society* 28, 169–249.

MacDonald, A. (1970). Revised scale for ambiguity tolerance: Reliability and validity. *Psychological Reports* 26, 791–798.

March, J. G. & H. A. Simon (1958). *Organizations.* New York: Wiley.

Martin, M. J. C. (1984). *Managing Technological Innovation and Entrepreneurship.* Va, Reston: Reston.

McDonough, E. F. & G. Barczak (1991). Speeding up new product development: The effects of leadership style and source of technology. *Journal of Product Innovation Management* 8, 203–211.

McDonough, E. F. & R. Leifer (1983). Using simultaneous structures to cope with uncertainty. *Academy of Management Journal* 26, 727–735.

McGhee, W., Shields, M. D. & Birnberg, J. G. (1978). The effects of personality on a subjects information process. *The Accounting Review* 62, 681–697.

Merchant, K. A. (1981). The design of the corporate budgeting system: influences on managerial behavior and performance. *The Accounting Review* 56, 813–829.

Merchant, K. A. (1982). The control function of management. *Sloan Management Review* 23, 43–55.

Merchant, K. A. (1984). Influences on departmental budgeting: an empirical examination of a contingency model. *Accounting, Organizations and Society* 9, 291–307.

Merchant, K. A. (1985a). Organizational controls and discretionary program decision-making. *Accounting, Organizations and Society* 10, 67–85.

Merchant, K. A. (1985b). *Control in Business Organizations*. Marshfield: Pitman.

Merchant, K. A. (1990). The effects of financial controls on data manipulation and management myopia, *Accounting, Organizations and Society* 15, 297–313.

Merchant, K. A. (1998). *Modern Management Control Systems*. Upper Saddle River, Prentice Hall.

Mia, L & R. H. Chenhall (1994). The usefulness of management accounting systems, functional differentiation and managerial effectiveness. *Accounting, Organizations and Society* 19, 1–13.

Miller, D. & Friesen, P. H. (1982) Innovation in conservative and entrepreneurial firms: two models of strategic momentum. *Strategic Management Journal*, 1–25.

Mohr, L. B. (1971). Organizational technology and organizational structure. *Administrative Science Quarterly*, 16, 444–459.

Moorman, C. & A. Miner (1998). The convergence of planning and execution: Improvisation in new product development. *Journal of Marketing* 62, 1–20.

Morse, J. J. & Lorsch, J. W. (1970). Beyond theory. *Harvard Business Review*, May-June, 61–68.

Murray, D. (1990). The performance effects of participative budgeting: an integration of intervening and moderating variables. *Behavioral Research in Accounting* 2, 104–123.

Nixon, B. (1998). Research and development performance measurement: a case study. *Management Accounting Research* 9, 329–355.

Nohria, N. & R. Gulati (1996). Is slack good or bad for innovation? *Academy of Management Journal* 39, 1245 –1264.

Noonan, R. & H. Wold (1982) PLS path modeling with indirectly observed variables: A comparison of alternative estimates for latent variables. In K. G. Jöreskog & H. Wold (eds). Systems Under Indirect Observation: *Causality, Structure, Prediction*. Part 2, 75–94. Amsterdam: North-Holland.

Nord, W. R. & S. Tucker (1987). *Implementing Routine and Radical Innovation*. Lexington, MA: Lexington books.

Norton, R. (1975). Measurement of ambiguity tolerance. *Journal of Personality Assessment* 39, 607–619.

Nunnally, J. C. (1978). *Psychometric Theory* (2nd. ed.). New York: McGraw-Hill.

Nutt, P. (1993). Flexible decision styles and the choices of top executives. *Journal of Management Studies* 30 695–721.

Oldham, G. R. & A. Cummings (1996). Employee creativity: Personal and contextual factors at work. *Academy of Management Journal* 39, 607–634.

Oldham, G. R. & A. Cummings (1997). Enhancing creativity: Managing work context for the high potential employee. *California Management Review* 40, 22–38.

Oliver, J. & E. Flamholtz (1978). Human resource replacement cost numbers, cognitive information processing, and personnel decisions: a laboratory experiment. *Journal of Business Finance and Accounting* 5, 137–157.

Otley, D. T. (1978). Budget use and managerial performance. *Journal of Accounting Research* 16, 122–149.

Otley, D. T. (1980). The contingency theory of management accounting: achievement and prognosis. *Accounting, Organizations and Society* 5, 413–428.

Otley, D. T. & A. Fakiolas (2000). Reliance on accounting performance measures: dead end or new beginning? *Accounting, Organizations and Society* 25, 497–510.

Ouchi, W. G. (1977). The relationship between organisational structure and organisational control. *Administrative Science Quarterly* 22, 95–113.

Ouchi, W. G. (1979). A conceptual framework for the design of organizational control mechanisms. *Management Science* 25, 833–848.

Page, A. L. (1993) Assessing new product development practices and performances: establishing crucial norms. *Journal of Product Innovation Management* 10, 273–290.

Paolillo, J. & W. Brown (1978). How organizational factors affect R&D innovation. *Research Management* 21, 12–15.

Pelz, D. & F. Andrews (1966). Autonomy, coordination, and stimulation in relation to scientific achievement. *Behavioral Science* 11, 89–97.

Pennings, J. M. (1992). Structural contingency theory: A reappraisal. In B. M. Staw & L. L. Cummings (eds). *Research in Organizational Behavior* 14, 267–309. Greenwich, CT: JAI Press.

Perrow, C. (1967). A framework for comparative analysis of organizations. *American Sociological Review* 32, 194–208.

Perrow, C. (1970). *Organizational Analysis: A Sociological View*. New York: Tavistock Publications.

Pierce, J. L. & A. L. Delbecq (1977). Organizational structure, individual attitudes and innovation. *Academy of Management Review* 2, 26–37.

Pincus, K. V. (1991). Audit judgement confidence. *Behavioral Research in Accounting*, 3, 39–65.

Pugh, D., D. Hickson, C. Hinings & C. Turner (1969). The context of organizational structures. *Administrative Science Quarterly* 14, 91–114.

Rabino, S. (2001). The accountant's contribution to product development teams –a case study. *Journal of Engineering and Technology Management* 18, 73–90.

Rockness, H. O. & M. D. Shields (1984). Organizational control systems in research and development. *Accounting, Organizations and Society* 9, 165–177.

Rockness, H. O. & M. D. Shields (1988). An empirical analysis of the expenditure budget in research and development. *Contemporary Accounting Research* 4, 568–581.

Rosenau, M. D. & J. J. Moran (1993). *Managing the Development of New Products*. New York: Van Nostrand Reinhold.

Rousseau, D. (1985). Issues of level in organizational research: Multilevel and cross-level perspectives. In L. L. Cummings & B. M. Staw (eds), *Research in Organizational Behavior* 7, 1–37. Greenwich, CT: JAI Press.

Russell, C. J. & P. Bobko (1992). Moderated regression analysis and likert scales: Too coarse for comfort. *Journal of Applied Psychology* 77, 336–342.

Rydell, S. & E. Rosen (1966). Measurement and some correlates of need cognition. *Psychological Reports* 19, 139–165.

Sawyer, G. C. (1978). Innovation in organisations. *Long Range Planning*, December, 53–57.

Scott, S. G. & R. A. Bruce (1994). Determinants of innovative behavior: A path model of individual innovation in the workplace. *Academy of Management Journal* 37, 580–607.

Shalley, C. E. (1995). Effects of coaction, expected evaluation, and goal setting on creativity and productivity. *Academy of Management Journal* 38, 483–503.

Shenhar, A. J. & D. Dvir (1996). Toward a typological theory of project management. *Research Policy* 25, 607–632.

Shields, J. F. & M. D. Shields (1998). Antecedents of participative budgeting. *Accounting, Organizations and Society* 23, 49–76.

Shields, M. D., Y. Kato & J. Deng (2000). The design of control systems: Test of direct and indirect – effect models. *Accounting, Organizations and Society* 25, 185–202.

Shields, M. D. & G. B. Sprinkle (Fortcoming). Operating Budgeting Systems. Working Paper, September, 2001.

Simons, R. (1987). Accounting control systems and business strategy: an empirical analysis. *Accounting, Organizations and Society* 20, 127–143.

Simons, R. (1990). The role of management control systems in creating competitive advantage: New perspectives. *Accounting, Organizations and Society* 15, 127–143.

Simons, R. (1991). Strategic orientation and top management attention to control systems. *Strategic Management Journal* 12, 49–62.

Simons, R. (1994). How new top managers use control systems as levers of strategic renewal. *Strategic Management Journal* 15, 169–189.

Simons, R. (1995). *Levers of Control: How Managers Use Innovative Control Systems to Drive Strategic Renewal.* Boston, MA: Harvard Business School Press.

Simons, R. (2000). *Performance Measurement and Control Systems for Implementing Strategy. Text and Cases*. Upper Saddle River, New Jersey: Prentice Hall.

Smith, D. & K. Langfield-Smith (2002). Conference paper. Presented in EAA, Copenhagen.

Staw, B. M. (1990). An evolutionary approach to creativity and innovation. In M. A. West & J. L. Farr (eds), *Innovation and Creativity at Work*, 287–308. Chichester, UK: Wiley.

Stone, M. (1974). Cross-validatory choice and assessment of statistical predictions. *Journal of the Royal Statistical Society* B36, 111–133.

Sutton, R. I. (2001). The weird rules of creativity. *Harvard Business Review* 79, 94–103.

Taylor, C. (1963). Variables related to creativity and productivity in men in two research laboratories. In C. Taylor & R. Barron (eds), *Scientific Creativity: Its Recognition and Development*, 513-597. New York: Wiley.

Thompson, J. (1967). *Organizations in Action*. New York: McGraw Hill.

Tushman, M. & Nadler, D. (1978). Information processing as an integrating concept in organizational design. *Academy of Management Review* 3, 613–624.

Tsui, J. (1993). Tolerance for ambiguity, uncertainty audit qualifications and bankers' perceptions. *Psychological Reports* 72, 915–919.

Van de Ven, A. H. (1986). Central problems in the management of innovation. *Management Science* 32, 590–607.

Van de Ven, A. H. & H. L. Angle (1989). An introduction to the Minnesota innovation research program. In A. H. Van de Ven, H. L. Angle & M. S. Poole (eds), *Research on the Management of Innovation*: The Minnesota Studies, 3–30. New York: Harper & Row.

Van de Ven, A. H. & Delbecq, A. (1974). A task contingent model of work unit structure. *Administrative Science Quarterly* 19, 183–197.

Van de Ven, A. H., A. Delbecq & Koenig, Jr. (1976). Determinants of coordination modes with organization. *American Sociological Review*, 332–338.

Van de Ven, A. H. & D. Polley (1992). Learning while innovating. *Organization Science* 3, 92–116.

Van der Stede, W. A. (2000). The relationship between two consequences of budgetary controls: budgetary slack creation and managerial short-term orientation. *Accounting, Organizations and Society* 25, 609–622.

Van der Stede, W. A. (2001). Measuring tight budgetary control. *Management Accounting Research* 12, 119–137.

Waterhouse, J. & P. Tiessen (1978). A contingency framework for management accounting systems research. *Accounting, Organizations and Society* 3, 65–76.

Werner, B. M. & W. E. Souder (1997). Measuring R&D performance – state of the art. *Research Technology Management*, March-April, 34–42.

Werts, C. E., R. L. Linn & K. G. Jöreskog (1974). Intraclass reliability estimates: Testing structural assumptions. *Educational and Psychological Measurement* 34, 25–33.

West, M. & J. Farr (1990). Innovation at work. In M. West & J. Farr (ed.), *Innovation and Creativity at Work: Psychological and Organizational Strategies*, 3–13. New York: Wiley.

Wheelwright, S. C. & K. B. Clark (1992). *Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality*. New York: Free Press.

Withey, M., R. L. Daft & R. H. Cooper (1983). Measures of Perrow's work-unit technology: an empirical assessment and a new scale. *Academy of Management Journal* 26, 45–63.

Wofford, J. C., V. L. Goodwin & S. Premack (1992). Meta-analysis of the antecedents of personal goal level and of the antecedents and consequences of goal commitment. *Journal of Management* 18, 595–615.

Wold, H. (1985). Systems analysis by partial least squares. In P. Nijkamp, L. Leitner & N. Wrigley (eds), *Measuring the Unmeasurable*, 221–251. Marinus Nijhoff: Dordrecht.

Woodman, R. W., J. E. Sawyer & R. W. Griffin (1993). Toward a theory of organizational creativity. *Academy of Management Review* 18, 293–321.

Woodward, J. (1965). *Industrial Organization: Theory and Practice*. London: Oxford University Press.

Zaltman, G., R. Duncan & J. Holbek (1973). *Innovations and Organizations*. New York: Wiley.

Zirger, B. J. & M. A. Maidique (1990). A model of new product development: an empirical test. *Management Science*, 867–883.

APPENDICES

Appendix 1. Group statistics.

	Project type	N	Mean	Std. Deviation	Std. Error Mean
Task difficulty	Technical	70	17,4470	4,2102	,5032
	Administrative	48	17,5681	5,4965	,7934
Task variability	Technical	70	24,7143	5,4324	,6493
	Administrative	48	26,3542	5,8400	,8429
Interactive style of use project MCS	Technical	70	15,3077	3,2679	,3906
	Administrative	48	15,9375	3,0416	,4390
Diagnostic style of use project MCS	Technical	70	20,0906	6,0114	,7185
	Administrative	48	22,6836	5,8227	,8404
Innovativeness	Technical	70	13,8402	3,0592	,3656
	Administrative	48	12,6239	3,2152	,4641
Performance	Technical	70	15,6222	2,6190	,3130
	Administrative	48	14,6667	3,3220	,4795
Intolerance for ambiguity	Technical	70	47,0568	11,2082	1,3396
	Administrative	48	48,9439	9,0184	1,3017

Appendix 2. Independent sample t-test.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Difficulty	Equal variances assumed	2,422	,122	-,135	116	,892	-,1212	,8945	-1,8929	1,6506
	Equal variances not assumed			-,129	83,248	,898	-,1212	,9395	-1,9897	1,7473
Variability	Equal variances assumed	,497	,482	-1,562	116	,121	-1,6399	1,0497	-3,7189	,4391
	Equal variances not assumed			-1,541	96,241	,127	-1,6399	1,0640	-3,7519	,4721
Interactive	Equal variances assumed	,544	,462	-1,057	116	,293	-,6298	,5956	-1,8094	,5499
	Equal variances not assumed			-1,072	105,730	,286	-,6298	,5876	-1,7948	,5353
Diagnostic	Equal variances assumed	,284	,595	-2,331	116	,021	-2,5931	1,1124	-4,7962	-,3899
	Equal variances not assumed			-2,345	103,243	,021	-2,5931	1,1057	-4,7859	-,4002
Innovativeness	Equal variances assumed	,032	,858	2,078	116	,040	1,2164	,5853	,709E-02	2,3757
	Equal variances not assumed			2,059	97,793	,042	1,2164	,5908	,390E-02	2,3889
Performance	Equal variances assumed	2,166	,144	1,744	116	,084	,9555	,5480	-,1299	2,0409
	Equal variances not assumed			1,669	85,075	,099	,9555	,5726	-,1830	2,0940
Tolerance for ambiguity	Equal variances assumed	2,891	,092	-,970	116	,334	-1,8870	1,9446	-5,7386	1,9645
	Equal variances not assumed			-1,010	112,965	,315	-1,8870	1,8679	-5,5877	1,8136

Appendix 3. Mann-Whitney test.

	Type	N	Mean Rank	Sum of Ranks
Task difficulty	Technical	70	60,17	4212,00
	Administrative	48	58,52	2809,00
	Total	118		
Task variability	Technical	70	54,74	3831,50
	Administrative	48	66,45	3189,50
	Total	118		
Interactive use of project MCS	Technical	70	56,96	3987,00
	Administrative	48	63,21	3034,00
	Total	118		
Diagnostic use of project MCS	Technical	70	53,22	3725,50
	Administrative	48	68,66	3295,50
	Total	118		
Project innovativeness	Technical	70	64,70	4529,00
	Administrative	48	51,92	2492,00
	Total	118		
Project performance	Technical	70	63,36	4435,00
	Administrative	48	53,88	2586,00
	Total	118		

	Difficulty	Variability	Interactive	Diagnostic	Innovativeness	Performance
Mann-Whitney U	1633,000	1346,500	1502,000	1240,500	1316,000	1410,000
Wilcoxon W	2809,000	3831,500	3987,000	3725,500	2492,000	2586,000
Z	-,258	-1,830	-,981	-2,411	-2,005	-1,488
Asymp. Sig. (2-tailed)	,796	,067	,327	,016	,045	,137

a. Grouping Variable: Project type

Appendix 4. Tests of normality.

Skewness and Kurtosis

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Tolerance for ambiguity	114	,034	,226	-,034	,449
Project task variability	114	-,343	,226	-,767	,449
Project task difficulty	114	,571	,226	,356	,449
Diagnostic use of project MCS	114	-,187	,226	-,609	,449
Interactive use of project MCS	114	-,319	,226	-,459	,449
Project innovativeness	114	-,271	,226	,081	,449
Project performance	114	-,320	,226	-,003	,449
Valid N (listwise)	114				

Kolmogorov-Smirnov test

		Project task variability	Project task difficulty	Diagnostic project MCS	Interactive project MCS	Project innovativeness	Project performance	Tolerance for ambiguity
N		114	114	114	114	114	114	114
Normal Parameters[a,b]	Mean	25,3070	17,4951	21,2470	15,6100	13,5944	15,2505	47,5902
	Std. Deviation	5,6633	4,6411	5,9056	3,2065	2,8727	2,8815	10,3165
Most Extreme Differences	Absolute	,118	,108	,079	,149	,118	,123	,075
	Positive	,054	,108	,065	,082	,067	,082	,075
	Negative	-,118	-,055	-,079	-,149	-,118	-,123	-,044
Kolmogorov-Smirnov Z		1,255	1,154	,844	1,593	1,255	1,316	,797
Asymp. Sig. (2-tailed)		,086	,139	,475	,012	,086	,063	,548

a. Test distribution is Normal.

b. Calculated from data.

Appendix 5. Measurement of tolerance for ambiguity.

R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
AT1_1	48,5490	94,4805	,4402	,7323
AT2_1	47,8711	96,9311	,4263	,7345
AT3_1	48,3385	96,7551	,3739	,7396
AT4_1	49,0024	94,5680	,3781	,7398
AT5_1	47,9856	109,8022	-,0362	,7845
AT6_1	49,4640	94,9509	,4395	,7325
AT7_1	49,2930	93,7832	,5040	,7259
AT8_1	47,2355	100,2077	,3653	,7409
AT9_1	50,3764	104,7856	,2137	,7532
AT10_1	49,5321	98,9969	,3230	,7448
AT11_1	48,6578	95,8840	,4312	,7336
AT12_1	49,8895	96,9065	,5205	,7280
AT13_1	49,4383	95,1178	,4511	,7314
AT14_1	46,8430	99,2040	,4010	,7378

Reliability Coefficients

N of Cases =   114,0   N of Items = 14

Alpha =   ,7545

Appendix 6. Outer model loadings: administrative type development projects (N=45).

	Original sample estimate	Mean of subsamples	Standard error	T-Statistic
Task Difficulty:				
(Composite Reliability = 0.870 , AVE = 0.575)				
TU6_1	0.7144	0.6517	0.2080	3.4352
TU7_1	0.6589	0.6139	0.2455	2.6843
TU8_1	0.7796	0.7206	0.1784	4.3709
TU9_1	0.8609	0.8232	0.1365	6.3066
TU10_1	0.7633	0.7405	0.1457	5.2381
Task Variability:				
(Composite Reliability = 0.916 , AVE = 0.686)				
TU1_1	0.7953	0.7686	0.1398	5.6871
TU2_1	0.8519	0.8398	0.1131	7.5333
TU3_1	0.7951	0.7839	0.1199	6.6329
TU4_1	0.8533	0.8188	0.0895	9.5379
TU5_1	0.8421	0.7846	0.1585	5.3140
Interactive use of project MCS:				
(Composite Reliability = 0.692 , AVE = 0.455)				
INT1_1	0.3506	0.4856	0.2851	1.2297
INT2_1	0.7052	0.6935	0.1775	3.9720
INT3_1	0.8630	0.7748	0.1171	7.3705
Diagnostic style of use project MCS:				
(Composite Reliability = 0.783 , AVE = 0.463)				
DIAG1_1	0.8022	0.7507	0.2294	3.4970
DIAG2_1	0.8479	0.7635	0.1833	4.6248
DIAG3_1	0.6480	0.6207	0.2625	2.4685
DIAG4_1	0.0929	0.1101	0.3999	0.2323
DIAG5_1	0.7239	0.6865	0.1872	3.8676
Project innovativeness:				
(Composite Reliability = 0.904 , AVE = 0.760)				
INN1_1	0.8097	0.7961	0.1459	5.5496
INN2_1	0.8236	0.8043	0.0930	8.8526
INN3_1	0.9727	0.9364	0.0403	24.1305
Project performance:				
(Composite Reliability = 0.928 , AVE = 0.811)				
PERF1_1	0.9276	0.9193	0.0269	34.4296
PERF2_1	0.8430	0.8406	0.0557	15.1441
PERF3_1	0.9282	0.9264	0.0210	44.2882

Appendix 7. Outer model loadings: Technical type development projects (N=69).

	Original sample estimate	Mean of subsamples	Standard error	T-Statistic
Task Difficulty:				
(Composite Reliability =	0.767 , AVE =	0.402)		
TU6_1	0.7452	0.6873	0.2026	3.6775
TU7_1	0.5929	0.5554	0.2455	2.4146
TU8_1	0.7180	0.6749	0.1493	4.8079
TU9_1	0.4721	0.4587	0.2581	1.8292
TU10_1	0.6059	0.5596	0.1702	3.5598
Task Variability:				
(Composite Reliability =	0.849 , AVE =	0.551)		
TU1_1	0.4489	0.4436	0.3014	1.4893
TU2_1	0.4593	0.5195	0.2512	1.8285
TU3_1	0.8016	0.7629	0.1457	5.5002
TU4_1	0.9433	0.8577	0.1269	7.4313
TU5_1	0.8994	0.8262	0.1202	7.4841
Interactive use of project MCS:				
(Composite Reliability =	0.710 , AVE =	0.470)		
INT1_1	0.8738	0.8061	0.1295	6.7475
INT2_1	0.7012	0.6406	0.2939	2.3856
INT3_1	0.3949	0.3841	0.2389	1.6531
Diagnostic use of project MCS:				
(Composite Reliability =	0.817 , AVE =	0.478)		
DIAG1_1	0.5436	0.5360	0.2049	2.6531
DIAG2_1	0.7692	0.7583	0.1300	5.9176
DIAG3_1	0.8212	0.8043	0.1058	7.7645
DIAG4_1	0.6232	0.6172	0.1588	3.9250
DIAG5_1	0.6621	0.6675	0.1104	5.9999
Project innovativeness:				
(Composite Reliability =	0.882 , AVE =	0.715)		
INN1_1	0.8482	0.8287	0.0944	8.9886
INN2_1	0.7522	0.7445	0.0846	8.8941
INN3_1	0.9266	0.9293	0.0170	54.4107
Project performance:				
(Composite Reliability =	0.878 , AVE =	0.705)		
PERF1_1	0.8383	0.8347	0.0580	14.4456
PERF2_1	0.8428	0.8460	0.0433	19.4467
PERF3_1	0.8376	0.8252	0.1303	6.4289

Appendix 8. Path coefficients, standard errors, and t-statistics for technical type development projects (N=69).

Path Coefficients Table (Original Sample Estimate):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	-0.3820	-0.1750	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	-0.1210	0.0000	0.0000	0.4630
Performa	0.0000	0.0000	0.0980	0.3900	0.0000	0.1110
Interact	-0.3120	0.2070	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (Standard Error):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	0.1388	0.2230	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.1367	0.0000	0.0000	0.1232
Performa	0.0000	0.0000	0.1270	0.1122	0.0000	0.1541
Interact	0.1671	0.1752	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (T-Statistic)

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	2.7526	0.7847	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.8853	0.0000	0.0000	3.7571
Performa	0.0000	0.0000	0.7714	3.4767	0.0000	0.7205
Interact	1.8675	1.1816	0.0000	0.0000	0.0000	0.0000

Appendix 9. Path coefficients, standard errors, and t-statistics for administrative type development projects (N=45).

Path Coefficients Table (Original Sample Estimate):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	-0.3230	-0.1040	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	-0.1510	0.0000	0.0000	0.1860
Performa	0.0000	0.0000	0.3600	0.4010	0.0000	0.1060
Interact	-0.3080	0.3040	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (Standard Error):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	0.1795	0.1907	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.2246	0.0000	0.0000	0.2321
Performa	0.0000	0.0000	0.1557	0.1066	0.0000	0.1537
Interact	0.1379	0.1949	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (T-Statistic)

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	1.7996	0.5454	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.6724	0.0000	0.0000	0.8015
Performa	0.0000	0.0000	2.3124	3.7628	0.0000	0.6897
Interact	2.2327	1.5600	0.0000	0.0000	0.0000	0.0000

Appendix 10. PLS estimates for path coefficients and standard errors.

Administrative projects – sub-group of project managers with high tolerance for ambiguity (N=23)

Path Coefficients Table (Original Sample Estimate):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	-0.4450	0.1100	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	-0.2500	0.0000	0.0000	0.2850
Performa	0.0000	0.0000	0.4150	0.5300	0.0000	0.0090
Interact	-0.1970	0.4590	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (Standard Error):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	0.2709	0.2974	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.3611	0.0000	0.0000	0.3575
Performa	0.0000	0.0000	0.2595	0.2261	0.0000	0.2989
Interact	0.3037	0.3123	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (T-Statistic)

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	1.6425	0.3698	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.6922	0.0000	0.0000	0.7971
Performa	0.0000	0.0000	1.5992	2.3437	0.0000	0.0301
Interact	0.6488	1.4700	0.0000	0.0000	0.0000	0.0000

Appendix 11. PLS estimates for path coefficients and standard errors.

Administrative projects – sub-group of project managers with low tolerance for ambiguity (N=22)

Path Coefficients Table (Original Sample Estimate):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	-0.4600	-0.4170	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	-0.1100	0.0000	0.0000	0.3930
Performa	0.0000	0.0000	-0.5300	-0.2720	0.0000	-0.1830
Interact	-0.5400	-0.0640	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (Standard Error):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	0.2599	0.2521	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.3780	0.0000	0.0000	0.3635
Performa	0.0000	0.0000	0.3387	0.3016	0.0000	0.3201
Interact	0.2755	0.3566	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (T-Statistic)

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	1.7700	1.6540	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.2910	0.0000	0.0000	1.0812
Performa	0.0000	0.0000	1.5647	0.9018	0.0000	0.5718
Interact	1.9598	0.1795	0.0000	0.0000	0.0000	0.0000

Appendix 12. PLS estimates for path coefficients and standard errors.

Technical projects sub-group of project managers with high tolerance for ambiguity (N=35)

Path Coefficients Table (Original Sample Estimate):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	-0.4220	-0.1900	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	-0.1170	0.0000	0.0000	0.5540
Performa	0.0000	0.0000	-0.0090	0.4120	0.0000	0.0910
Interact	-0.3520	0.2310	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (Standard Error):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	0.1761	0.2994	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.2249	0.0000	0.0000	0.2015
Performa	0.0000	0.0000	0.2105	0.1896	0.0000	0.3130
Interact	0.2782	0.3057	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (T-Statistic)

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	2.3964	0.6347	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.5203	0.0000	0.0000	2.7498
Performa	0.0000	0.0000	0.0428	2.1732	0.0000	0.2907
Interact	1.2653	0.7556	0.0000	0.0000	0.0000	0.0000

Appendix 13. PLS estimates for path coefficients and standard errors.

Technical projects – Sub-group of project managers with low tolerance for ambiguity (N=34)

Path Coefficients Table (Original Sample Estimate):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	-0.6130	-0.4900	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	-0.3180	0.0000	0.0000	-0.2880
Performa	0.0000	0.0000	0.2900	-0.1580	0.0000	0.2520
Interact	-0.5590	-0.4360	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (Standard Error):

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	0.2437	0.3799	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	0.2127	0.0000	0.0000	0.2578
Performa	0.0000	0.0000	0.1901	0.1846	0.0000	0.1836
Interact	0.2759	0.2366	0.0000	0.0000	0.0000	0.0000

Path Coefficients Table (T-Statistic)

	Difficul	Variabil	Diagnost	Innovati	Performa	Interact
Difficul	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Variabil	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Diagnost	2.5154	1.2899	0.0000	0.0000	0.0000	0.0000
Innovati	0.0000	0.0000	1.4948	0.0000	0.0000	1.1173
Performa	0.0000	0.0000	1.5252	0.8558	0.0000	1.3722
Interact	2.0259	1.8426	0.0000	0.0000	0.0000	0.0000

Appendix 14. Contact email, web-questionnaire, and remainder email for project managers on survey research: performance measurement and management control systems for development projects

(Translation from original Finnish)

Dear respondent

The purpose of this survey is to provide insight into how organizations are responding to these challenges before them. In particular, I am interested how project managers in environments were innovation is highly required and task uncertainty is high, like in different research and development project environments, exercise adequate control over project teams that by their nature require some degree of flexibility, creative freedom and participative decision processes.

Therefore, an important and interesting research question becomes how do different levels and types of control impact on project teams innovation performance and adherence to targets.

The results of this study will develop a more complete understanding of the design and effects of management control systems on important organisational dependent variable (innovation) and antecedents to those control system components (task uncertainty and managers tolerance for ambiguity). This survey is a part of my doctoral thesis, which I do in University of Vaasa.

The questionnaire is addressed to the project managers. Questions are self- explanatory, but if for some reason an item is not applicable for your project, please mark "0". Similarly, if you cannot determine an answer to a question please mark "0".

Your answers to the survey will be kept in strict confidence and anonymously. The data will be analyzed and reported only on an aggregate basis. If you would like a copy of the final report please provide a contact person and address.

Thank you

Mika Ylinen, M.Sc. (Economics)
E-mail: myl@uwasa.fi or mika.ylinen@puv.fi
Tel(GSM): +358400617700
Tel: +35863263570

Hyvä projektitoiminnan asiantuntija!

Tämä yhteydenotto liittyy väitöskirjatutkimukseen, joka on meneillään Vaasan yliopistossa professori Erkki K. Laitisen ohjauksessa. Projektijohtamisen asiantuntijana osallistumisenne tutkimukseen on erittäin tärkeää tutkimuksen tulosten näkökulmasta! Toivoisin, että voisitte osallistua tutkimukseen vastaamalla kyselylomakkeeseen osoitteessa: http://www.bet.puv.fi/mika.ylinen

Tutkimus on suunnattu henkilöille, jotka toimivat tai ovat toimineet kehitysprojektin johtotehtävissä. Kehitysprojekti voi liittyä organisaation, liiketoiminnan, toimintaprosessien ja -tapojen, tietojärjestelmien, uusien tuotteiden ja palveluiden kehitykseen tai tutkimustoimintaan. Kaikille kyselyyn osallistuneille toimitetaan yhteenveto tutkimuksen tuloksista.

Tutkimushankkeen tavoitteena on arvioida kehitysprojektien erilaisten johtamistapojen vaikutuksia projektiryhmän innovatiivisuuteen ja suorituskykyyn:

1. Miten innovatiivisuutta ohjataan kehitysprojekteissa?

2. Milloin tiukasti määritelty / väljempi ohjausjärjestelmä ja johtamistapa sopii parhaiten?

3. Miten projektipäällikön persoonallisuus vaikuttaa hänen tapaansa johtaa projektia?

Kyselylomakkeeseen vastaaminen ei vie paljoa aikaa ja kaikki vastaukset säilyvät nimettöminä ja käsitellään täysin luottamuksellisesti.
Keskustelen mielelläni tutkimukseeni liittyvistä asioista, mikäli haluatte tietää enemmän hankkeestani.

Vastaathan kyselyyn mahdollisimman pian, viimeistään 14.03.2003 mennessä!

Kiitos avusta tutkimukseeni liittyen. Lähetän sinulle yhteenvedon tutkimukseni tuloksista!

Terveisin
Mika Ylinen, KTM
E-mail: myl@uwasa.fi mika.ylinen@puv.fi
Tel(GSM): +358400617700
Tel: +35863263570

Dear project manager!

This contact concerns my doctoral thesis research project, which is guided by professor Erkki K. Laitinen in the University of Vaasa. As the expert of the project management your participation in the study is extremely important! I hope that you could participate in the study by answering a questionnaire my web page:

http://www.bet.puv.fi/mika.ylinen

The study has been directed to persons who operate or have worked in the management tasks of the development project. The development project can be connected to the development or research activities of an organisation, business, operation processes and ways of action, information processing systems, the new products and services. If you would like a copy of the final report please provide a contact person and address.

The objective of the research project is to estimate the effects of the different styles of use project management control systems of development projects on the innovativeness and performance of the project group:

1. How is the innovativeness directed in development projects?

2. When tightly defined / loose project management control system works best?

3. How does the project manager's personality have effect his way to lead the project?

Your answers to the survey will be kept in strict confidence and anonymously. The data will be analyzed and reported only on an aggregate basis. I discuss willingly the matters, which are related to my study if you want to know more about my project.

Please, answer my questionnaire as soon as possible, at the latest by 14.03.2003!

Thanks for your time and help in participating my study. I send summary from the results to you!

Thank you

Mika Ylinen, M.Sc. (Economics)
E-mail: myl@uwasa.fi or mika.ylinen@puv.fi
Tel(GSM): +358400617700
Tel: +35863263570

Hyvä projektitoiminnan asiantuntija!

Noin kaksi viikkoa sitten lähetin sinulle sähköpostitse tiedustelun yhteistyöstä väitöskirjatutkimukseeni liittyen. Toiveenani on, että projektijohtamisen asiantuntijana voisitte siirtää näkemyksiänne ja kokemustanne tutkimukseeni vastaamalla kyselylomakkeeseen osoitteessa: http://www.bet.puv.fi/mika.ylinen

Ymmärrän, että kyselyyn vastaamiselle ei päivittäisistä työkiireistä johtuen tahdo löytyä aikaa, mutta siitä huolimatta toivon, että ehtisitte osallistumaan tutkimukseeni. Projektijohtamisen asiantuntijana osallistumisenne tutkimukseeni on erittäin tärkeää tutkimuksen tulosten näkökulmasta! Mikäli olette jo vastanneet kyselyyni, kiitän osallistumisestanne ja avustanne tutkimukseeni liittyen!

Tutkimus on suunnattu henkilöille, jotka toimivat tai ovat toimineet kehitysprojektin johtotehtävissä. Kehitysprojekti voi liittyä organisaation, liiketoiminnan, toimintaprosessien ja -tapojen, tietojärjestelmien, uusien tuotteiden ja palveluiden kehitykseen tai tutkimustoimintaan. Kaikille kyselyyn osallistuneille toimitetaan yhteenveto tutkimuksen tuloksista.

Tutkimushankkeen tavoitteena on arvioida kehitysprojektien erilaisten johtamistapojen vaikutuksia projektiryhmän innovatiivisuuteen ja suorituskykyyn:

1. Miten innovatiivisuutta ohjataan kehitysprojekteissa?

2. Milloin tiukasti määritelty / väljempi ohjausjärjestelmä ja johtamistapa sopii parhaiten?

3. Miten projektipäällikön persoonallisuus vaikuttaa hänen tapaansa johtaa projektia?

Kyselylomakkeeseen vastaaminen ei vie paljoa aikaa ja kaikki vastaukset säilyvät nimettöminä ja käsitellään täysin luottamuksellisesti.

Keskustelen mielelläni tutkimukseeni liittyvistä asioista, mikäli haluatte tietää enemmän hankkeestani.

Vastaathan kyselyyni mahdollisimman pian, kuitenkin viimeistään 24.3.2003 mennessä!

Kiitos avustasi tutkimukseeni liittyen ja hyvää kevättä! Lähetän sinulle yhteenvedon tutkimukseni tuloksista.

Terveisin
Mika Ylinen, KTM
E-mail: myl@uwasa.fi mika.ylinen@puv.fi
Tel(GSM): +358400617700
Tel: +35863263570

Dear project manager!

About two weeks ago I sent an inquiry by e-mail to you concerning my doctoral thesis research project. My wish is that as the expert of the project management you could move your views and your experience in the address to my study by answering a questionnaire: http://www.bet.puv.fi/mika.ylinen

I understand that it is hard to find time for answering an inquiry because of daily work duties. However, I hope that you could find time to participate my study. As the expert of the project management your participation to my study is extremely important! If you have answered already my inquiry, I thank you from your participation and help to my study!

The study has been directed to persons who operate or have worked in the management tasks of the development project. The development project can be connected to the development or research activities of an organisation, business, operation processes and ways of action, information processing systems, the new products and services. A summary of the results of the study is delivered to the ones, which had participated in the inquiry all.

The objective of the research project is to estimate the effects of the different management methods of development projects on the innovativeness and performance of the project group:

1. How is the innovativeness directed in development projects?

2. When tightly defined / loose project management control system works best?

3. How does the project manager's personality have effect his way to lead the project?

The answering a questionnaire does not take much time and all the answers remain anonymous and it is totally confidentially dealt with. I discuss willingly the matters, which are related to my study if you want to know more about my project.

Please answer my questionnaire as soon as possible, however, at the latest by 24.3.2003!

Thanks for your help to my study joining and good spring! I send summary from the results to you.

With regards

Mika Ylinen, M.Sc. (Economics)
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PERFORMANCE MEASUREMENT AND MANAGEMENT CONTROL SYSTEMS FOR DEVELOPMENT PROJECTS

Please answer the following questions of this survey from the point of view one project that is ending or has ended and in which you have been the project manager.

Project Control System	
Please rate the degree of your agreement with the following items:	1 = Strongly Disagree to 7 = Strongly Agree
1. I judged my project team performance with performance measures that explain in detail project performance variances on a line- by-line basis.	0
2. I was not only interested how well my project team achieves overall project performance target but I also evaluate how well my project team is on target on each of the project performance line items.	0
3. I attached a great deal of importance to interim project performance target deviations from budgeted performance and project milestones.	0
4. I used performance target variances as a pressure device for my project team to emphasize the need to meet project performance targets.	0
5. I require my project team sub-ordinates to report the actions taken to correct causes of interim project performance target variances.	0
Please rate the degree of your agreement with the following items:	1 = Strongly Disagree to 7 = Strongly Agree
1. I called my project team sub-ordinates in to discuss project performance deviations in face-to-	0

face meetings.	
2. Myself, and my own project team subordinates often discussed informally and solved project performance matters together.	0
3. Project performance matters are discussed regularly with my project team sub-ordinates even if there were no negative performance target deviations to report.	0
Tolerance for Ambiguity	
Please rate your agreement with following statements about how you deal with uncertainty:	1 = Strongly Disagree to 7 = Strongly Agree
1. I function very poorly whenever there is a serious lack of communication in a job situation.	0
2. In a situation in which other people evaluate me, I feel a great need for clear and explicit evaluations.	0
3. If I am uncertain about the responsibilities of a job, I get very anxious.	0
4. If I were a scientist, I might become frustrated because my work would never be completed (because science will always make new discoveries).	0
5. If I were a doctor, I would prefer the uncertainties of a psychiatrist to the clear and definite work of someone like a surgeon or X-ray specialist.	0
6. Once I start a task, I don't like to start	0

another task until I finish the first one.	
7. Before any important job, I must know how long it will take.	0
8. In a problem-solving group it is always best to systemically attack the problem.	0
9. A problem has little attraction for me if I don't think it has a solution.	0
10. I do not like to get started in group projects unless I feel assured that the project will be successful.	0
11. In a decision-making situation in which there is not enough information to process the problem, I feel very uncomfortable.	0
12. I don't like to work on a problem unless there is a possibility of coming out with a clear-cut and unambiguous answer.	0
13. Complex problems appeal to me only if I have a clear idea of the total scope of the problem.	0
14. A group meeting functions best with a definite agenda.	0
Task Uncertainty	
Please rate the level of uncertainty faced in your project:	Items are coded 1 = to a small extent, 7 = to a great extent scale unless otherwise noted.
1. How repetitious were the duties of those in your project? (Very	0

little…very much)	
2. To what extent would you say the work of your project was routine?	0
3. Basically, project members performed repetitive activities in doing their jobs.	0
4. How many of the tasks in your project were the same from day to day? (very few…most of them)	0
5. People in my project did about the same job in the same way most of the time.	0
6. To what extent was there an understandable sequence of steps that can be followed in doing the work of your project?	0
7. To what extent was there an understandable sequence of steps that can be followed in carrying out the work in your project?	0
8. To what extent was there a clearly known way to do the major types of work normally encountered in your project?	0
9. To what extent was there a clearly defined body of knowledge of subject matter, which can guide the work done in your project?	0
10. To do the work of your project, to what extent could personnel actually rely on established procedures and	0

practises?	
Project Innovation Performance	
Please rate the level of innovativeness of your project team:	Anchored by 1 = Extremely low, and 7 = Extremely high
Innovative accomplishments are defined here very broadly to include any policy, structure, method or process, product or market opportunity that you as the manager of the project perceived to be new.	
1. The level of my project team innovation performance (number of innovations) measured relative to project performance targets (standards).	0
2. The level of my project team measured innovation performance (number of innovations) relative to other project teams measured innovation performance working in the same type of projects.	0
3. The level of my project team measured innovation performance.	0
Project performance	
Please rate the level of performance of your project team:	Anchored by 1 = Extremely low, and 7 = Extremely high
1. The level of my project team measured performance relative to my performance targets (standards).	0
2. The level of my project team measured performance relative to other project teams measured performance working in the same kind of project.	0

3. The level of my project team measured performance.	0
Background information	
Project type	
What was the main type of the project?	
Technical or administrative development:	Please choose the right item
Technical development project. The main goal was to develop new products, services, or production process technology; that is project is related to the basic work activity of the organization.	○
Administrative development project. The main goal was to develop organizational structure and administrative processes; that is, project is indirectly related to the basic work activities of the organization and more directly related to its management.	○
1. Please indicate the main industry of your organization.	
2. During the project how many people approximately worked for your project?	
3. What was the duration of the project (in months)?	
4. What was the project budget approximately (in euros)?	
5. What is your functional area in	

organization?	
Production	◉
Marketing	○
R&D	○
IT	○
Administration	○
Something else	○
If something else, what is your functional area?	[ ]
Contact information	
If you would like a copy of the final report please provide a contact person and address.	[ ]
THANK YOU VERY MUCH FOR YOUR TIME!	
Please press the Submit button below to send your answers.	

Submit Reset

KYSELY KEHITYSPROJEKTIEN JOHTAMISESTA

Vastaa tämän kyselyn kysymyksiin jonkin johtamasi projektin näkökulmasta, joka on jo päättynyt tai on pian päättymässä.

Projektin johtaminen	
Arvioi omia menetelmiäsi ja tapaasi johtaa projektia:	1 = Täysin eri mieltä, 7 = Täysin samaa mieltä
1. Arvioin projektiryhmäni suorituksia mittareilla, jotka mittasivat yksityiskohtaisesti projektin suorituskyvyn vaihtelua kaikilla suorituskyvyn eri osa-alueilla (kustannukset, aika ja laatu).	0
2. En ollut kiinnostunut ainoastaan projektille asetetun yleisen päätavoitteen saavuttamisesta, vaan seurasin tarkasti projektiryhmäni suorituksia suhteessa asetettuihin välitavoitteisiin kaikilla projektin suorituskyvyn osa-alueilla.	0
3. Kiinnitin runsaasti huomiota suorituskyvyn poikkeamiin suhteessa projektille asetettuihin välitavoitteisiin.	0
4. Käytin suorituskyvyn poikkeamia projektille asetetuista välitavoitteista painostuskeinona korostaakseni projektiryhmälleni tavoitteiden saavuttamisen tärkeyttä.	0
5. Projektiryhmäni oli raportoitava minulle niistä toimenpiteistä, joita poikkeamien eliminoimiseksi projektille asetetuista välitavoitteista oli tehty.	0
Arvioi tapaasi kommunikoida projektiryhmäsi kanssa seuraavien tekijöiden suhteen:	1 = Täysin eri mieltä, 7 = Täysin samaa mieltä
1. Kutsuin projektiryhmäläisiäni	0

keskustelemaan kanssani kasvotusten poikkeamista, jotka liittyvät projektin suorituskyvylle asetettuihin välitavoitteisiin.	
2. Keskustelin projektiryhmäni kanssa usein epävirallisesti ratkoaksemme yhdessä projektille asetettujen tavoitteiden saavuttamiseen liittyviä ongelmia.	0
3. Keskustelin projektiryhmäni kanssa säännöllisesti projektin suorituskykyyn liittyvistä asioista, vaikka projekti etenikin täysin ennalta laaditun suunnitelman ja asetettujen tavoitteiden mukaisesti.	0
Suhtautuminen epävarmuuteen	
Arvioi suhtautumistasi epävarmuuteen seuraavien tekijöiden suhteen:	1 = Täysin eri mieltä, 7 = Täysin samaa mieltä
1. Mikäli kommunikointi työtilanteessa on puutteellista, työskentelen huonosti.	0
2. Tilanteessa jolloin muut ihmiset arvioivat minua, koen tarvetta selkeisiin ja täsmällisiin arviointiperusteisiin.	0
3. Tulen levottomaksi, mikäli olen epävarma työtehtävääni liittyvistä velvollisuuksista ja vastuualueista.	0
4. Mikäli olisin tiedemies, saattaisin turhautua, koska työni ei tulisi koskaan täysin valmiiksi (sillä tiede tekee jatkuvasti uusia keksintöjä ja löydöksiä).	0
5. Mikäli toimisin lääkärinä, pitäisin mielekkäämpänä vaihtoehtona	0

psykiatrin tointa kaikkine työnkuvaan liittyvine epävarmuustekijöineen kuin selkeää ja täsmällistä kirurgin tai röntgenlääkärin työnkuvaa.	
6. En halua aloittaa uuttaa työtehtävää ennen kuin olen saanut edellisen valmiiksi.	0
7. Ennen kuin aloitan mitään tärkeään työtehtävää, minun on tiedettävä kauanko se vaatii aikaa.	0
8. Ongelmanratkaisuryhmässä on aina parasta lähestyä ongelmaa järjestelmällisesti.	0
9. Ongelman ratkaisun etsiminen ei juurikaan kiinnosta minua, mikäli uskon, että se ei ole ratkaistavissa.	0
10. En halua aloittaa projektiryhmässä ellen ole vakuuttunut, että projekti tulee onnistumaan.	0
11. Tunnen oloni epämiellyttäväksi päätöksentekotilanteessa, jossa ei ole tarpeeksi informaatiota ongelman käsittelemiseksi.	0
12. En halua työskennellä ongelman parissa, ellei ole mahdollista päätyä selväpiirteiseen ja yksiselitteiseen ratkaisuun.	0
13. Monimutkaiset ongelmat kiinnostavat minua ainoastaan, mikäli minulla on selkeä käsitys ongelman kokonaislaajuudesta.	0
14. Ryhmäpalaveri toimii parhaiten,	0

mikäli käytössä on selkeä asialista.	
Projektiin liittyvä epävarmuus	
Arvioi projektiisi liittyvää epävarmuutta seuraavien tekijöiden suhteen:	1 = Vähäisessä määrin, 7 = Suuressa määrin
1. Miten samanlaisina toistuvia projektiin liittyvät tehtävät olivat? (hyvin vähän...hyvin paljon)	0
2. Missä määrin projektiin liittyvät työtehtävät olivat mielestäsi rutiininomaisia?	0
3. Yleisesti ottaen projektiryhmäläiset suorittivat samanlaisina toistuvia työtehtäviä koko projektin ajan.	0
4. Kuinka suuri osa projektiryhmäsi työtehtävistä oli samanlaisia päivästä toiseen? (hyvin pieni osa...suurin osa)	0
5. Projektiryhmäläiset tekivät projektissa suunnilleen samaa työtä lähes samalla tavalla suurimman osan aikaa.	0
6. Missä määrin projektissa oli ymmärrettävissä oleva työvaiheiden järjestys, jota voitiin seurata projektin suorittamisessa?	0
7. Missä määrin projektissa oli olemassa ymmärrettävissä olevat selkeät toimintaohjeet, joita voitiin noudattaa projektin eri työvaiheita suoritettaessa?	0
8. Missä määrin projektissa oli olemassa selkeästi tiedossa oleva tapa suoriutua projektiin liittyvistä päätehtävistä?	0
9. Missä määrin projektiin liittyvistä	0

työtehtävistä oli olemassa selkeästi määriteltyä tietoa, joka ohjasi projektiryhmää tehtävien suorittamisessa.	
10. Suoriutuakseen projektiin liittyvistä työtehtävistä, missä määrin projektiryhmäläiset pystyivät noudattamaan vakiintuneita menettelytapoja ja käytäntöjä?	0
Projektiryhmän innovatiivisuus	
Arvioi projektiryhmäsi innovatiivisuutta ja projektin tuloksia seuraavien tekijöiden suhteen:	1 = Erittäin pieni, 7 = Erittäin suuri
Innovaatio on määritelty tässä yhteydessä hyvin laajasti käsittäen minkä tahansa uuden toimintatavan, järjestelmän, menetelmän, prosessin, tuotteen tai markkinamahdollisuuden jonka omasta mielestäsi koet uudeksi.	
1. Projektiryhmäni tuottamien uusien innovaatioiden määrä suhteessa projektille asetettuihin tavoitteisiin.	0
2. Projektiryhmäni tuottamien innovaatioiden määrä suhteessa muihin vastaaviin projektiryhmiin, jotka työskentelevät saman tyyppisissä projekteissa.	0
3. Yleisarviosi projektiryhmäsi innovatiivisuudesta projektissa.	0
Projektin suorituskyky	
Arvioi projektin tuloksia seuraavien tekijöiden suhteen:	1 = Erittäin matala, 7 = Erittäin korkea
1. Projektin suorituskyky suhteessa	0

asetettuihin tavoitteisiin.	
2. Projektin suorituskyky suhteessa muihin vastaaviin projekteihin.	0
3. Yleisarviosi projektin suorituskyvystä.	0
Projektin tyyppi	
Kumpaa oheisista tyypeistä johtamasi kehitysprojekti enemmän on/oli?	Valitse oikea vaihtoehto
Technical development project. Projektin tavoitteet liittyivät uuden tuotteen, palvelun tai näiden tuotantoprosesseihin liittyvän teknologian kehittämiseen.	○
Administrative development project. Projektin tavoitteet liittyivät organisaation rakenteen ja hallinnollisten prosessien kehittämiseen ja keskittyvät siten organisaation johtamisen ja tukitoimintojen kehittämiseen.	○
Projektin taustatiedot	
1. Yrityksesi toimiala?	
2. Kuinka monta henkilöä projektiryhmääsi keskimäärin kuului?	
3. Mikä oli projektin kesto kuukausissa?	
4. Mikä oli projektin budjetti suunnilleen (euroissa)?	
5. Mihin organisaatiosi toimintoon kuulut?	Merkitse oikea vaihtoehto

Tuotanto	○
Tuotekehitys	○
Markkinointi	○
Hallinto	○
IT	○
Jokin muu	◉
Mikäli vastasit jokin muu, mikä se on?	
Yhteystiedot	
Mikäli haluat raportin tutkimuksen tuloksista, täytä yhteystiedot mihin raportti voidaan lähettää.	
KIITOS YHTEISTYÖSTÄ!	
LÄHETTÄÄKSESI VASTAUKSESI PAINA ALLA OLEVAA LÄHETÄ-PAINIKETTA.	**MIKÄLI SINULLA ON ONGELMIA LÄHETYKSEN KANSSA OTATHAN YHTEYTTÄ: mika.ylinen@puv.fi**

Lähetä | Tyhjennä