2009

Management control systems: a model for R&D units

Parulian Silaen
University of Wollongong, parulian@uow.edu.au

Robert B. Williams
University of Wollongong, bobwil@uow.edu.au

Publication Details

Silaen, P. & Williams, R. B. (2009). Management control systems: a model for R&D units. Accounting Research Journal, 22 (3), 262-274.

Management control systems: a model for R&D units

Abstract
Purpose - The purpose of this paper is to develop a proposal for a new conceptual framework for management control systems (MCS) in R&D units. Design/methodology/approach - The paper is a descriptive study that reviews the control literature and proposes an MCS framework in the light of four key elements: desired ends, actors, control implementation, and control tools. Findings - The study found two sub-elements of desired ends (directional and yardstick) to be complementary in a low level of uncertainty, while directional should be emphasized more in a high level of uncertainty. Five sub-elements of actors are used differently along the levels of uncertainty. The timing and use of formal and informal control types are found to be different regarding the level of uncertainty. Finally, the dimension and the value of control tools are used differently in those two distinctive situations. Research limitations/implications - The paper is limited to a descriptive study that may have further implication for research by using the framework to investigate the MCS applied by R&D units. Practical implications – The four key elements of MCS may be used in practice by developing a detail measure of each element to suit the condition of the unit. Originality/value - The paper is a new way of looking at MCS, broadening the comprehension, and introducing new MCS key elements.

Keywords
units, r, control, model, management, systems

Publication Details
Silaen, P. & Williams, R. B. (2009). Management control systems: a model for R&D units. Accounting Research Journal, 22 (3), 262-274.

Management Control Systems: A Model for R&D Units

INTRODUCTION

The purpose of research and development (R&D) activities is to contribute new knowledge, whether or not these activities have specific commercial objectives (Place, 1977). This may include creating new or improved devices, products, process systems, and concepts (Nason, 1981). Since the task is characterised by non-repetitive activities, the causal relationships may be poorly understood in advance and thus creates uncertainty (Duncan, 1972).

Environmental uncertainty may influence the effectiveness of goal setting, planning and control systems simultaneously. Since goals and planning have a close relationship with the control function, (Euske, 1984; McCaskey, 1974), the different characteristics of goals and planning (McCaskey, 1974; Davila, 2000) may influence the choice of control systems (Chenhall, 2003; Davila, 2000; Abernethy & Brownell, 1997; Hartmann, 2000). This study proposes a management control systems (MCS) framework for a R&D organisation in the light of four key elements of a MCS, namely Desired Ends, Actors, Control Implementation, and Control Tools. The paper presents a discussion on the significance of the roles of each element in different stages of control strategy as well as some examples of how they are used in practice. Finally, the paper will close with a conclusion including suggestion for further research.

RESEARCH AND DEVELOPMENT ORGANISATIONS

R&D activities are described differently among authorities. The US National Science Foundation (NSF) devided the R&D task into three categories: Basic research, applied research, and development (Rockness & Shields, 1984, p. 169).

Place (1977) held a view that the output of R&D activities is knowledge that involves a learning process. Place (1977) classified two types of learning process; Type I and Type II learning. Type I learning is the extension of present areas of knowledge, it is more certain and predictable. It can be scheduled and budgeted for even if it requires a longer time and larger investment, and it may be found in applied research but more likely in product development (Place, 1977).

Type II learning requires an intuitive leap away from the present areas of knowledge, and result in brand new knowledge. It cannot be kept on schedule and budget. The program is exciting and rapid, and demands a relatively small investment. Though it is difficult to place a clear boundary between basic and applied research (Nason, 1981), the Type II learning process is likely to occur during the basic research up to applied research activities.

The R&D operation is clearly a learning process to transform the unknown to the known, which needs innovative scientists and management to translate it into viable business projects. The behaviour of the scientists may be different from those assumed by administrative behaviour that tends to be bounded by rigid rules and procedures. The scientists might require a fair degree of autonomy (Abernethy & Stoelwinder, 1991) to give them a space for innovation.

ORGANISATIONAL ENVIRONMENT AND GOALS

Thompson (1967, p. 127) referred to goals as "...some imagined state of affairs which may conceivably be attained or approached (if not finite) at some future time." Latham & Yukl (1975, p. 824) used a simple definition of goals, being "...what the individual is consciously trying to do." If goals were defined as a psychological trait, then the goal characteristics will depend upon individual perception that affects the goal setting process. The organisational goals are not without problems either (Weick, 1969). March (cited in Cooper et al, 1981, p. 181) suggested that it appeared to him to be

> ... perfectly obvious that a description that assumes goals come first and action comes later is frequently radically wrong. Human choice behaviour is at least as much a process for discovering goals as for acting on them.

Chenhall (2003, p. 135) also supports this view by saying;

> Distinguishing official and operative goals would seem an essential aspect of MCS [*Management Control Systems*] research that includes consideration of goals, mainly as it flags that the issue of organisational goals is far from unproblematic.

Some authorities proposed different approaches than economic rationality in goal setting (Cohen, et al, 1972; Cooper et al, 1981; March & Simon, 1958; March, 1978; Lindblom, 1959). Cohen et al. (1972) characterised intangible goals as organised anarchies where problematic preferences, unclear technology, and fluid participation exist. March & Simon (1958) suggested a bounded rationality model to replace economic rationality. March (1978) proposed the technology of foolishness as the basis for action. Lindblom (1959) proposed the science of muddling through, while Gouldner (1959, cited in Georgiou, 1973, p. 293) proposed a natural system model that viewed an organisation as an organism and its primary concern is to survive. Those alternative views direct the choice to a position, which emphasises learning and adaptive behaviour. The choice of the directions is based on their priorities in relation to the announced goals and is bounded by the constraints dealt with by the organisation. However, once the directions are perceived to be inappropriate, then other directions may be chosen to replace the old direction. This is a continual process of action during the organisation's life in which the R&D organisations may deal with this type of situation.

ORGANISATIONAL ENVIRONMENT AND CONTROL

Environmental uncertainty has been seen to require different control systems (Chenhall, 2003; Davila, 2000: Abernethy & Brownell, 1997: Hartmann, 2000). Amigoni (1978) conducted a literature review on management control systems (MCS) and suggested that effective control systems should match appropriate combinations among three important elements: *independent variables*, *distinctive features of the management control systems*, and *control tools*. However, the study by Amigoni (1978) tied the influence of environmental characteristics to the choice of control systems, and ignored the qualities of goals and planning that would probably have had more effect on the choice of MCS. When goals are ambiguous and technologies uncertain by nature, the applicability of the control concepts, which pretend that goals come before action, will be problematical (Euske, 1984; Otley and Berry, 1980). Similarly, Chenhall (2003, pp. 137-138) concluded that;

> …it can be seen that a consistent stream of research over the past 20 years has confirmed that uncertainty has been associated with a need for more open, externally focused, non financial styles of MCS. However, hostile and turbulent conditions appear, in the main, to be best served by a reliance on formal controls and an emphasis on budgets. The question may be posed, what is the appropriate MCS for organisations operating in conditions of uncertainty, turbulence and hostility?

Ouchi (1977) examined the appropriateness of two types of control: *behaviour control* and *output control* in 78 retail department store companies in the USA. *Behaviour control* refers to control of behaviour of subordinates by watching and guiding their behaviour toward the expected behaviour preferred by the supervisors. *Output control* refers to the measurement of output in which knowledge of the transformation process is not compulsory. Ouchi (1977) indicated that better knowledge of the transformation processes is associated with less emphasis on output control, except for sales person groups. For this group it was indicated that output control was predominantly used. These findings led him to conclude that the availability of an output measure would influence the emphasis on output control.

In the case of a R&D organisation, it is plausible to suggest that it may be difficulty in measuring the output, and so there should not be an emphasis on output control. Some studies that investigated the behavioural aspect of control systems indicated that the failure to match appropriate control systems with goal characteristics caused undesirable results such as job related tension (Hopwood, 1972) and manipulative behaviour (Birnberg, et al., 1983).

In R&D organisations, the creativity of an individual plays an important part (Gibson, 1981). The tension and/or pressure resulting from the control system that may reduce creativity and innovation (Gerstenfeld, 1970) such as to emphasis on the financial dimension alone should be avoided and shifted to other dimensions (Govindarajan, 1984).

MANAGEMENT CONTROL SYSTEMS (MCS) FRAMEWORK

Giglioni & Bedeian (1974) reviewed the literature on the evolution of the management control concept from 1900 to 1972. Their historical study identified some definitions of management control in the early literature. Newman (1951, cited in Giglioni & Bedeian, 1974, p. 298) wrote of three control elements as; standards or plans, motivation, and corrective action. Brech (1965) assumed that objectives and targets are measurable quantitatively and/or in monetary terms and to be used to measure performance. Ouchi (1977, pp. 96-97) also held a similar position by saying that,

> ...the control system itself consists primarily of a process for monitoring and evaluating performance, while the preconditions specify the reliability and validity with which such comparisons can be made.

The above still contain the notions of the control concept defined in the earlier literature by making the standard criteria central to the function of the control mechanism and presume that the environment is certain. Birnberg & Snodgrass (1988) hold the view that organisational control is a mechanism designed to modify the behaviour of performers through delimiting the decision space. Flamholtz (1983) viewed the control function as a behavioural modification process. Chua et al. (1989, p.4) extended the control literature by pointing out three meanings of control:

> ...one, as a means of steering or regulation, which is the classical cybernetic meaning: a second as a means of domination of one or more people or groups of people by other people or groups, which has more sociological and political overtones: and a third, as a process of the management of control and power.

From the discussion above, four broad core elements of MCS can be identified. They are *desired ends*, *actors*, *control implementation*, and *control tools*.

Desired ends

The *desired ends* refer to the expected ends or the final destination of an action at the end of an operational cycle. These ends, if tangible and physically quantifiable, are used as measurement criteria where the comparison process can take place. The *desired ends* may have two aspects; the *direction* of an action to describe where to go, rather than what to achieve and the *yardstick* to measure the progress of an action or the result of an action.

When the organisation deals with environmental certainty and the desired ends can be translated into precise and reliable quantitative figures, then the emphasis would be on the *yardstick*. In a situation of uncertainty as dealt with by a R&D unit however, the means-ends relationships are unclear, the prediction of future events and consequences cannot be made relatively accurately, and the *desired ends* cannot be translated reliably into quantitative features. Therefore, the *desired ends* may only contain the *direction* to guide the action and cannot be used accurately to measure the performance quantitatively.

The use of these elements may be seen as applied by the 3M Company, which is a well-known innovation base company. The 3M Company has various policies and philosophies that support the use of direction as its desired end (Anthony and Govindarajan, 2007, p. 596) such as the Dual-Ladder Career Path, Genesis Grants and the Carlton Award. The Dual-Ladder Career Path is a policy that allows the employees to be promoted without sacrificing their research or professional interests. Genesis Grants is a policy to provide internal funds up to $50,000 for researchers to develop and market test prototypes, and the Carlton Award is given to employees as recognition of outstanding and technical contribution within the company (Collins and Porras, 1997, p.156).

3M encourages its employees toward innovative behaviour as a direction by allowing 15 percent of their workload to be used on individual projects of their choice, and combined with the dual-ladder career path to allow them to stay focused on their research or professional interests. Considering that the desired ends are dominated by a directional characteristic that is difficult to measure quantitatively, 3M may adopt a policy that has a tolerance for failure (Anthony and Govindarajan, 2007, p. 596).

Actors

The element of *actors* refers to individuals or groups of individuals within a system as the objects being controlled. Five aspects are embodied in the element of *actors,* they are; *behavioural*, *domination, power*, *decision space* and *motivation*. The *behavioural* aspect refers to behaviour that is preferred by the system where the actors operate, such as the achievement of the desired ends that may or may not be objectively measurable. The use of preferred behaviour particularly for researchers, is also applied by 3M as indicated by its policy of the Genesis Grant and the Carlton Award (Anthony and Govindarajan, 2007, p. 596).

Domination refers to the ability to influence others in making decisions, and *power* refers to the degree of strength of the influencing capacity. Though it is difficult to distinguish *domination* from *power*, this study considers them distinct. An individual within the organisation may have an ability to dominate others, however, the strength of the dominating ability will relate to the degree of power the individual has in hand. Keeping these two aspects distinct may allow a more detailed analysis of the MCS. The existence of these aspects seems to be considered by the 3M Company in the use of the Dual Ladder Career policy (Anthony and Govindarajan, 2007, p. 596) that separates the technical and bureaucratic authority, so domination between the two can be avoided.

Decision space refers to the degree of autonomy given to an individual to act within the system such as job description or job specification, and amount of time or funds allocated. An

example of the use of this aspect can also be seen implemented by 3M in its "15 percent option" policy (Anthony and Govindarajan, 2007, p. 596). *Motivation* is another important aspect in the element of actors. The MCS should be able to identify potential factors to motivate the actor being controlled to remain within a preferred behaviour such as monetary reward or bonus and hierarchical promotion. However, when the actors prefer to place their reputation ahead of monetary and hierarchical promotion (Luecke, 1973), other potential motivational factors are needed. This can be seen in the Carlton Award policy of 3M Company (Anthony and Govindarajan, 2007, p. 596).

As the operation of a R&D facility depends greatly on the individual abilities and dedication of its personnel, the actor dimension is a very important part of the MCS. Without the abilities and dedication of the personnel the facility will not function.

Control Implementation

Control implementation consists of two main aspects; *control types* and *control implementation stages*. Regarding the types, this study suggests two types of control may be applied; *formal* and *informal control*. The *formal control type* is an explicit process that is carried out to influence actors in making a decision. The *formal* control type will be carried out with regard to written norms such as accounting reports, job description, employee appraisal system, budget, rules, standards, statistical reports, and diagrams such as PERT and CPM.

The *informal control type* is an implicit process to influence actors in making decisions and will be implemented with regard to norms and values that form a belief among individuals within an organisation. The accumulation of norms and values may emerge from two sources that construct two types of informal control: *surveillance* and *cultural* control. *Surveillance* control may come from written norms and values that have been internalised by the actors, and applied to the actors who perform the tasks by watching and guiding them toward the proper way of performing the tasks. *Cultural* control is the accumulation of norms and values that are originated from common norms, beliefs, and shared values among the actors in a group without having any relationship with written norms. The use of cultural control can be seen in the use of a Technology forum by 3M (Anthony and Govindarajan, 2007, p. 596). This forum allows technical people to present papers and exchange ideas and findings (Collins and Porras, 1997, p. 157).Cultural control is very relevant to a R&D situation where the scientists and engineers are linked by shared values relating to research and innovation.

This study proposes three *stages of control implementation*. Firstly, *input control* which is carried out during the selection and the provision of input that will be used for an operation.

The second stage is *process control* that is performed during the operation to monitor how tasks are performed, and the third is *output control* that is carried out to measure the outputs achieved.

Control tools

The control tools refer to instruments that are used in performing the control function concerning the desired ends. For example, control tools that include the concept of Key Performance Indicators (KPI) can be found in the control literature. However, the desired ends are commonly multiple and vague, and therefore they need agents to represent the value embodied in the desired ends. The fundamental role of the control tools is to represent both the value of the desired ends and the effort, so the control function can monitor, compare and evaluate how far the effort is performed. This study proposes two elements of control tools: *dimensions* and *values of representation*.

The dimension refers to solid characteristics that are used by the control tools regarding the desired ends. Four groups of the dimensions are proposed: Directional, Bureaucratic, *Scientific* and *Financial*. The *directional dimension* refers to control tools that contain qualitative characteristics that represent the general directions to be followed by the action such as system goals and general policy guidelines. The *bureaucratic dimension* refers to either quantitative or qualitative characteristics which represent the technical tasks, such as standard operating procedures, quality control, inventory control, and scheduling including PERT, CPM, and production scheduling. The *scientific dimension* contains the control tools that are used particularly in a R&D organisation to measure ideas and innovations such as new or improved processes, products or techniques, patents and patent applications, scientific publications, and membership of professional organisations. The *financial dimension* refers to the control tools that contain monetary measurement and includes budgets, cost effectiveness report, standard costs, and return on investment.

Three *values* of representation are proposed: *external values*, *internal values*, and *social values*. *External value* refers to values that are developed by an external party such as a market mechanism to define a fair price for transfers (Ouchi, 1979; Lebas & Weigenstein, 1986) and scientific publications in the case of R&D. *Internal values* refer to values that are developed by an internal party by reference to the internal conditions. The internal values can be seen in the bureaucratic control (Ouchi, 1979, Lebas & Weigenstein, 1986) that is commonly labelled by setting rules, standard operating procedures and policies, and standard costs. This value setting process may be done by force by the dominant party within the organisation. Therefore, it would have a greater chance for dysfunctional behaviour if it is used in a highly uncertain and low goal congruence situation as in the case of R&D units.

Social values are values that result from social interaction among the members of a group of individuals, and may be reflected by the organisational culture. This value is not done by force; rather, it is accepted by the members willingly. The social values are not disturbed by clear or unclear boundaries of desired ends, because they are set by the social interactions that have a chance to change over time. Therefore, the use of social values in the control system will have less chance for dysfunctional behaviour than the internal values. These values are obviously displayed by a R&D unit through seminars and scientific publications. Though this study divided the values represented by the control tools into three types, it should be kept in mind that in exercising the control tools there would be a combination among these values embodied in the set of control tools applied.

THE RELATIONSHIP AMONG CORE ELEMENTS OF MCS

Take in Figure 1

Desired Ends and Control Tools

The relationship among core elements of control is suggested as depicted in figure 1. The relationship between the *desired ends* and the *control tools* occurs during the three important functions of the MCS: monitoring, evaluation, and performance measurement. The MCS will use the control tools to monitor, measure, and evaluate the action by reference to the desired ends. With regard to the yardstick, the MCS will measure and evaluate how far the action has achieved the expected outputs. Whereas, with respect to the directional dimension, the MCS will function to ensure that the actions are in the correct directions for achieving the desired ends.

When dealing with environmental certainty, the control tools may emphasise the yardstick dimension. As it is envisaged by that perfect situation, the expected output may be relatively complete and accurate in representing the characteristics of the desired ends while the direction will still be used to indicate where to go. This will encourage the use of internal values of control tools which commonly involve quantitative attributes such as; standard cost, budget, financial ratios, and statistical quality control. In contrast, under environmental uncertainty as in a R&D unit the MCS may focus on the directional dimension and use either external or social values (Abernethy and Brownell, 1997; Chenhall, 2003).

Desired Ends and Actor

The relationship between *desired ends* and *actor* essentially relies on the behavioural dimension, that is, how preferred behaviour is defined in regard to the desired ends. Under a perfect situation, preferred behaviour is clear, that is, the achievement of a clear and certain desired end. The motivational element may be based on monetary and other hierarchical promotions. Moreover, the delegation of authorities along the hierarchy will be clear and then

the decision space can be defined precisely. In turn, the capacity to dominate others may come from the formal network, and the power to influence others will be dominated by the formal source rather than the informal (Abernethy and Brownell, 1997; Chenhall, 2003).

In a situation dealt with by a R&D unit, the behaviour is guided toward the desired ends which are dominated, by the directional dimension rather than the yardstick. Motivation may need to be extended to cover individual satisfaction such as reputation and professional acknowledgment. Moreover, as it is caused by unclear and less quantifiable goals, the delegation of authority among individuals would not be clear and the decision space for every individual cannot then be defined precisely. The domination and the source of power may not only come from the formal but also from the informal network including seniority and professional norms as indicated by research awards.

Desired Ends and Control Implementation

The relationship between the *desired ends* and *control implementation* is related to the implementation of the predominant control type between the two dimensions of desired ends. Many studies have examined this relationship (Hopwood, 1972; Govindarajan, 1984; Hirst, 1983; Abernethy & Stoelwinder, 1991, Abernethy and Brownell, 1997; Tatikonda & Rosenthal, 2000; Ditillo, 2004; Bonner, et al, 2004). Most of those studies indicated that when the desired ends are dominated by the yardstick, the MCS uses formal and the surveillance type of control. In contrast, when the directional dimension dominates the desired ends as in a R&D unit, informal control (particularly cultural control) may play an important role in the MCS.

Actors and Control Tools

The relationship between the *actors* and *control tools* traditionally rests on the function to measure behaviour. Output is commonly measured as a surrogate for behaviour. However, at an extreme point where the appropriate outputs cannot be taken for granted as in a R&D unit, the behaviours cannot be measured with regard to the output resulting from behaviour. In this situation, the control system cannot precisely monitor and evaluate the output, which is derived from the behaviour. Moreover, to monitor and to evaluate an action does not necessarily mean to measure it quantitatively. The action can be monitored and evaluated with regard to the direction. Therefore, this study does not view the control function as limiting the measuring process, rather as consisting also of the process of influencing behaviour. The influencing process may be carried out through the other four actors' elements.

Domination, power and decision space may be influenced by four dimensions of control tools. For example, directional and bureaucratic dimensions may limit the decision space of the actor, therefore making a decision possible only within a particular area. In turn, those dimensions will also reduce the power and domination of the actor in influencing his or her peers in making a decision. The reduction of power and domination may result from delimiting the decision space. The scientific and financial dimensions may also have the same effect on decision space. As in the case of a R&D unit, when the independent panel or expert rating can evaluate the appropriateness of the scientific quality proposed, the actors' decision space would be bound by that quality. Similarly, the budget availability would also limit the actors in making a financial decision.

Actors and Control Implementation

The relationship between the *actors* and the *control implementation* refers to the use of the control type to influence the actor. In a situation of certainty, the formal and surveillance control type may be applied by the MCS. In addition, it can also be used to monitor and evaluate whether the actors operate within the decision space that is given. However, for a R&D unit, the cultural control would be preferred more than the formal and surveillance control that may lead to dysfunctional behaviour.

Control Tools and Control Implementation

The relationship between *control tools* and *control implementation* refers to when and how the tools will be used. As the instruments of the control function, the control tools may be used by the formal and informal control type. However, most of the control tools in the literature seem to have quantitative expression, although some of the control tools may have qualitative characteristics such as bureaucratic evaluation, political public affairs, directional constraint and

general policy guidelines. Obviously, the control tools are used by the formal control rather than the informal control. Though it is difficult to place a clear boundary on the use of control tools between the two, in some ways the use of the control tools may be distinct, and needs to be defined by reference to those two control types.

The control tools used by the formal control type are clearly defined in the literature as written norms and may use any or a combination of the four dimensions of control tools. Accordingly, there are some tools used by informal control and these include shared values (Hopwood, 1974), personal objectives (Jaworsky, 1988), mutual commitments among employees toward objectives (Hopwood, 1974; Ouchi, 1979; Jaworsky, 1988), and norms (Jaworsky, 1988; Lebas & Weigenstein, 1986). In turn, as the informal control contains surveillance and cultural control, the control tools that are used by the surveillance control type may only consist of the bureaucratic dimension, while the cultural control type as it is applied to a R&D unit may contain the directional and/or the scientific dimension.

FINDINGS AND CONCLUSION

The above discussion has indicated the appropriate use of the core elements of the MCS by a R&D unit that is involved in non-repetitive work; with a low-level knowledge of the transformation process, and unpredictable and unmeasurable desired ends. Table 1 summarises the use of control elements by a R&D organisation.

Table 1: The Choice of Control Elements under Environmental Uncertainty.

Core Elements	Environmental Uncertainty as dealt with by R&D unit
Desired Ends	*More to Direction than Yardstick*
Actors	• *Behaviour through culture* • *Motivation:monetary, rank & professional accreditation* • *Domination through formal & informal* • *Decision space through formal & informal* • *Power source from formal & informal*
Implementation	• *Control Types:more to informal(cultural) than formal* • *Implementation: Input, process, and output*
Control Tools	• *Dimensions: Directional, Bureaucratic,Scientific, and Financial* • *Values of representation: Internal, External and social values*

In the case of a R&D unit, the yardstick dimension seems to be less useful, and the directional element becomes significant. This can be seen by the use of the 15 percent option policy by the 3M Company (Anthony and Govindarajan, 2007, p. 596). For this situation, the appropriateness of the actors' elements in a R&D unit would also be affected. The cultural aspect may be significant in motivating behaviour. Motivation may not be limited to monetary rewards

and rank, but also professional accreditation such as the Carlton award used by 3M (Anthony and Govindarajan, 2007, p. 596) as well as recognition by outside professional and scientific bodies. Domination may be extended to informal sources such as seniority and professionalism. Decision space may not be able to be clearly defined by the formal system, therefore informal mechanisms such as self-control as used by 3M in its Technology Forum (Anthony and Govindarajan, 2007, p. 596) may operate. In addition, the power source may also come from informal sources such as professional accreditation and research awards or grants rather than a bureaucratic source alone. In an uncertain situation as dealt with by a R&D unit, the control tools that contain external and social values such as directional and scientific dimensions may play important roles in the execution of the control function. The scientific dimension such as publication, research grant and patent achievement may be used to provide Key Performance Indicators (KPI). Similarly, in an uncertain situation dealt with by a R&D organisation, the cultural control type that contains the directional and scientific dimension and is applied trough a scientific seminar may play a significant role in the control function.

Though this study is limited to descriptive study, acknowledging the presence of these four control elements will broaden the comprehension of the control concept. Further study is needed to describe the use of these dimensions by R&D organisations. In exercising control, the dimensions may be complementary, and it is possible that one dimension will be more dominant than other dimensions in different situations being dealt with by the R&D organisation. In addition, the emphasis of control types, control dimension and values may differ along different types of R&D activities (basic, applied or development) and control implementation stage (input, process, and output). Though the relationship among the dimensions seems to be conspicuous from the above discussion, the degree of combination between certain and uncertain situations may occur in a practical situation and need to be explored for further research.

References

Abernethy, M. A., and J. U. Stoelwinder (1991), "Budget Use, Task Uncertainty, System Goal Orientation and Subunit Performance: A Test of the 'Fit' Hypothesis in Non-For-Profit Hospitals", *Accounting, Organizations and Society*, Vol. 16, No. 2, pp. 105-120.

Abernethy, M. A., and Peter Brownell (1997), "Management Control Systems in Research and Development Organizations: The role of Accounting, Behavior and Personnel Controls", *Accounting Organizations and Society*, vol 22, No. 3/4, pp. 233-248.

Amigoni, Franco (1978), "Planning Management Control Systems", in *Journal of Business Finance and Accounting*, 5. 3., 1978, pp. 279-291.

Anthony, Robert N., and Vijay Govindarajan (2007), "Management Control Systems", New York, McGraw-Hill Irwin.

Birnberg, J, G., L. Turopolec and S. M. Young (1983), "The Organizational Context of Accounting", *Accounting* Organization *and Society*, Vol. 8, No. 2/3, pp. 111-129

Birnberg, J. G., and Coral Snodgrass (1988), "Culture and Control: A Field Study", *Accounting, Organizations and Society*, 13, 5, pp.447-464.

Bonner, Joseph M., R. W. Ruekert, and O. C. Walker Jr., (2002), "Upper Management Control of New Product Development Projects and Project Performance", *The Journal of Product Innovation Management*, 19, pp. 233-245.

Brech, E. F .L. (1965), *Organisation*, 2nd ed., Longmans, Green and Co. Ltd., London.

Chenhall, R. H., (2003), "Management Control Systems Design within its Organizational Context: Finding from Contingency Based Research and Directions for the Future", *Accounting, Organization and Society*, 28, pp. 127-168.

Chua, Wai Fong, Tony Lowe, and Tony Puxty (1989), *Critical Perspectives in Management Control*, London, Macmillan Press ltd.

Cohen, M., March, J. and Olsen, J, (1972), "A Garbage Can Model of Organizational Choice", *Administrative Science Quarterly*, March, pp.1-25.

Collins, James C., and J. I. Porras, (1997),"Built to Last: Sucessful Habits of Visionary Companies", New York, HarperBusiness.

Cooper, D. J., David Hayes, and Frank Wolf (1981), "Accounting in Organized Anarchies: Understanding and Designing Accounting System in Ambiguous Situations", *Accounting, Organizations and Society*, Vol. 6, No. 3, pp. 175-191.

Ditillo, Angelo (2004), "Dealing with uncertainty in knowledge-intensive firms: the role of management control systems as knowledge integration mechanisms", *Accounting, Organizations and Society*, 29, pp. 401-421.

Duncan, Robert B. (1972), "Characteristics of Organizational Environments and Perceived Environmental Uncertainty", *Administrative Science*, vol.17, pp.313-327.

Euske, K. J. (1984), *Management Control: Planning, Control, Measurement and Evaluation*, Addison-Wesley.

Flamholtz, Eric G. (1983), "Accounting, Budgeting and Control Systems in Their Organizational Context: Theoretical and Empirical Perspectives", *Accounting, Organizations and Society*, 8, 2/3, pp. 153-169.

Georgiou, Petro (1973), "The Goal Paradigm and Notes Toward a Counter Paradigm", *Administrative Science Quarterly*, pp. 291-310.

Gerstenfeld, Arthur (1970), *Effective Management of Research and Development*, Reading, Massachusetts.

Gibson, J. E. (1981), *Managing Research and Development*, New York, John Wiley & Sons.

Giglioni, G. B., and A. G. Bedeian (1974), "A Conspectus of Management Control Theory: 1900-1972", *Academy of Management Journal*, Vol. 17, No.2, pp. 292-305.

Govindarajan, V. (1984), "Appropriateness of Accounting Data in Performance Evaluation: An Empirical Examination of Environmental Uncertainty as an Intervening Variable", *Accounting, Organizations and Society*, vol. 9, no.2, pp.125-135.

Hartmann, F. G. H., (2000), "The Appropriateness of RAPM: Toward the Further Development of Theory", *Accounting, Organizations and Society*, Vol. 25, pp. 451-482.

Hirst, M. K. (1983), "Reliance on Accounting Performance Measures, Task Uncertainty and Dysfunctional Behaviour: Some Extensions", *Journal of Accounting Research*, pp. 596-605.

Hopwood, Anthony G. (1972), "An Empirical Study of the Role of Accounting Data in Performance Evaluation", Supplement to *Journal of Accounting Research*, vol. 10, pp. 156-182.

Hopwood, Anthony G. (1974), *Accounting and Human Behaviour*, Haymarket, London.

Jaworsky, B. J. (1988), "Toward a Theory of Marketing Control: Environmental Context, Control Types, and Consequences", *Journal of Marketing*, Vol 52, July, pp. 23-39.

Latham, G.P., and G. A. Yukl (1975), "A Review of Research on the Application of Goal Setting in Organizations", *Academy of Management Journal*, Vol. 18, No. 4, pp. 824-845.

Lebas, Michel, and J. Weigenstein (1986), "Management Control: The Roles of Rules, Markets and Culture, *Journal of Management Studies*, 23, 3, May, pp. 259-272.

Lindblom, Charles E. (1959), "The Science of Muddling Through", *Public Administration Review*, 19, No. 2, pp. 78-88.

Luecke, David S. (1973), "The Professional as Organizational Leader", *Administrative Science Quaterly*, Vol. 18, pp. 86-94.

March, J. G., and H. A. Simon (1958), *Organization*, Wiley, New York.

March, J.G. (1978), "Bounded Rationality, Ambiguity and the Engineering of Choice", *The Bell Journal of Economics*, Autumn, pp. 587-608.

McCaskey, M. B. (1974), "A Contingency Approach to Planning: Planning With Goals and Planning Without Goals", *Academy of Management Journal*, Vol. 17, 2, pp. 281-291.

Nason, Howard K. (1981), "Distinctions between Basic and Applied in Industrial Research", *Research Management*, May, pp.23-28.

Otley, D. T., and A. Berry (1980), "Control, Organization and Accounting", *Accounting, Organizations and Society*, pp. 231-244.

Ouchi, W. G (1977), "The Relationship Between Organizational Structure and Organizational Control", *Administrative Science Quarterly*, pp. 95-113.

Ouchi, W. G (1979), "A Conceptual Framework for the Design of Organizational Control Mechanisms", *Management Science*, pp. 833-848.

Place, Geoffrey (1977), "National Policies for Science & Technology-Needed-More Intuitive Applied Research", *Research Management*, November, pp. 19-23.

Rockness, H. O., and M. D. Shields (1984), "Organizational Control Systems in Research and Development", *Accounting, Organizations and Society*, v. 9, no.2, pp.165-177.

Tatikonda, Mohan V and S. R. Rosenthal (2000), "Successful Execution of Product Development Projects: Balancing Firmness and Flexibility in the Innovation Process", *Journal of Operation Management*, 18, pp. 401-425.

Thompson, J. D. (1967), *Organization in Action*, McGraw Hill, New York.