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Management accounting system design in manufacturing departments: an empirical investigation using a multiple contingencies approach

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Abstract

This paper proposes a multiple contingencies model that examines the combined effect of departmental interdependencies and organization structures on management accounting system (MAS) design. The model was tested by means of empirical data collected from a questionnaire addressed to 160 production managers. The response rate was 82.5%. The findings provide some support for the notion that organizations adapt their MAS design to the control requirements of the situation. Furthermore, the study offers some empirical support for the existence of suboptimal equifinality. That is, in situations which lack of a single dominant imperative, several alternative, and functionally equivalent management control system (MCS) designs, may arise.

Introduction

Since the mid-eighties, there has been a trend in manufacturing towards customization and novel approaches to organizing production, including JIT/TQM models of control (Schonberger, 1986; Womack, Jones, & Roos, 1990). The pursuit of such strategies poses significant challenges for the management since they typically imply intensified interdependencies among functionally differentiated departments and new means of managing the workflow (Bouwens & Abernethy, 2000; Kalagnanam & Lindsay, 1998). As organizations adapt to these developments, they must make sure that the MAS is designed congruent with the new control requirements (Chenhall, 2003). Drawing on contingency-based approaches, it is argued that the study of appropriate MAS designs in these new settings can be enhanced by considering the fit between the MAS, departmental interdependencies [1] and organizational structure (Chenhall & Morris, 1986; Hayes, 1977; Macintosh & Daft, 1987; Williams, Macintosh, & Moore, 1990). This study adds to research in this area by proposing a multiple contingencies model that examines the combined effect of departmental interdependencies

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[1] Departmental interdependencies are defined here as the extent to which departments need to rely on other departments for resources, such as materials and knowledge, to accomplish their respective tasks (Thompson, 1967).

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and organization structure on MAS design. Fig. 1 outlines the proposed model.

The multiple contingencies model stems from recognition that the demands placed on MAS design by multiple contingencies may conflict (Fisher, 1995), i.e., attempts to satisfy one demand may mean that other demands cannot be satisfied. It is also explicitly assumed that the need for coordination and control can be met by several alternative, and equifinal, management control system design strategies. The assumption is justified by the long-held view that management control subsystems may not only complement each other but also substitute for each other (Fisher, 1995; Galbraith, 1973; Mintzberg, 1983). Finally, the current study contributes to the management control literature by adopting a more holistic approach than has typically been the case. It is true that a so-called systems approach has been used for some time in the organization design literature (see e.g., Drazin & Van de Ven, 1985; Miller & Friesen, 1984; Mintzberg, 1983). However, very few researchers have looked on the MAS as a system with internal consistency among multiple structural characteristics (see e.g., Chenhall & Langfield-Smith, 1998a; Greve, 1999).

The remainder of the paper is structured as follows. The following two sections define the constructs, develop the theoretical model, and conclude with a number of exploratory propositions. The process of data collection and data analysis is then detailed in the fourth section. The results of the study are presented and discussed in the fifth and sixth sections, respectively. The last section contains concluding comments and some suggestions regarding future research.

Definition of constructs

For a long time there has been an interest among scholars in documenting fit relationships between features of context in which the organization operates and its management control arrangements. One key characteristic of the literature is that the identification of variables is typically based on the assumption that they are related to each other in a one-to-one manner, i.e., in a particular context, there is only one optimal combination of management control mechanisms (Gresov, 1989; Gresov & Drazin, 1997). For example, it is normally expected that low task uncertainty will be coupled with a mechanistic organization structure and an "efficiency-focused" performance evaluation system, if the organization is to perform well (Abernethy & Lillis, 1995; Macintosh, 1994).

A second key characteristic is that definitions normally are derived from prior literature (see e.g., Bouwens & Abernethy, 2000; Macintosh & Daft, 1987). Although the merits of this approach are acknowledged, in terms of providing stringency in theory development and testing, it is also important that the limitations be understood. One such limitation is that the sole use of established typologies, e.g., the extensive use of the mechanistic/organic structure continuum developed by Burns and Stalker in 1961 (cf. Abernethy & Lillis, 1995; Gordon & Narayanan, 1984; Kalagnanam & Lindsay, 1998), *risks overlooking more recently developed structural designs*. For example, Chenhall (2003, p. 21) notes that "an important element of contemporary structures is teams. As yet there are few studies that have considered the role of MCS within team based structures". The absence

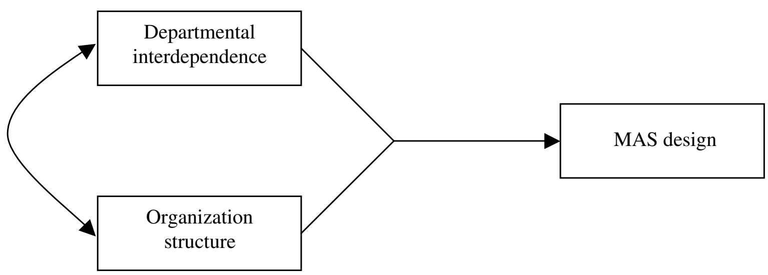

Fig. 1. Research model.

of these new designs of a contemporary nature in MAS research may give weak or inconsistent results because they have the potential to fundamentally change the way that integration and adaptation in managing functional interdependencies is achieved (Chenhall, 2003).

Furthermore, it has been argued elsewhere that the study of equifinality implies a different approach to research design compared with that of traditional contingency theory (Doty & Glick, 1994; Gresov & Drazin, 1997). In particular, *the use of a priori dichotomies sharply limits the possibility of identifying several equally effective structural designs in a particular situation* (Gresov & Drazin, 1997). Therefore, Gresov and Drazin (1997), discussing how to conduct equifinality research, suggest that the identification of design variables should be "deduced as well as supplemented with inductive identification of the range of available structures" (p. 419). Based on these arguments, the approach set out below is to first derive the elements used to describe the organization structure, and the MAS, from prior accounting-control literature. Two categorizations of departments are then empirically derived on the basis of their values on the organizational structure elements and the MAS elements, respectively. Since one of the objectives of this study is to describe the MAS as a system with internal consistency among multiple structural characteristics, cluster analysis is used to explore how the elements combine. Cluster analysis provides a sophisticated means of determining how they combine insofar as it groups observations into clusters such that each cluster is as homogeneous as possible with respect to the characteristics of interest and the groups are as different as possible (see sections Data analysis and Results below for a detailed description of how categories were derived). Table 1 summarizes the definition of constructs. The organization structure and MAS categories are based on the cluster solutions provided in section Results, Table 7.

In the following three sections, each variable in Table 1 is discussed in more detail and related to prior literature.

Departmental interdependence

Departmental interdependence means the extent to which departments depend upon each other for resources to accomplish their tasks. The construct relates to the work of Thompson (1967), where three types of dependence were identified: pooled, sequential and reciprocal. *Pooled dependence* is the lowest form. In this type of dependence, departments are relatively autonomous in that little work flows between them. *Sequential*

Table 1
Research variables

Variables	Description
Departmental interdependence	
Sequential interdependence	Work flows between departments in a serial fashion
Reciprocal interdependence	Work flows back and forth between departments and the selection, combination and order of the task is determined by the particular problem in question
Organizational structure	
The Functional unit	Formalized procedures, medium sized and medium complex, centralized power for decision-making, and reliance on the functional basis for grouping tasks
The Lateral unit	Nonformalized behavior, large and complex, decentralized decision-making and relies on the product basis for grouping units
The Simple unit	Little behavior is formalized, small size and low complexity, power over decisions is fairly centralized, and a product-oriented unit grouping
MAS design	
The Rudimentary MAS	All types of accounting information is aggregated and seldom issued
The Broad scope MAS	Budgetary and operational information is detailed and reported frequently
The Traditional MAS	Detailed budget and product cost reports are issued frequently

dependence involves the outputs of one unit becoming the inputs of another unit. This implies that one unit cannot act before receiving the input from the preceding unit (cf. mass production assembly lines). *Reciprocal dependence* represents the highest form of interdependence. The movement of work back and forth between units characterizes this type. In the case of manufacturing firms, reciprocal dependence typically occurs when several departments are involved in a product development project.

Interdependencies will always exist between the manufacturing department and other subunits (e.g., marketing and purchasing) because the production function reflects only one link in the organization's value chain. Theoretically, it would be possible for a manufacturing department's interdependence to be limited to pooled dependence. However, this is an unlikely scenario as extensive stockpiling between subunits "is an expensive option and one that successful firms are unlikely to pursue" (Bouwens & Abernethy, 2000, p. 224). Therefore, only the *sequential* and *reciprocal* forms of interdepartmental dependence were used in the present study (see Table 1).

Organizational structure

The organizational structure variable draws heavily on the seminal works of Bruns and Waterhouse (1975), and Merchant (1981, 1984), who identified several organizational characteristics that were strongly related to the choice of accounting-control strategy. In summary, they found that as organizations and departments grow and become more complex, they tend to decentralize and implement a more administratively oriented control strategy, which involves a higher degree of behavior formalization and an increasing use of formal patterns of communication. In line with expectations, they also found that the MASs in these organizations "matched" the overall control strategy insofar as they tended to use "a more highly developed and formal budgeting system, with greater standardization of information flows and greater operating manager involvement in budgeting" (Merchant, 1984, p. 291). In contrast, smaller, more homogeneous and centralized firms tended to rely more highly on informal, personally oriented control mechanisms such as direct supervision and face-to-face communication. Accordingly, firms were less reliant on formal use of the budget when using this interpersonal control strategy.

Based on the studies of Bruns and Waterhouse, and Merchant, four design elements were identified, which have the potential to influence MAS design, namely degree of behavior formalization (i.e., the extent to which work processes are standardized), unit size, complexity (degree of differentiation), and degree of decentralization. These elements have also been found to be relevant in more recent contingency-style accounting-control research (see e.g., Chenhall & Morris, 1986; Gordon & Narayanan, 1984; Gul & Chia, 1994; Lind, 2001; Mia & Chenhall, 1994).

When attempting to extend empirical research in any area, it is important to keep variables constant over time. However, it is also important that the design elements used be able to provide for emerging structural designs. Therefore, it was decided to include a fifth element—unit grouping—to allow a distinction between traditional grouping by function, and more recently developed product-oriented structures (Galbraith, 1993, 1994; Nemetz & Fry, 1988). Recent research indicates that as uncertainty in manufacturing increases, e.g., as the result of a customization strategy and the adoption of JIT production systems, more reliance is placed on teamwork to achieve integration and adaptation in managing functional interdependencies (Abernethy & Lillis, 1995; Galbraith, 1993, 1994; Kalagnanam & Lindsay, 1998).

As was mentioned above, categories of departments were empirically derived based on their values on the five organizational design elements developed above (i.e., degree of behavior formalization, unit size, complexity, degree of decentralization, and principles of unit grouping) and cluster analysis was used to determine the way the elements combined. The results of the clustering procedure are provided in Table 7. A negative sign on the elements means that the centroid value of the departments contained in the cluster is below average while a positive sign denotes the opposite.

Accordingly, the first row in Table 7 shows that the degree of formalization is higher than average for departments contained in Cluster 1 while it is lower than average for departments contained in Cluster 3, for instance. In Table 1, the profiles of the three cluster solutions are described verbally. Below, each of the cluster profiles depicted in Table 1 are described in more detail and related to previous research.

Both the first and second organizational designs (i.e., the Functional unit and the Lateral unit) depicted in Table 1 have characteristics akin to the administratively oriented organizational-control strategy identified by Bruns and Waterhouse (1975), and Merchant (1981, 1984), yet they are dissimilar. For example, departments in the second category (the Lateral unit) are typically larger and more complex than the average, and decision-making is more decentralized. However, they do not rely heavily on formalized standard operating procedures and rules to govern work relations as suggested by Bruns and Waterhouse, and Merchant (cf. the centroid value on the formalization design element for Cluster 2 in Table 7, which is slightly below the average). However, behavior formalization is a key characteristic of the first category of departments (cf. the positive centroid value on the formalization design element for Cluster 1 in Table 7). These departments also are fairly large and complex. [2] If we consider the unit-grouping element, the picture becomes clearer. Unit grouping by function, combined with a high degree of centralization of authority and a high degree of behavior formalization, has apparent similarities with the "mechanistic design" construct, traditionally employed in the organizational design literature (Burns & Stalker, 1961; Mintzberg, 1983; Nemetz & Fry, 1988), and more recently applied to manufacturing settings in the accounting-control literature (see e.g., Abernethy & Lillis, 1995; Kalagnanam & Lindsay, 1998). This literature suggests that these designs are highly bureaucratic and rigid. The prime coordination mechanism is standardization of work processes. Any communication stemming from unexpected problems in the workflow is largely formalized using vertical communication channels. In the following sections, this organizational design will be referred to in terms of *Functional units*.

In contrast, the second organization structure in Table 1 borrows characteristics from an organizational form that has been discussed in the organizational-control literature in recent years, namely the "Lateral organization" (Abernethy & Lillis, 1995; Galbraith, 1993, 1994; Kalagnanam & Lindsay, 1998). In contrast to Functional units, these departments exhibit greater decentralization of control and authority, and rely more on product-oriented unit grouping to achieve integration and adaptation in managing workflow interdependencies (cf. the profiles of Functional units (Cluster 1) and Lateral units (Cluster 2) in Table 7). Accordingly, these departments will be referred to as *Lateral units*.

The third organizational design depicted in Table 1 has a profile similar to that of the interpersonal strategy approach to organizational control identified by Bruns and Waterhouse (1975), and Merchant (1981, 1984). That is, when compared with the other two organizational forms derived, these units are smaller, less complex, little of their behavior is formalized, and they are fairly centralized (cf. the profile of Cluster 3 in Table 7). This organizational type has also been discussed in the organizational design literature. For example, Mintzberg (1983) identified a category of companies that he called the Simple structure. According to Mintzberg this structure "is characterized, above all, by what it is not—elaborated" (p. 157). With this in mind, the third organizational design will be referred to in terms of *Simple units*.

Management accounting system

The MAS was defined as those parts of the formalized information system used by organizations to influence the behavior of their managers that leads to the attainment of organizational objectives (Horngren, Bhimani, Datar, & Foster, 2002). The design of the MAS was conceptualized in terms of two interrelated dimensions: level of

[2] An analysis of raw data shows that these departments have around 230 full-time employees, and the average number of organizational levels and job titles are 3 and 13, respectively.

detail, and frequency of reporting. The argument is that managers in some organizational contexts are likely to benefit from accounting information that is detailed and issued frequently, whereas MAS information in other contexts tends to be general rather than detailed, and issued less frequently (Bouwens & Abernethy, 2000; Chenhall & Morris, 1986; Davila, 2000; Macintosh, 1994; Macintosh & Daft, 1987; Merchant, 1981).

Three critical elements of the MAS were examined with respect to their level of detail and frequency of reporting: the operating budget, the standard costing system, and the reliance on operational information. There is ample evidence from surveys recently conducted in many countries that these aspects of the MAS are widely adopted and are perceived useful by managers (see, e.g., Ask & Ax, 1997; Brierley, Cowton, & Drury, 2001; Chenhall & Langfield-Smith, 1998b; Lukka & Granlund, 1996). *The operating budget* is used to schedule and record department revenues and expenditures, including materials and salaries. Usually, a budget is generated for the forthcoming period, and periodic budget follow-up reports are issued to provide information to department managers about progress toward budget targets. In contrast to the operating budget, in which costs are recorded at the cost-center level, the *standard costing system* provides information at the product level. Typically, standard costs are used to aid managerial decision-making by providing projected product costs. However, standards also enable management periodically to compare actual costs with standard costs in order to gauge performance and to correct inefficiencies (Ask & Ax, 1997).

In addition to the two financially based management accounting techniques mentioned above, manufacturing departments rely on *operational information* that provides management with data on departmental outputs and performance, e.g., production volumes, lead and delivery times, product defects and resource consumption. Recent empirical findings suggest that nonfinancial data should have a prominent place in manufacturing departments (Kaplan, 1983), not the least in companies emphasizing customization and manufacturing flexibility (Chenhall, 1997; Perera, Harrison, & Poole, 1997).

The categories of MASs identified by means of the cluster analysis are depicted in Table 1 (cf. the cluster profiles in Table 7). The first category had the lowest scores on every aspect of the MAS. Compared with the other MASs identified, accounting information is less detailed and is issued less frequently on all three parts of the system. A suitable name for this cluster is therefore *Rudimentary MAS*. The second and third MAS categories share the common denominator of a sophisticated budgetary system insofar as information on subunits is detailed and reported frequently. However, with respect to the other MAS elements (i.e., the standard costing system and reliance on operational information), the two categories differ significantly.

MASs in the second category are characterized by frequent issuing of detailed nonfinancial information, while the standard cost reports have the opposite characteristics. Therefore, this category has similarities with so-called broad scope MASs insofar as information provided is also nonfinancial (Bouwens & Abernethy, 2000; Mia & Chenhall, 1994). Therefore, these systems are called *Broad scope MASs*.

In contrast, the third category of MASs has a profile almost the opposite of that of the previous cluster. That is, it has a well-developed standard costing system, but reliance on operations-based measures is fairly low. Therefore, this type of system resembles the notion of traditional accounting systems (narrow-scope MAS) in that these systems are typically limited to providing financially oriented information (Bouwens & Abernethy, 2000; Chenhall & Morris, 1986; Gul & Chia, 1994; Mia & Chenhall, 1994). In the light of this profile, they will be referred to as *Traditional MASs*.

Theory development

The theoretical model is developed in two stages. Firstly, the impact of each variable on MAS design in isolation is examined. Secondly, the combined effect of departmental interdependence and organizational design is discussed, and a number of exploratory propositions are presented.

Departmental interdependence and MAS design

Sequential interdependence puts great demands on the organization for coordination and close control (Macintosh, 1994; Thompson, 1967), and since input/output relations typically are understood in these situations, MAS information has the potential to play a key part in accomplishing this task. Plans and schedules are crucial to ensure that no activities in the value chain are underutilized and that departments provide necessary resources for other departments (Van de Ven, Delbecq, & Koenig, 1976). Detailed and frequent measurements of output ensure that management can monitor whether activities are on schedule and can respond to exceptions and deviations that arise (Macintosh & Daft, 1987).

These findings provide little guidance on whether traditional financially based or more broad scope MASs are preferred for sequentially dependent departments. However, it has been argued that standard costing systems, with their focus on task segregation and efficiency, are well suited for standard production (Abernethy & Lillis, 1995; Kaplan, 1983; Waterhouse & Tiessen, 1978). Therefore, it is reasonable to believe that traditional systems are associated with sequential interdependence (cf. Chenhall, 2003). However, empirical research indicates that nonfinancial information may also be used in subunits experiencing sequential interdependence. For example, Macintosh and Daft (1987) found that several statistical report characteristics *as well as* operating budget characteristics were positively related to sequential interdependence. Therefore, it is likely to find broad scope MASs under these conditions (cf. Macintosh, 1994).

In contrast, MASs are expected to be less useful for accomplishing coordination and control of reciprocally interdependent units because the absence of standardization makes it difficult to specify unambiguous performance standards (Macintosh, 1994). Rather, coordination and control come from rapid mutual adjustment and personal interaction (Thompson, 1967; Van de Ven et al., 1976). Accordingly, the training and socialization of employees become more important than formal management control systems such as operating budgets and statistical reports (cf. Hayes, 1977; Macintosh & Daft, 1987; Van de Ven et al., 1976; Williams et al., 1990).

In summary, sequentially linked departments put great demands on the organization for coordination and close control. This may be accomplished by means of rigorous planning and measurement systems (cf. the Traditional MAS and the Broad scope MAS). In contrast, reciprocal interdependence requires real-time, intensive information flows between the various departments. MASs are not well suited to these needs. Therefore, reciprocal interdependence may be proposed to be associated with rudimentary MASs.

Organizational structure and MAS design

In the literature, a mechanistic manufacturing design, which characterizes Functional units, has generally been associated with a traditional financially based MAS (Abernethy & Lillis, 1995, Kaplan, 1983; Macintosh, 1985; Merchant, 1984). The argument is that these systems, which emphasize task segregation and efficiency, are well suited for mass producers of standard products. Furthermore, earlier research indicates that a large unit size increases the reliance on sophisticated financially oriented subsystems such as the operating budget (Bruns & Waterhouse, 1975; Merchant, 1981, 1984) and the product-costing system (Bjørnenak, 1997; Innes & Mitchell, 1995).

The Lateral unit design has become more important in manufacturing departments during the last decades (Galbraith, 1993, 1994). Very few accounting-control researchers have examined the direct effects of this organization structure on MAS design (see, e.g., Abernethy & Lillis, 1995). However, considerable effort has been invested in exploring the impact of modern management practices—JIT/TQM production in particular—on different aspects of the MAS (Chenhall, 1997; Fullerton & McWatters, 2002; Ittner & Larcker, 1995). Based on the argument that the profile of Lateral units is consistent with these modern practices (see Table 1), the hypothesized link between this organizational structure and MAS design will be based on this literature. However, it should be noted that in these studies, organization structure is only one explanatory variable among several others (e.g., reliance on programs to improve quality, time delays and waste). [3] Accordingly, expectations derived should be regarded as tentative.

According to the literature that has examined the association between JIT/TQM and MAS, Lateral units should increase their reliance on nonfinancial information (Chenhall, 1997; Fullerton & McWatters, 2002; Ittner & Larcker, 1995; Johnson, 1992). One argument is that the MAS must support these new management practices by "monitoring, identifying, and communicating to decision makers the sources of delay, error, and waste in the system" (Atkinson, Banker, Kaplan, & Young, 2001, p. 244). It is also argued that the MAS information in Lateral units should focus on those factors that support their strategic commitment to customer-adaptation and flexibility (Abernethy & Lillis, 1995; Perera et al., 1997). However, the role of financial information in this organizational context is unclear. Whilst there is considerable normative support for the idea that traditional accounting measures based on budget variances are inappropriate in JIT/TQM environments because they do not track the sources of competitiveness (Johnson, 1992; Kaplan, 1983), recent empirical research indicates that operations-based information complements, rather than substitutes for, financially oriented information (cf. Chenhall & Langfield-Smith, 1998a; Tayles & Drury, 1994). Accordingly, it can be expected that Broad scope MASs are extensively used among Lateral units.

Referring to section Definition of constructs above, the findings of Bruns and Waterhouse (1975) and Merchant (1981, 1984) suggest that Simple units typically adopt an interpersonal control strategy. Therefore, it is reasonable to believe that formal control mechanisms, such as the MAS, are unnecessary and expensive ways of coordinating and controlling behavior in Simple units (Mintzberg, 1983). Accordingly, Rudimentary MASs should dominate in these units (Bjørnenak, 1997; Bruns & Waterhouse, 1975; Innes & Mitchell, 1995; Merchant, 1981, 1984).

In summary, it is proposed that different MASs should be associated with each organizational structure. The demand for central planning and efficiency measurement imposed by the Functional unit, implies a high reliance on the operating budget and the standard costing system (cf. the Traditional MAS). In contrast, Lateral units should benefit most from the Broad scope MAS to handle customer-initiated demands. Finally, Simple units tend to be more reliant on direct supervision and more frequent personal interactions and less on formal communication via the MAS. Accordingly, the Rudimentary MAS should dominate in these units.

The combined effect of departmental interdependence and organizational structure on MAS design

Based on the "bivariate" theory development in the prior two sections, the research model is extended to include the *combined* effect of departmental interdependence and organization structure on MAS design. However, before we address the question of which MASs are most likely to be used in different organizational contexts, we shall discuss the extent to which different combinations of interdependence and organizational designs are viable. The premise is that potential misfit between interdependencies and structure may have consequences for MAS design in these contexts (Gresov, 1989; Gresov & Drazin, 1997).

Relations between departmental interdependence and organizational structure

While the importance of departmental interdependence for the design of organizations for long has been stressed in the literature (Fry, 1982; Pennings, 1992; Thompson, 1967), there are only a few studies that have empirically explored the relationship between these variables. However,

[3] The author is indebted to one anonymous reviewer for pointing this out.

one important study is that of Van de Ven et al. (1976) who found that impersonal means of coordinating sequentially interdependent departments (e.g., rules and plans), being the least costly mechanisms to operate, are used the most. However, as interdependencies increase, reliance on these means declines while the use of more expensive coordination mechanisms increases significantly (e.g., horizontal channels and group meetings). Some of these results have been confirmed in subsequent studies (see, e.g., Gresov, 1989; Ito & Peterson, 1986; Macintosh & Daft, 1987).

These arguments, when applied to the present study, suggest that the mechanistic design that characterizes Functional units should be preferred under conditions of sequential interdependence. There is also reason to believe that Lateral units, which exhibit greater decentralization of control and authority and rely more on product-oriented unit grouping to achieve integration and adaptation in managing workflow interdependencies, should be preferred in situations characterized by reciprocal interdependence between subunits.

Based on prior research, it is more difficult to determine whether the Simple unit is likely to be used most under conditions of sequential or reciprocal interdependence. On the one hand, it has been suggested elsewhere that the pressure to run sequentially interdependent departments without interruption is likely to lead to a strong control mentality from the top to coordinate the workflow (Mintzberg, 1983). Therefore, Simple units, characterized by centralized decision-making, seem appropriate in these conditions. On the other hand, it is difficult to argue that Simple structures necessarily are inappropriate in departments facing reciprocal interdependencies. True, the literature convincingly argues that coordination and control must come from rapid mutual adjustment and face-to-face communication among empowered coworkers (Gresov, 1989; Thompson, 1967; Van de Ven et al., 1976). However, this idea seems to be based on the assumption that the organization is so large that coordination by means of the hierarchy is impossible. In small and noncomplex units, department managers may very well be highly familiar with the actual operations (Mintzberg, 1983). Consequently, workflow interdependencies between departments can be handled by direct supervision, and department management can directly solve problems encountered (cf. the interpersonal control strategy identified by Bruns & Waterhouse (1975) and Merchant (1981, 1984)).

The above arguments have several important implications. Firstly, while Functional and Lateral units are likely to be preferred under sequential and reciprocal interdependence, respectively, Simple units have the potential to be appropriate in both contexts. [4] This in turn implies a form of equifinality insofar as several structural designs may be suitable in the same contextual setting. Secondly, drawing on Gresov and Drazin (1997), it is important that the development of hypotheses below for Functional and Lateral units addresses the possible implications on MAS design of misfit between interdependencies and structural design.

Relations between interdependence, organization structure and MAS design

In this section, the complexity of the analysis (cf. Fisher (1995)) is increased in two important and interrelated respects compared with the "bivariate" theory development in sections Departmental interdependence and MAS design and Organizational structure and MAS design. Firstly, it is acknowledged that MAS design may have to be tailored to multiple contextual factors, namely interdependencies and organization design. Because demands may conflict, MAS design may involve tradeoffs that preclude a "fit" to all factors simultaneously (Fisher, 1995; Gresov, 1989).

Secondly, unlike most prior studies, it is explicitly assumed that the need for coordination

[4] The results in Table 9 in Appendix A provide some empirical support for these expectations. Functional units and Lateral units were the most widely used structures under conditions of sequential and reciprocal interdependence, respectively. A chi square test showed that the differences were statistically significant ($p = 0.038$).

and control can be met by several alternative, and equifinal, management control system design strategies. The assumption is justified by the long-held view that management control subsystems not only may complement each other but also may substitute for each other (Fisher, 1995; Galbraith, 1973; Mintzberg, 1983). Substitution is most likely to occur when the design alternatives available are functionally equivalent. As Galbraith (1973) pointed out, for example, there are at least two design strategies by which the organization can increase its information-processing capacity: (i) through the investment in vertical information systems and (ii) through the development of lateral relationships. Importantly, the organization is unlikely to pursue both structures simultaneously because of the duplication of costs or fundamental incompatibilities between the two designs. Furthermore, when considering several functionally equivalent design strategies, profit-maximizing organizations will prefer the alternative that provides the required outcome at the lowest cost (Donaldsom, 1996; Mintzberg, 1983; Thompson, 1967).

Table 2 summarizes the "bivariate" theory development set out in sections Departmental interdependence and MAS design and Organizational structure and MAS design where the impact of each contextual variable on MAS design *in isolation* was examined. In the north-east part of the table, we find the expected implications of the two forms of interdependencies on MAS design (i.e., sequential interdependencies will be associated with the Traditional MAS and the Broad scope MAS while reciprocal interdependencies will be associated with the Rudimentary MAS). In the south-west part of the table, the expected relationships between the three organizational structures and MAS design are shown. Below, the research model is extended to include the *combined effect* of these two variables on MAS design. That is, we address the question of which MASs are most likely to be used in each combination of interdependence and organization structure (Cells 1–6). Let us start with the expected combined effect of the Functional unit experiencing sequential interdependencies on MAS design (Cell 1 in Table 2).

Cell 1: Functional units experiencing sequential interdependence. This cell is quite unproblematic since this combination of interdependence and structural design is likely to be viable, and the MAS design implications of both variables are fairly consistent. That is, sequential interdependence implies that units should benefit from a sophisticated MAS (i.e., the Traditional or the Broad scope MAS), while a functional organization structure implies that a Traditional MAS should be used extensively for coordination and control purposes. Overall, this suggests that, in all cases, traditional MASs should be common in these contexts.

However, based on the argument that both Traditional and Broad scope MASs should be able to perform the same underlying function (cf. Gresov & Drazin, 1997), of ensuring that the units provide necessary resources to other sequentially linked units in a timely manner by means of frequent and detailed planning and measurement (Macintosh, 1994; Macintosh & Daft, 1987), it can be expected that the Broad scope MAS may also be extensively used in this organizational context. Note that this implies the presence of equifinality in the sense that both MASs represent functionally equivalent alternatives to achieving coordination

Table 2
Implications of departmental interdependence and organizational structure on MAS design

	Sequential interdependence	Reciprocal interdependence
	↓	↓
	Traditional MAS and/or Broad scope MAS	Rudimentary MAS
Functional unit → Traditinal MAS	Cell 1	Cell 4
Lateral unit → Broad scope MAS	Cell 2	Cell 5
Simple unit → Rudimentary MAS	Cell 3	Cell 6

and control in Functional units experiencing sequential interdependence.

According to sections Departmental interdependence and MAS design and Organizational structure and MAS design, both sequential interdependence and a traditional functionally oriented structure call for rigorous planning and measurement systems (cf. Lind, 2001; Macintosh, 1994). Therefore, it can be expected that the MAS and the organization structure are used in a reinforcing way, implying a *complementary relationship*. That is, an appropriate organization structure alone may not be sufficient to achieve high organizational performance. Therefore, the focus on task segregation and efficiency should be complemented by sophisticated planning and control systems to ensure sufficient coordination among sequentially dependent parts. Accordingly, the number of departments having Rudimentary MASs in this context should be relatively few.

To sum up, *for Functional units experiencing sequential interdependence (Cell 1 in Table* 2*), both Traditional MASs and Broad scope MASs will be over-represented while Rudimentary MASs will be under-represented*. Over- (under-)representation means that the number of departments having the proposed MAS in a particular cell, as a proportion of all departments in that cell, will be significantly higher (lower) than the average proportion of departments having that MAS across the overall sample. That is, it is expected that MAS proportions in individual cells will differ from MAS proportions in the whole sample because organizations adapt their systems to the requirements of their particular contexts.

Cell 2: Lateral units experiencing sequential interdependence. The contextual situation in this cell gives rise to at least two important issues related to MAS design. Firstly, we must consider the potential effects of "misfit" between interdependence and organizational structure. Referring to the discussion in the former section, organizations with sequentially dependent units are likely to prefer structural characteristics associated with a mechanistic design. However, this does not imply that a more organic structure, characterizing Lateral units, is incapable of meeting the demands on the organization for coordination of sequentially interdependent tasks. It merely implies that unnecessarily expensive means of coordinating tasks are used. Thus, the "misfit" between interdependence and organization structure in Cell 2 *does not mean that MAS designers are confronted with an inherent and critical conflict in contingencies*. This is apparent in Table 2, which indicates that both contextual factors imply that units in this situation should benefit from a sophisticated MAS (i.e., a Traditional MAS or a Broad scope MAS).

This leads to the second issue raised by the contextual situation in Cell 2, namely the question of which (if any) of the two more sophisticated MASs is likely to be preferred. According to Table 2, the accounting-control literature suggests that either a Traditional or a Broad scope MAS is appropriate for coordination and control under sequential interdependence, while only a Broad scope MAS is expected to be extensively used among Lateral units. Although it was argued above that both Traditional and Broad scope MASs should be able to perform the same underlying function, in terms of providing close control of sequentially dependent units, there is no reason to believe that Lateral units, when performing this fundamental function, should prefer traditional information to operations-based information. The premise is that only the latter supports their strategic commitment to customer-adaptation and flexibility (Abernethy & Lillis, 1995; Macintosh, 1985). Based on the above arguments, it can thus be expected that *for Lateral units experiencing sequential interdependence (Cell 2 in Table* 2*), Broad scope MASs will be over-represented while Traditional MASs and Rudimentary MASs will be under-represented.*

Cell 3: Simple units experiencing sequential interdependence. In this cell, the two bivariate analyses give seemingly contradictory results; sequential interdependence implies that sophisticated formula-based MASs should be over-represented, whereas the Simple unit design suggests the opposite (i.e., Rudimentary MASs). However, there is reason to believe that at least two functionally equivalent MCS design alternatives are available for Simple units: either the demand for coordination and close control is met by a rigorous and detailed planning and measurement system, *or* by direct supervision effected through the superstructure. According to Mintzberg (1983) and others (Bruns & Waterhouse, 1975; Merchant, 1981, 1984), *only the latter alternative is viable* because direct supervision and frequent personal interactions are the most efficient means of control in a simple structure and the organization is unlikely to pursue both mechanisms simultaneously because of the duplication of costs. In other words, a substitution effect is likely to be present. Therefore, it is proposed that *for Simple units experiencing sequential interdependence (Cell 3 in Table 2), Rudimentary MASs will be over-represented while Traditional MASs and Broad scope MASs will be under-represented.*

Cell 4: Functional units experiencing reciprocal interdependence. It was argued above that the use of a traditional organizational design under conditions of reciprocal interdependence implies a "misfit". Coordination of reciprocally interdependent units is handled by ad hoc mutual adjustment and feedback from both the various units involved and from the object itself (e.g., Hayes, 1977; Thompson, 1967; Van de Ven et al., 1976; Williams et al., 1990), while the inherent logic of coordination and control in large organizations having a mechanistic design is the reliance on sophisticated and formalized MCSs (e.g., Bruns & Waterhouse, 1975; Merchant, 1984; Van de Ven et al., 1976). Since research in accounting-control seldom considers the possible effects of misfit between contextual factors on MAS design, the literature cannot be used to make strong predictions. However, based on Gresov and Drazin (1997), it can be argued that management in these situations makes a trade-off between contextual demands. The factors considered most important determine what the structure should look like. Furthermore, the lack of a single imperative typically implies that several alternative, and equifinal, structural designs may exist, or as Gresov (1989) put it, "there is an enhanced likelihood of design variation" (p. 434). Transferred to this study, this implies that none of the MASs identified should be clearly over- or under-represented in Cell 4 in Table 2. [5]

Cell 5: Lateral units experiencing reciprocal interdependence. While the organizational-control literature suggests that the Lateral unit design should be viable under conditions of reciprocal interdependence, Table 2 indicates that there may be a conflict between the MAS design implications of these contextual factors. That is, coordination and control under conditions of reciprocal interdependence come from rapid mutual adjustment and personal interaction, whereas the large unit size and high level of complexity characterizing the Lateral unit, implies that a sophisticated MAS should be used.

In a sense, the state of conflicting contingencies in Cell 5 is more "problematic" than that in Cell 3 discussed above, because attempts to satisfy one demand inevitably mean that other demands are unsatisfied (cf. Gresov, 1989). Units may adopt a formula-based management control strategy to handle unit size and complexity and ignore the need to manage external interdependence, or they may adopt a nonformalized MCS design and thereby ignore the control difficulties arising from large size and complexity. However, it is not unreasonable that MAS design in these contexts is entirely the result of reciprocal interdependence; i.e., unit size and complexity have very little impact on the reliance on accounting control. The argument is that large size and complexity may very well imply sophisticated planning and control systems—this, however, is "not" possible since the absence of standardization makes it difficult to specify unambiguous performance standards because the optimal relationships between inputs and outputs of production tasks are usually not known (Macintosh, 1994). Thus, reciprocal interdependence sharply limits the number of alternative

[5] In line with the situation in Cell 1 above, this suggests a form of equifinality insofar as several alternative MAS designs are likely to exist in Cell 4. However, the equifinality in the latter situation is always suboptimal (cf. Gresov & Drazin, 1997) because one or several demands on the MAS inevitable go unattended.

control mechanisms available in the management control package. In other words, a substitution effect between MCS mechanisms can be expected. In contrast to that of Cell 3 above however, the substitution effect suggested here is not based on the argument that both are functionally equivalent and that management is likely to use the least costly one. Rather, the rationale is that *only one is applicable*. Based on the above arguments, it is therefore proposed that *for Lateral units facing reciprocal interdependence (Cell 5 in Table 2), Rudimentary MASs will be over-represented while Traditional MASs and Broad scope MASs will be under-represented.*

Cell 6: Simple units experiencing reciprocal interdependence. Finally, in conformity with Cell 1, the situation in Cell 6 suggests that no apparent "misfit" between interdependencies and organization structure exists and that the MAS design implications of the two contextual factors are consistent, i.e., both reciprocal interdependence and a Simple unit design should be related to Rudimentary MASs. Based on the arguments presented in sections Departmental interdependence and MAS design and Organizational structure and MAS design, it is therefore proposed that *for Simple units facing reciprocal interdependence (Cell 6 in Table 2), Rudimentary MASs will be over-represented while Traditional MASs and Broad Scope MASs will be under-represented.*

The hypotheses developed above are summarized in Table 3. Positive signs denote that the MAS in question should be over-represented in that particular context while negative signs denote the opposite. The "(0)" symbol means that none of the MASs identified should be clearly over- or under-represented in this context.

Research method

Data collection

Empirical data were collected by means of a questionnaire survey in 1999. A pilot study involving five manufacturing companies in different lines of business was conducted to develop and validate the questionnaire. One hundred and sixty production managers from manufacturing organizations with more than 200 employees situated in Sweden were drawn randomly from the PAR register (industry affiliation and organizational size are detailed in Table 4).

In a few companies, there was more than one manufacturing department, e.g., as the result of an overall product-oriented structure (where the functions of order receiving, manufacturing and sales have been brought together into self-contained teams). In these cases, the production manager responsible for the dominant part of the manufacturing function (if any) was asked to

Table 3
Summary of hypotheses[a]

	Sequential interdependence	Reciprocal interdependence
Functional unit	*Cell 1*	*Cell 4*
	H_{1a} Rudimentary MAS (−)	H_{4a} Rudimentary MAS (0)
	H_{1b} Broad scope MAS (+)	H_{4b} Broad scope MAS (0)
	H_{1c} Traditional MAS (+)	H_{4c} Traditional MAS (0)
Lateral unit	*Cell 2*	*Cell 5*
	H_{2a} Rudimentary MAS (−)	H_{5a} Rudimentary MAS (+)
	H_{2b} Broad scope MAS (+)	H_{5b} Broad scope MAS (−)
	H_{2c} Traditional MAS (−)	H_{5c} Traditional MAS (−)
Simple unit	*Cell 3*	*Cell 6*
	H_{3a} Rudimentary MAS (+)	H_{6a} Rudimentary MAS (+)
	H_{3b} Broad scope MAS (−)	H_{6b} Broad scope MAS (−)
	H_{3c} Traditional MAS (−)	H_{6c} Traditional MAS (−)

[a] (+) = MASs that are expected to be over-represented. (−) = MASs that are expected to be under-represented. (0) = MASs that neither are expected to be over-represented, nor under-represented.

Table 4
Industry affiliation and organizational size

Industry classification		Organizational size	
Food and beverages	12	No. of employees	
Wood products	4	200–499	87
Pulp and paper products	11	500–999	29
Printing industry	8	>1000	16
Chemical products	15		
Rubber and plastic products	5		
Metal production	7		
Metal goods	43		
Machinery and equipment	10		
Electrical equipment	7		
Other manufacturing	8		
Unidentified companies	2		
Total sample	132		132

participate. Following a telephone call, if the manager agreed to participate, a questionnaire was sent with a covering letter, a confidentiality agreement, and a reply-paid envelope. Questions not correctly filled in were copied and sent to the respondent for completion. If these were not returned, missing data were substituted by the so-called hot-deck imputation method (i.e., missing values were estimated based on valid values of other cases in the sample). To prevent the database becoming biased, two conservative rules were applied. Firstly, the cases used to derive valid values were randomly selected out of the *total* sample. That is, no attempt was made to predict a missing value based on its relationship to other variables in the data set, since these methods run the risk of reinforcing relationships already in the data (cf. regression imputation discussed by Hair, Anderson, Tatham, & Black (1998)). Secondly, questionnaires with missing data on more than 20% of the questions were excluded from the study. Of the 135 questionnaires received, 132 could be used, making an effective response rate of 82.5%. Of the 25 production managers who did not return the questionnaire, 10 indicated by telephone that they would not fill in the questionnaire because of lack of time. One respondent said that it was company policy not to respond to such voluntary surveys.

Variable measurements

Departmental interdependence

The instrument utilized by Macintosh and Daft (1987) was used to measure the degree to which the focal department relies on other departments to accomplish its tasks. Since only sequential and reciprocal dependence were included, the two types of interdependence were located at the extreme points of a single seven-point Likert scale (see Appendix B).

Organizational structure

This construct was measured using six questions about behavior formalization, unit size, complexity, unit grouping and decentralization (see Appendix B).

Behavior formalization was measured in terms of the extent to which there were standard operating procedures, routines, job descriptions or the like, that could guide workers when doing their job. The instrument was based on Van de Ven and Ferry (1980).

Departmental size was measured by the number of full-time employees, and this number was transformed logarithmically to adjust for expected nonlinear impacts (Merchant, 1984; Robbins, 1990).

Complexity was conceptualized as the degree of vertical and horizontal differentiation. The construct was measured as the number of organizational levels (adapted from Miller & Dröge, 1986) and the number of job titles (based on Van de Ven & Ferry, 1980), respectively. In order to give the two parts of the instrument equal weight in a composite indicator of complexity in the present department, the answers to the latter question were first divided into quartiles and then summed with the number of organizational levels.

Unit grouping was measured using an adapted version of the instrument developed by Abernethy and Lillis (1995). Production unit managers were asked to describe their department's structure in terms of whether it was (i) functionally oriented, (ii) product oriented or (iii) a combination of the two. Following the arguments of Abernethy and Lillis (1995), a product-focused structure was considered as a first-order response to facilitating lateral coordination of the workflow. A combination of product and functional grouping was given the second-highest score, etc.

Decentralization was measured using a series of standard decisions, and identified whether managers have decision autonomy. The instrument used by Miller and Dröge (1986) was changed slightly to tailor it to a manufacturing work-unit-specific study. The calculated Cronbach alpha was 0.79.

Management accounting system design

In the contingency-based literature, MAS design has been described in many different ways (cf. Chenhall, 2003). One common approach is that of Chenhall and Morris (1986), who measured the "perceived usefulness" of different aspects of MAS information. A major advantage of this approach is that research findings may help system designers to develop MASs that have the potential to assist managers to achieve organizational goals. The premise is that if a piece of information is perceived as useful, it is likely to be used. More recently, however, this approach has been criticized because "what is perceived as useful MAS information might not be what was available MAS information to the user" (Gul & Chia, 1994, p. 419). Accordingly, in this study, which is based on the assumption that different departmental interdependencies and organizational structures should be associated with different MASs, it is logical to describe the MASs in terms of what is *actually* supplied to managers. After all, only information that is available can help managers to achieve organizational goals. However, the difference between the two approaches should not be overly exaggerated. Based on the argument that contextual factors influence managers' information needs, it is reasonable to believe that these needs are reflected in the information actually made available to them, at least in the long run (see also Chenhall (2003) for a more extensive discussion on these matters).

The questions used to measure the availability of MAS information were constructed specifically for this study (see Appendix B). As mentioned in section Definition of constructs, the design of each MAS subsystem was conceptualized in terms of two interrelated dimensions, namely level of detail and frequency of reporting. The level of detail in the MAS information reported was measured on two scales. For information on organizational units (i.e., the operating budget and operational information), respondents were asked to mark the departmental levels at which different types of information are reported. If the information compiled concerned only the department as a whole, it was considered as aggregated. In contrast, information about individual subunits was considered as detailed. For information concerning products (i.e., the standard costing system), respondents were asked to mark whether direct costs are specified or not and how many overhead rates are used to allocate indirect costs. Cost information has low detail if the system only reports total direct costs and uses single overhead rates (if any). It has high detail if direct costs are specified and multiple overhead rates are used. Frequency of reporting was measured, for each MAS subsystem, on a scale ranging from "once a year" to "several times a week". The scales were based on experience from the pilot study.

Referring to the arguments in sections Definition of constructs and Theory development, it is reasonable to believe that managers in some contexts (e.g., in Functional units experiencing sequential interdependence) benefit from accounting information that is detailed and issued frequently, whereas MAS information in other contexts tends to be general rather than detailed, and issued less frequently (e.g., in Simple units experiencing reciprocal dependence). Therefore, a score for use in the cluster analysis for each subsystem was obtained by multiplying the level of detail by the frequency of reporting. Table 5 contains descriptive statistics for the three variables.

Data analysis

The data were analyzed using the following two steps:

Firstly, the 132 manufacturing departments were categorized with respect to their values on the three variables. In the two cases where the variables were composed of several elements (i.e., organizational structure and MAS design), cluster

Table 5
Descriptive statistics

Variables	Mean	Std dev
Departmental interdependence	3.14	1.89
Organizational structure		
Formalization	5.56	1.22
Unit size	2.20	0.41
Complexity	5.77	1.56
Decentralization	2.97	0.44
Unit grouping	1.87	0.84
Management accounting system		
Operating budget	34.06	23.06
Standard costing system	45.86	31.68
Operational information	43.08	19.77

analysis was used to determine the way in which they combined. Cluster analysis is a technique for categorizing observations into groups such that observations in each group are similar to each other while observations in one group should be different from those of other groups.

There are several methods for forming clusters. In this study, a hierarchical agglomerate method was used to compute initial cluster seeds for a nonhierarchical method (*K*-means clustering). In this way, the advantages of hierarchical methods are complemented by the ability of the nonhierarchical methods to "fine-tune" the results by allowing the switching of cluster membership (Hair et al., 1998). To prevent different scale intervals from affecting the clustering procedures, data were standardized (with a mean of 0 and a standard deviation of 1).

Within the hierarchical cluster procedure, there are several ways of forming clusters (see Sharma (1996) for an overview of widely used clustering algorithms). Ward's optimizing algorithm, combined with squared Euclidean distance as the measure of similarity, was chosen on the basis that it has been widely used within the social sciences (Everitt, 1993). This method maximizes within-clusters homogeneity; i.e., it minimizes the within-group sum of squares (Sharma, 1996).

In contrast to hierarchical methods, the nonhierarchical procedure does not involve the construction of a treelike structure, where the results at an earlier stage are always nested within the results of a later stage. Instead, objects may be reassigned if they are closer to another cluster than the one originally assigned (Hair et al., 1998). Furthermore, unlike hierarchical methods, the number of clusters must be known a priori. As mentioned above, in this study the results from the hierarchical clustering procedure were used to establish the number of clusters and the profile of cluster centers for the nonhierarchical procedure.

Secondly, for each of the propositions developed above, a chi-square (χ^2) test was used to examine whether the proportion of departments having the hypothesized MAS in each cell (i.e., each combination of interdependence and organization structure), as a proportion of all departments in that cell, was significantly higher (lower) than their average proportion across all cells. The following procedure to test the propositions was used. First, a 2×2 contingency table including the *observed* frequencies was developed for each MAS in each cell (see the numerical example provided in Table 6 where the observed frequencies are marked with bold numbers). The left column in Table 6 contains the observed number of departments having, and not having, the proposed MAS *in the focal cell* while the right column contains the observed number of departments having, and not having, the proposed MAS *across all cells.*

Next, the corresponding *expected* frequencies were calculated (see the numbers inserted in parentheses in Table 6), i.e., the frequencies that we would theoretically expect if the variables are

Table 6
Observed and expected frequencies of departments having, and not having, the proposed MAS in the focal cell and across the overall sample, respectively[a]

	Focal cell	All cells	Row totals
Departments having the proposed MAS	**22** (18.55)	**61** (64.45)	83
Departments not having the proposed MAS	**16** (19.45)	**71** (88.52)	87
Column totals	38	132	170

[a] Bold numbers denote observed frequencies. Numbers inserted in parentheses denote expected frequencies.

independent. The expected frequencies E were computed as follows:

$$\text{Expected frequency } E = \frac{(\text{row total}) \times (\text{column total})}{(\text{grand total})} \quad (1)$$

where *grand total* refers to the total number of observations in the table. Finally, the χ^2 test statistic was used to test whether or not the observed frequencies differ significantly from the expected frequencies. The χ^2 tests were performed where the expected frequencies in all cells were 2.0 or more and at least 50% were 5.0 or more (Neter, Wasserman, & Whitmore, 1993).

Results

As a first step, the manufacturing departments were divided into homogeneous groups based on their values for the three variables. The division into sequential and reciprocal interdependence was based on their score on the departmental interdependence instrument, while cluster analysis was used to develop categories of organizational structure and MAS. Fig. 2 shows the dendograms that resulted from the hierarchical cluster procedures.

A critical issue in cluster analysis is the determination of the appropriate number of clusters.

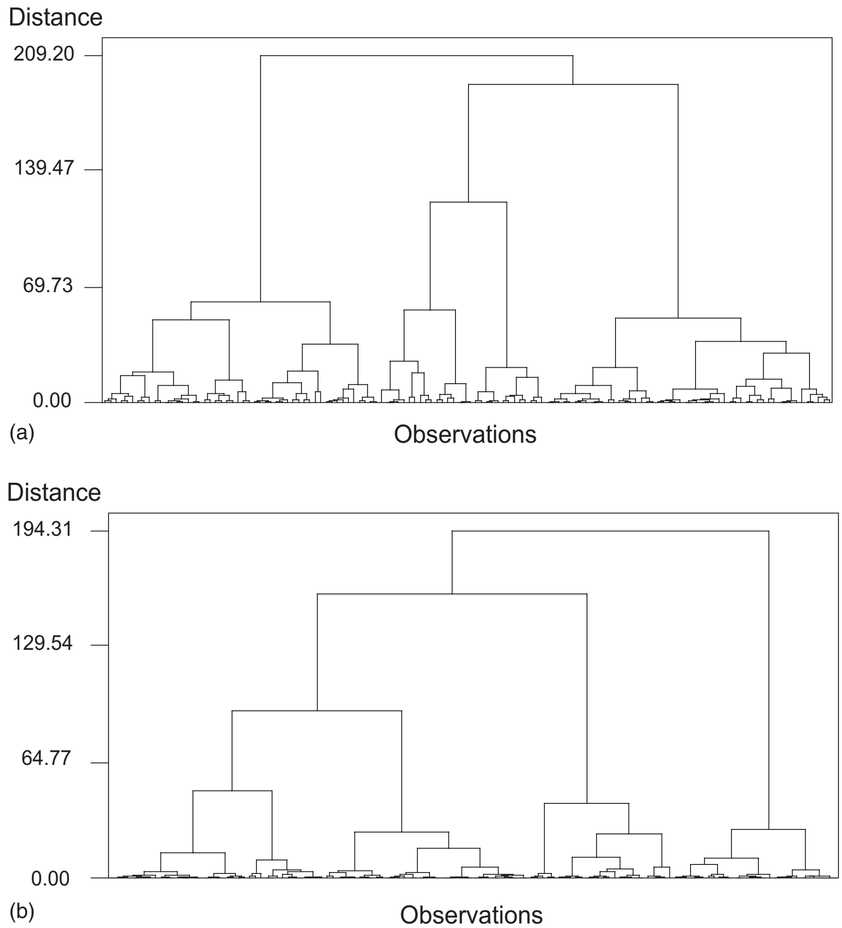

Fig. 2. Dendograms showing the results of the hierarchical cluster analysis: (a) organisation structure, (b) management accounting systems.

Table 7
Results of the *K*-mean clustering[a]

	Cluster 1	Cluster 2	Cluster 3
Organizational structure	*The Functional unit*	*The Lateral unit*	*The Simple unit*
Formalization	**0.4632**	−0.0655	<u>−0.5883</u>
Unit size	−0.0667	**0.7093**	<u>−1.0526</u>
Complexity	−0.2020	**0.7516**	<u>−0.9183</u>
Decentralization	<u>−0.3990</u>	**0.3889**	−0.0334
Unit grouping	<u>−0.9113</u>	0.4043	**0.7099**
Number of observations in each cluster	48	52	32
MAS design	*The Rudimentary MAS*	*The Broad scope MAS*	*The Traditional MAS*
Operating budget	<u>−0.7738</u>	**0.6951**	0.6156
Standard costing system	<u>−0.4435</u>	−0.3199	**1.5232**
Operational information	<u>−0.5728</u>	**0.7941**	−0.0001
Number of observations in each cluster	61	44	27

[a] Bold numbers denote the highest centroid values on each element. Underlined numbers denote the lowest centroid values on each element.

Unfortunately, no generally accepted criterion exists. Researchers are therefore reduced to using existing theory to identify a natural number of clusters that are interpretable in terms of the research question. However, as a complement, more formal "rules of thumb" can be used. One such method is to examine how the distance between objects within clusters changes (the vertical axes in Fig. 2) as the number of clusters decreases. The idea is to identify the points where within-cluster distance makes a sudden jump. In Fig. 2a two "jumps" were identified—between two and three clusters, and between three and four clusters. Both solutions were examined. The three-cluster solution was chosen because it provided clusters that were consistent with previous research in the area (see also section Definition of constructs above). On the same grounds, the three-cluster solution in Fig. 2b was considered the most interesting (see also section Theory development).

The results from the hierarchical clustering procedure were used as cluster seeds in the non-hierarchical clustering. Table 7 shows the results from the *K*-means clustering. Bold numbers denote the highest scores on each design element while underlined numbers represent the lowest. Since data were standardized (with a mean of 0 and a standard deviation of 1), negative signs mean that the centroid values of the objects contained in the cluster are below average while positive signs denote the opposite.

As a second step, the 132 manufacturing departments were categorized with respect to their values on the interdependence variable and the organizational structure variable. For each of the six dependence/structure combinations, it was then examined the extent to which the three MASs identified were used. Table 8 exhibits the observed MAS proportions and the observed frequencies and expected frequencies (inserted in parentheses) within each context. The MASs that are expected to be significantly over-represented in each context are marked with bold numbers while MASs expected to be significantly under-represented are underlined.

Several hypotheses were supported. [6] For Lateral units experiencing sequential dependence,

[6] Referring to section Data analysis above, the hypotheses stating that the proportion of departments having the proposed MAS in each cell, as a proportion of all departments in that cell, is significantly higher (lower) than their average proportion across all cells were tested by means of the χ^2 statistic measuring the degree of disagreement between the observed frequencies and the corresponding expected frequencies.

Table 8
Proportion of MASs in different contexts[a]

	Sequential interdependence	Reciprocal interdependence
Functional unit		
Rudimentary MAS	58%	30%
	(22, 18.6)	(3, 4.5)
Broad scope MAS	**32%**	40%
	(12, 12.5)	(4, 3.4)
Traditional MAS	**10%**	30%
	(4, 6.9)	(3, 2.1)
Lateral unit		
Rudimentary MAS	29%*	**29%**
	(9, 13.3)	(6, 9.2)
Broad scope MAS	**52%***	33%
	(16, 11.4)	(7, 7.0)
Traditional MAS	19%	38%(*)
	(6, 6.3)	(8, 4.8)
Simple unit		
Rudimentary MAS	**62%**	**83%***
	(16, 12.7)	(5, 2.9)
Broad scope MAS	19%	0%[b]
	(5, 8.1)	(0, 1.9)
Traditional MAS	19%	17%[b]
	(5, 5.3)	(1, 1.2)

Asterisks in parentheses represent significant but unexpected results. Numbers in parentheses represent observed frequencies and expected frequencies, respectively.
$^{*}p < 0.10$. $^{**}p < 0.05$.
[a] Underlined numbers denote MASs that are expected to be over-represented. Bold numbers denote MASs that are expected to be under-represented.
[b] This proposition could not be tested since a χ^2 test ideally requires that the expected frequencies in all cells are 2.0 or more (Neter et al., 1993).

Broad scope MASs were significantly over-represented (H_{2b}), while Rudimentary MASs were significantly under-represented (H_{2a}). Furthermore, Rudimentary MASs were significantly over-represented among Simple units under conditions of reciprocal interdependence (H_{6a}). In addition, in Simple units facing reciprocal interdependence, the proportion of Broad scope MASs was, as expected, lower than the proportion across the overall sample (H_{6b}). Also for Simple units experiencing sequential interdependence, the proportions of Rudimentary MASs (62%) and Broad scope MASs (19%) differ from their proportions in the overall sample (46% and 33%, respectively) in the proposed direction (H_{3a} and H_{3b}). However, these differences were not statistically significant.

Interestingly, none of the three MASs in Functional units facing reciprocal interdependence was significantly over- or under-represented. This corresponds well with the general expectation expressed in H_{4a}–H_{4c}, i.e., that a situation of misfit between interdependence and organization structure and, furthermore, conflicting implications of these variables on MAS design, is likely to lead to design variation rather than similarity.

A number of findings in Table 8 did not support the hypotheses set out in section Theory development. Firstly, neither of the expected associations between Functional units experiencing sequential interdependence and Broad scope and Traditional MASs, respectively, was confirmed (cf. H_{1b} and H_{1c}). In fact, the proportion of Traditional MASs (10%) was, in this particular context, below the proportion across all units (21%). Contrary to all expectations, however, Rudimentary MASs were over-represented among these units (cf. H_{1a}). However, the difference was not statistically significant.

Secondly, no support was found for the expectation that Traditional MASs should be under-represented among Simple units experiencing sequential or reciprocal interdependence (H_{3c} and H_{6c}).

Thirdly, no support was found for the expectation that Rudimentary MASs should be over-represented among Lateral units facing reciprocal interdependence (H_{5a}). In fact, their proportion was lower than would be expected. Interestingly however, the proportion of Traditional MASs was significantly higher in this context compared with its proportion across all cells (cf. H_{5c}). Furthermore, Broad scope MASs were not significantly under-represented in this context, which is contrary to the expectation suggested in H_{5b}.

Discussion

The results presented above provide some support for the expected relationships between departmental interdependence, organizational structure and MAS design in manufacturing departments. Under conditions of sequential interdependence, Broad scope MASs were significantly over-represented among Lateral units. Furthermore, the proportion of Rudimentary MASs was generally higher among Simple units compared with that of the overall sample.

A number of findings from the study did not confirm prior research. Firstly, Traditional MASs were not common among Functional units experiencing sequential interdependence. Contrary to expectations, Rudimentary MASs were somewhat over-represented. However, the concept of equifinality may help to explain this finding. That is, Functional units may satisfy the need for coordination and control by other mechanisms (cf. the substitution effects discussed in section The combined effect of departmental interdependence and organizational structure on MAS design). For example, Waterhouse and Tiessen (1978, p. 72) suggested that centralization and behavior formalization (cf. the characteristics of the Functional unit) develop as an efficient means of control in routine technologies, which implies that "planning through procedure specification will decrease the reliance placed on planning through the budgeting process". In the same vein, Mintzberg (1983, p. 77) argued that "direct supervision effected through the superstructure and standardization of work processes emerge as key mechanisms to coordinate the work in functional structures. They are preferred because they are the tightest available control mechanisms".

A second interesting and unexpected finding is the significantly high proportion of Traditional MAS among Lateral units facing reciprocal interdependence. This is contrary to the view in the literature that traditional financially oriented systems are inappropriate in uncertain environments (Abernethy & Lillis, 1995; Dunk, 1992; Kaplan, 1983; Macintosh, 1985; Merchant, 1984). The characteristics of Lateral units may provide an explanation for the contradictory result. Galbraith (1973) argued that decentralization and the creation of self-contained units are appropriate ways to handle the high information-processing needs caused by task uncertainty. However, decentralization has a price since it creates a potential for loss of control. Decentralization in large and complex organizations is therefore often associated with well-developed systems to enable subunit performance evaluation (Bruns & Waterhouse, 1975; Chenhall & Morris, 1986; Gordon & Miller, 1976; Gul & Chia, 1994; Khandwalla, 1974; Merchant, 1981; Waterhouse & Tiessen, 1978). However, critical prerequisites of output control are that the unit's performance can be isolated and that relevant output measures can be identified. Referring to Table 1, these prerequisites are met in Lateral units in that responsibility centers are organized around "natural economic entities", namely products/projects. [7] These self-sustained units can thus be held responsible for more aggregated measures such as profits, which give management an overall measure of the units' performance. Consequently, it is reasonable to believe that financially oriented MASs, under certain organizational conditions, may also be appropriate for performance evaluation in nonroutine situations. Kaplan and Mackey's (1992) finding that there was a greater tendency for flow shops to use financial information for managerial performance evaluation supports this argument.

Another, perhaps complementary, interpretation is that the financial information is used in a way that is *qualitatively different* from that often assumed in MAS research, namely performance evaluation. For example, Hopwood (1980) and Chapman (1997) argue that accounting information may well be useful in uncertain contexts, but the systems are used as "learning machines" rather than as "answer machines". In the same vein, Macintosh (1994, p. 117) concluded: "[I]t is not surprising that managers are less satisfied with controls than they are in programmable technologies. Budgets, however, can be valuable for inducing managers to coordinate with other departments and to speculate about future prospects. Control may also be used for coordination and planning." Williams et al. (1990) and Otley (1994) also argue in this direction. Consequently, it can be expected that management in these decentralized departments also need problem-solving

[7] It should be remembered, however, that the Lateral unit has a relation of reciprocal dependence with other departments within the company, which makes it difficult to isolate its performance.

oriented information aggregated around objects other than organizational units (Bouwens & Abernethy, 2000; Chenhall & Morris, 1986; Gul & Chia, 1994). The frequent issue of detailed product-cost reports characterizing the Traditional MAS indicates that this may be the case.

A third plausible explanation of the unexpected result is that corporate management adapts the *company-wide* MAS—in which the financial structure is a central part—to contingency factors influencing the firm as a whole (e.g., environmental uncertainty, firm size, and business strategy) rather than to particular contexts facing individual subunits. In other words, the level of detail and the frequency of financial plans and measurement systems may be imposed on subunits by top management, while others (e.g., operations-based information) are subject to subunit discretion. Only the latter parts can be expected to be adapted to the context of the individual subunit (Drazin & Van de Ven, 1985).

Finally, the unexpected high proportion of Traditional MASs among Lateral units may be the result of conflicting contingencies. That is, reciprocal interdependence implies coordination by means of ad hoc mutual adjustment (e.g., Hayes, 1977; Macintosh, 1994; Williams et al., 1990), whereas coordination and control in larger and more complex organizations tend to rely on sophisticated and formalized MASs (e.g., Bruns & Waterhouse, 1975; Merchant, 1981, 1984). In section The combined effect of departmental interdependence and organizational structure on MAS design, it was argued that MAS design in this type of context is primarily the result of high interdependence since the absence of standardization makes it difficult to specify unambiguous performance standards. In retrospect, however, it seems more reasonable to believe that, in line with departments in Cell 4 (see H_{4a}–H_{4c}), these departments do not face any single dominant imperative. Rather, as Gresov and Drazin (1997) suggested, a so-called suboptimal equifinality arises in these situations. That is, management makes a trade-off between contextual demands. The factor considered most important determines what the structure should look like. Importantly, this type of equifinality is always suboptimizing because one or several of the demands on the organization go unattended. Furthermore, since no single dominant imperative exists, there is also an enhanced likelihood of design variation among these departments (see also Gresov, 1989). The fact that all three MASs can be found in approximately equal proportions (1/3) in this context may be consistent with this argument.

Concluding comments and implications for future research

A main argument for this study was that there is a lack of research where the effect of multiple contextual factors on MAS design is examined simultaneously. At a broad level, the results reported here support the notion of a combined effect of departmental interdependence and organizational structure on MAS design.

A number of directions for further research emerge from this study. Firstly, cluster analysis seems useful for exploring the way in which a wide range of dimensions combines. This approach has been widely used in organization theory (Drazin & Van de Ven, 1985; Miller & Friesen, 1984), but until recently, rarely in MAS research (Chenhall & Langfield-Smith, 1998a; Greve, 1999; Johansson, 2001). The MAS categories found in this study provide a broader picture of how different elements of the MAS make up a *system*, where the different components may complement as well as replace each other. The approach also shows that it may be difficult to place identified categories on a single scale (a technique often used in contingency research). For example, it is difficult to place the three organization categories found along the often used mechanistic/organic continuum. Hence, the use of categories, rather than single one-dimensional variables, may give a clearer picture of the appropriateness of different control mechanisms in different environments.

Secondly, the findings suggest that it may be important *not* to assume automatically that there is a one-to-one relationship between context and MCS design. Rather, different control mechanisms available in the control package may well combine in different ways in a particular context. Several organizational researchers have explicitly taken up the concept of equifinality in their empirical work (see, e.g., Doty, Glick, & Huber, 1993; Gresov, 1989). However, to my knowledge, this is rarely the case in accounting-control research. In the same vein, inclusion of multiple, and possibly conflicting, contingencies seems helpful in explaining contradictions and unexpected patterns. Therefore, an important task for future research is to explore more systematically the way in which important contingent factors affect MAS design, and to investigate the existence of alternative and functionally equivalent MCS designs.

Several limitations of the current study are acknowledged. Firstly, although established measurement instruments were used in most of the study, the MAS description questionnaire was novel. Several measures were taken to increase its validity (e.g., a pilot study was conducted). However, further work is needed to refine this instrument. Of particular interest is an exploration of the relationship between the *availability* of MAS information (as depicted in the present instrument) and managers' *use* of that information. If information made available to managers was not used, there would be no reason to expect any causal relationship between contextual factors and MAS design (see also Chong, 1996). Furthermore, an instrument measuring MAS information availability provides no information of *how* it is used. The findings of Simons (2000, p. 208) underline the importance of this argument:

> The difference between diagnostic and interactive control systems is not in their technical design features. A diagnostic control system may look identical to an interactive control system. The distinction between the two is solely in the way that managers *use* these systems.

Secondly, another limitation relates to the analysis design in that the taxonomies of organization structure and MAS were developed in isolation. This implies that possible relationships between variables were not acknowledged. It is also implicitly assumed that management "choose" between different control factor "configurations" rather than incrementally adjust single elements to each other. It is too early to have a strong opinion on the validity of these assumptions. Rather, further research is needed that examines in more detail how different elements are related to each other, and how adaptation processes develop over time.

Finally, compared with most traditional studies (which focus on interaction effects between single contingent and single MCS factors), the research design used in this paper has neither their statistical rigor, nor their clear notion of fit. Nevertheless, more holistic approaches are still in their infancy and their potential is yet to be explored—an interesting and rewarding challenge for future research.

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Appendix A

See Table 9.

Table 9
Portion of organization structures in under conditions of sequential and reciprocal interdependence, respectively

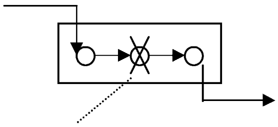
	Sequential interdependence	Reciprocal interdependence
Functional unit	40%	27%
Lateral unit	33%	57%
Simple unit	27%	16%

Appendix B

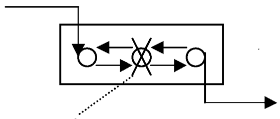
Departmental interdependence

How would you describe the normal flow of work between your department and other units? Your department is marked with a cross.

Sequential work flow where work normally flows in one direction.	☐	☐	☐	☐	☐	☐	☐	Reciprocal work flow where work flows between units in a back-and-forth manner before it leaves the company.



Your department



Your department

Organizational structure

Behaviour formalization	Not at all						To a large extent
To what extent are there clear rules, routines, job descriptions or the like that can guide your workforce in doing their work?	☐	☐	☐	☐	☐	☐	☐

Departmental size
How many full-time employees are there within your department? ……….

Complexity
How many levels are there within your department? That is, count the number of levels in the longest line between direct worker and yourself (include both these levels). ………..

How many job titles (e.g., foreman, operator, constructor, and product line supervisor) are there in your department (including your own position)? ………

Decentralization
Which level in your firm has the authority to make the following decisions? Your position is called Functional manager.

Decision concerning:	CEO or above	Functional manager	Middle mgmt	Lowest dpt. level	Individual level	Not relevant
a. The number of workers required	☐	☐	☐	☐	☐	☐
b. Whether to employ a worker	☐	☐	☐	☐	☐	☐
c. Overtime to be worked at the shop level	☐	☐	☐	☐	☐	☐
d. Delivery dates and priority of orders	☐	☐	☐	☐	☐	☐
e. Methods of personnel selection	☐	☐	☐	☐	☐	☐
f. Method of work to be used	☐	☐	☐	☐	☐	☐
g. Machinery or equipment to be used	☐	☐	☐	☐	☐	☐
h. Allocation of work among available workers	☐	☐	☐	☐	☐	☐
i. Minor investments	☐	☐	☐	☐	☐	☐
j. Larger investments	☐	☐	☐	☐	☐	☐

Unit grouping

How would you describe the structure within your department? Please indicate the principal form.

- ☐ A functional structure where responsibilities are divided primarily by function, e.g., production planning, construction, maintenance, and assembly.
- ☐ A product-focused structure where all functional departments working on one product are grouped together.
- ☐ A combination of a functional and a product-focused structure where neither dominates (e.g., where component manufacturing is functionally organized whereas product assembly is product-focused, or a matrix organization with dual responsibilities).

Management accounting system design

Manufacturing departments can be organized in different ways. Henceforth, the following simplified description of organizational levels will be used.

- Highest departmental level: The whole department for which you are responsible.
- Lowest departmental level: Manufacturing units at the lowest departmental level (can be both permanent groups and temporary project groups).
- Middle management: All departmental levels (if any) between the highest and the lowest level.
- Individual level: Individual co-workers.

If any level does not exist within your department, please leave out that column when you answer the following questions.

Operating budget

Please mark which of the following revenues/costs regularly are reported at each departmental level.

	Highest dpt. level	Middle mgmt	Lowest dpt. level	Individual level
a. Materials costs	☐	☐	☐	☐
b. Labour costs	☐	☐	☐	☐
c. Depreciation (e.g., on machines or buildings)	☐	☐	☐	☐
d. Capital employed (e.g., rents on inventories or equipment)	☐	☐	☐	☐
e. Costs for services bought from other departments or from external suppliers (e.g., repairs, insurance or freights)	☐	☐	☐	☐
f. Revenues (from external or internal sales)	☐	☐	☐	☐

If you in the previous question have marked that reports are compiled, please mark below how often the outcome is reported at each departmental level.

	Highest dpt. level	Middle mgmt	Lowest dpt. level	Individual level
a. Once a year	☐	☐	☐	☐
b. 2–5 times a year	☐	☐	☐	☐
c. 6–12 times a year	☐	☐	☐	☐
d. Several times a month	☐	☐	☐	☐
e. Several times a week	☐	☐	☐	☐

Standard costing system

Please mark how often product costs are reported in your department for each of the product levels below.

	Never	Once a year	2-5 times a year	6-12 times a year	Several times a month	Several times a week
a. Batch level (one specific batch of a certain product)	☐	☐	☐	☐	☐	☐
b. Product level (one type of product)	☐	☐	☐	☐	☐	☐
c. Product line level (a group of products)	☐	☐	☐	☐	☐	☐

If you in the previous questions have marked that product costs are reported, please mark which of the listed items are included in the cost build-up.

a. Direct materials	- Different materials are specified	☐
	- Only total direct materials are reported	☐
b. Direct labour	- Is not specified	☐
	- Specified per operation/activity	☐
	- Only total direct labour is reported	☐
c. Machine overhead	- No machine overhead is allocated	☐
	- One overhead rate is used	☐
	- 2-4 overhead rates are used	☐
	- Five or more overhead rates are used	☐
d. Remaining manufacturing Overhead	- No overhead is allocated	☐
	- One overhead rate is used	☐
	- 2-4 overhead rates are used	☐
	- Five or more overhead rates are used	☐
e. Other, namely	……………………………………………..	☐

Operational information

Please mark which of the following items regularly are reported at each departmental level.

	Highest dpt. level	Middle mgmt	Lowest dpt. level	Individual level
a. Resource consumption (e.g., materials, labour hours)	☐	☐	☐	☐
b. Time (e.g., on-time deliveries, length of cycle time from order to delivery)	☐	☐	☐	☐
c. Product quality (e.g., product defects, customer complaints)	☐	☐	☐	☐
d. Productivity (e.g., machine utilization, amount of output per employee)	☐	☐	☐	☐
e. Flexibility (e.g., ability to adapt the product to the demands of individual customers, ability to manufacture new products)	☐	☐	☐	☐
f. Staff welfare (e.g., attitudes to work)	☐	☐	☐	☐

If you in the previous question have marked that reports are compiled, please mark below how often the outcome is reported at each departmental level.

	Highest dpt. level	Middle mgmt	Lowest dpt. level	Individual level
a. Once a year	☐	☐	☐	☐
b. 2–5 times a year	☐	☐	☐	☐
c. 6–12 times a year	☐	☐	☐	☐
d. Several times a month	☐	☐	☐	☐
e. Several times a week	☐	☐	☐	☐

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