The use of management accounting systems in functionally differentiated organizations

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The Use of Management Accounting Systems in Functionally Differentiated Organizations

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Proefschrift

ter verkrijging van de graad van doctor aan de Katholieke Universiteit Brabant, op gezag van de rector magnificus, prof.dr. L.F.W. de Klerk, in het openbaar te verdedigen ten overstaan van een door het college van decanen aangewezen commissie in de aula van de Universiteit op woensdag 24 juni 1998 om 16.15 uur door

Johannes Franciscus Maria Gijsbertus Bouwens

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Promotores: Prof. dr. M.A. Abernethy
Prof. dr. D.V. DeJong

Copromotor: Dr. Ir. B.W.M. Bettonvil

Dissertaties zijn onvermijdelijk en soms zelfs nuttig.

E. du Perron

To Peter Brownell

Abstract

Management accounting systems (MAS) primarily serve two functions: the control function and the decision facilitating function. Much of the empirical research in management accounting has tended to focus on the control function. The literature which has focused on the decision facilitating function of MAS has theoretical and methodological limitations. This study attempts to address these limitations by developing a conceptual model to study the antecedents of MAS use. In particular the study develops a conceptual model to study how the pursuit of customization, as a strategic priority, influences the design of MAS for decision making in functionally differentiated firms. It is argued that the information required for decision making by managers in firms pursuing customization differs significantly from the requirements of managers in firms which produce primarily standardized products. Information requirements change not only in direct response to the pursuit of customization but also due to the increasing levels of interdependence which occur between functional departments. As MAS are one of the major sources of information for decision making, it is hypothesized that the design characteristics of these systems will differ in response to these information requirements. A theoretical framework is developed to study the effect of customization on the use of MAS. This theory suggests that customization has a direct effect on the use of MAS, but also that customization augments interdependence between departments which in turn affects MAS use. The data were collected from interviews with 170 production and sales managers drawn randomly from a cross section of manufacturing and service companies in The Netherlands. A structured questionnaire was used as the basis of the interviews. Path analysis is used to test the model. The study reveals that customization increases levels of interdependence in functionally differentiated structures. Partial support is found for a direct relationship between customization and MAS use. Strong support exists for an indirect relationship were customization influences MAS use via interdependence. Also there is strong support for the relationship interdependence and MAS use.

Preface

I commenced this project knowing virtually nothing of what was going on in accounting research, nor was I familiar with conducting a research project of my own. I had a tough time defining my project. During that stage, Anne-Marie van Balsfoort emphasized (and still emphasizes) the relative unimportance of actually solving self-defined problems, which helped me considerably to put my troubles in perspective. And if that did not help, Alma and Tessel where always there to show me the bright side of life.

First, I had to find my way through accounting journals that were almost without exception new to me. Then, I started to look for potential thesis topics. Economic organization theory and socio-technical work, supervision of students engaged in consultancy assignments, and discussions with my colleagues helped me to acquire a research focus. Economic organization theory helped me understand the relation between types of decisions and hierarchical context. Socio-technical work, on the other hand, provided me with the insight that it makes no sense to look at (accounting) information without knowledge of the way in which production is organized. My supervision activities gave me an excellent opportunity to try my ideas in the field. Indeed, I took the opportunity to discuss my ideas intensively with users of accounting systems and colleagues to improve my research proposal.

Like Bruckner, I was inclined to heed every comment I got so that in the end I ran the risk to loose track. Therefore, it was important for me to have Laurence van Lent around to assess whether a potential change would actually improve the work. We continued to discuss issues to the very end of the thesis process. Bert Bettonvil was very important during the first stage to examine whether my proposal was researchable from a statistical point of view.

There it was: my first research proposal. I was very lucky to find IOSA, i.e. Gijs Bak, prepared to support my project. I was given the opportunity to look for a supervisor who had successfully conducted accounting-research projects similar to my proposal. The late Peter Brownell embraced the project when I asked him to supervise my PhD. One can hardly overestimate the boost of his YES to my self-esteem. I went to The University of Melbourne in Australia twice. One month in 1996 to work with Peter Brownell, and six months in 1997 to work with Margaret Abernethy. I wrote a first draft of the first two chapters under Peter's supervision. In the process, he improved my knowledge of managerial accounting considerably. Just after my arrival in 1997, Peter passed away. Both Maggie and I thought it would be imperative to write a thesis befitting Peter's memory. This is how we tried to accomplish this. Only the underlying ideas remain from the firts drafts of the chapters I wrote. Every draft was challenged to the limit, in the process sharpening my argumentation. At several points during the write-up I experienced

how knowledge and its comminication are intertwinend. It is very satisfying to have this experience.

In addition to Bert Bettonvil's comments, the statistical analyses benefited from Gerry Gannon's and Ben van der Genugten's support.
The PhD process ended with the submission of my work in January 1998. I like to thank Rob Bannink, Harry Barkema, Doug DeJong, David Otley, and Martin Wijn for accepting the thesis. I also thank all 85 organizations that provided me with the necessary data to conduct the study. Nancy Kanters is acknowledged for her help with the layout.

Now that the work is accomplished, I can say: it was fun to do!

's-Hertogenbosch, 15 April 1998

Contents

Chapter 1

The purpose of the research

1.1 The research issue

This study investigates whether strategy and interdependence between departments are associated with the use of management accounting systems (MAS). The following relationships are examined:

* strategy and the use of MAS;
* interdependence between departments and the use of MAS;
* strategy, interdependence between departments and the use of MAS.

These links are investigated to explore under what conditions MAS differs and what governs these differences.

This chapter is structured as follows. The next section discusses the theoretical relevance of the study. Section 1.3 discusses how the design of this study assists in attributing results. Section 1.4 identifies managerial relevance of the study. The last section describes the structure of the study.

1.2 Motivation

The purpose of this study is to develop a better understanding of the factors that influence the design and use of management accounting systems. The study contributes to the literature by developing a theoretical framework to examine the relationships between strategy, interdependence and MAS. The study was motivated by the absence of a coherent theoretical framework to study these relationships and also by a number of methodological weaknesses associated with research studying the strategy/accounting link.

Prior research in both the organizational and accounting literature provides theoretical, and some empirical support, for the *separate* relationships between strategy and interdependence, interdependence and MAS, and strategy and MAS. However, this is the first study that develops an integrative model to examine the inter-relationships among strategy, interdependence and the design and use of MAS. The model pays particular attention to the

conceptualization of the constructs of interest. This enables the development of a more coherent framework for specifying the nature of the relationships examined (Chapman, 1997; Otley, 1980; Otley and Pollanen, 1997). The way in which the model is operationalized limits the potential for omitted variable bias. The model controls for type of decision, managerial level and organizational structure (Otley and Pollanen, 1997). This study focuses on operational decisions of production and sales managers in functionally differentiated business units. This ensure a distinct attribution of the results.

The following sub-sections elaborate on the motivation by providing an overview of the study and highlighting the way in which the study contributes to the extant literature on accounting systems.

Influence of strategy on accounting systems design

The strategy organizations pursue has been recognized as an important management issue since the early work of Chandler (1962). While Chandler (1962) introduced the notion of strategy into the literature at the corporate level, strategy has also been studied at the business unit and functional level of organizations (Chrisman et al. 1988). Corporate strategy is concerned with the types of businesses a firm chooses to operate. Business unit strategy "deals with the specifics of how particular strategic business units within the firm will compete" (Macintosh, 1995). "Functional strategy is concerned with how the various functions contribute to the particular business strategy" (Langfield-Smith, 1997).

The general management literature has studied the managerial implications when firms pursue different strategies for some time. However, research in management accounting did not start investigating the association between strategy and MAS until the mid-1980s. The main proposition examined in this literature is that MAS are more (less) sophisticated and used less (more) formally depending on the strategy organizations pursue. Studies have developed conceptual frameworks which argue that prospector-type strategies are associated with more sophistication and less formal MAS use, whereas defender-type strategies are associated with less sophisticated MAS and more formal MAS use. A number of studies have focused on the relationship between strategy and usefulness of various dimensions of MAS. Dimensions that have been investigated include time horizons and tightness of controls (Chenhall and Morris, 1995; Govindarajan and Gupta, 1985; Govindarajan, 1988; Govindarajan and Fisher, 1990; Simons, 1990, 1991), integrative control devices and scope of information (Abernethy and Guthrie, 1994; Abernethy and Lillis, 1995). However, these studies use broad definitions of strategy which embrace all aspects of a business unit strategy (Govindarajan and Gupta, 1985; Simons, 1990) or focus on functional-level strategy (Abernethy and Guthrie, 1994). A serious drawback of these broad definitions of strategy in empirical work have been identified by Langfield-Smith (1997) and Chapman (1997). They argue that conflicting or

equivocal results associated with this literature is partly attributed to the way in which strategy is operationalized. This is particularly evident in studies that use generic strategy typologies to operationalize the strategy construct. Classifying firms according to an archetype assumes that firms are homogeneous in the way in which they pursue a particular strategic position. For example, it is often assumed that all firms classified as defenders will compete based on costs. However, organizations are likely to pursue a similar strategy differently. For instance, some firms pursuing a defender strategy may do so by emphasizing production quality, while others may emphasize cost control. Similarly, a prospector strategy may be operationalized by emphasizing new product development and a flexible manufacturing strategy. Yet, prospectors may also emphasize quality and defenders may cut costs with the help of a flexible manufacturing strategy, reducing set-up costs to zero.

It is thus extremely difficult to use a generic typology such as that provided by Miles and Snow (1978) or Porter (1980, 1985) to develop theoretical propositions concerning the relationship between strategy and MAS. Some elements of a strategy may differ between organizations despite the fact that they both pursue the same generic type of strategy. Similarly, certain strategic elements may be similar even though the organizations are pursuing different generic strategies. It is, therefore, not surprising that the findings of research that link strategy to accounting and control systems are often 'fragmentary and conflicting.'

This study controls for the problem of differences within and between strategies by focusing on one element of strategy, namely, customization

Customization and business unit strategy

Customization is a strategic response to customers' demand for increased product variety, more features, and higher quality in products and service (Kotha 1995; Kotler, 1989; Pine, 1993). Customization is defined in this study as the extent to which a business unit allows individual customers to affect the product/service attributes that it produces. Customization is related to Porter's (1980) notion of differentiation. However, it does not cover all the features that Porter associated with the pursuit of that strategy. For instance, the frequency and speed of new product introduction is not part of the customization concept used in this study. Also, his notion of narrow versus broad business focus is not captured by customization. One can, however, contend that organizations with high scores on customization (i.e. with many product varieties available on relatively short notice) are more likely to pursue a differentiation strategy than organizations that produce standardized products. Customization can be seen as the operational means of implementing a strategy of differentiation (Murray, 1988; Parthasarthy and Sethi, 1993).

Influence of interdependence on accounting systems design

Interdependence affects the way in which work in organizations is co-ordinated, and has received, therefore, considerable theoretical and empirical attention (Daft and Lengel, 1986; Galbraith, 1973; Macintosh and Daft, 1987; Macintosh, 1995; and Thompson, 1967). This study uses Thompson's (1967) notion of interdependence, which is defined as the extent to which departments depend upon each other to accomplish their tasks. The empirical work that has investigated the relation of interdependence and MAS starts from the proposition that management accounting systems can be used by managers to deal with the interdependence that exists between different organizational functions (Chenhall and Morris, 1986, Macintosh and Daft, 1987).

These studies, however, have a serious drawback in that they fail to discern between interdependence that exists between the tasks employees perform in a department (intra-departmental interdependence) and interdependence between functional units (inter-departmental interdependence. Intra-departmental interdependence pertains to co-ordination between tasks performed within a department which has been consciously established because these tasks are logically related to each other. Inter-departmental interdependence pertains to the co-ordination of tasks that differ to such an extent that the organization has decided to carry them out in different departments (Daft and Lengel, 1987; Macintosh, 1995; Thompson, 1967).

These differences are manifest in the nature of the tasks and the objectives that are pursued. For instance, a sales person is specialized in sales activities and maximizes revenue while employees in production are specialized in production-related activities and strive for efficiency. While differences in the nature of tasks and objectives are less manifest within departments, it is likely that co-ordination between departments is more complex because this requires reconciliation of both the nature of tasks and objectives. In conclusion, co-ordination between departments is more complex than within departments. It is, therefore, likely that co-ordination mechanisms used within departments will also differ from those used to co-ordinate inter-departmental interdependence (Macintosh, 1995).

It is difficult to identify what is driving accounting systems design, if it is not known what type of interdependence is investigated. Is it interdependence between departments or between individuals performing tasks within an department that triggers MAS use? For this reason interdependence is operationalized in this study as interdependence between departments.

The linkage between strategy and interdependence

The general management literature has tended to focus on how strategy affects structure (Hammond, 1994). There exists considerable theoretical support for the idea that structural arrangements are a response to the interdependencies created by pursuit of different strategies (Brickley et al. 1996; Galbraith, 1973; Macintosh, 1995; Milgrom and Roberts, 1990, 1992). Yet, empirical research investigating this relationship is absent. Milgrom and Roberts (1990,

1992) argue that co-ordination problems between manufacturing and marketing arises when the strategic choice has been made to offer a larger product variety to clients. Macintosh (1995) argues that a prospector strategy is likely to augment interdependence. Galbraith (1973) describes how interdependencies are increased with a shift to more customer responsive strategies. Brickley et al. (1996) identify co-ordination problems across departments in functionally differentiated organizations that adopt a customer responsive strategy.

The empirical studies that have investigated the relationship between strategy and MAS have either simply ignored the relationship between strategy and interdependence between activities (e.g. Simons, 1987, 1990) or implicitly assumed that strategy would be related to interdependence. Abernethy and Lillis (1995), for instance, partly build their theory on the strategy-performance system relationship on the premises that increased levels of interdependence are associated with customer responsiveness. Govindarajan and Gupta (1985) use interdependence to support the argument that strategy affects accounting systems design. Other studies have identified interdependence as a factor of importance without reference to strategy or other antecedents whatsoever. Gresov (1989) refers to interdependence as an important contingent factor to control activities, without any further reference to the antecedents of interdependence. Similarly, Chenhall and Morris (1986) consider interdependence a separate contextual variable without modelling the antecedent conditions that give rise to it. The strategy-interdependence relationship has received virtually no attention in MAS studies, while MAS are supposedly designed to:

> '....co-ordinate between managers of different organizational sub-units, so that each is aware of the requirements and constraints faced by others with whom he or she interact' (Drury, 1996)

> 'integrate and co-ordinate the efforts of all business functions in addition to developing the capabilities of each individual business function' (Horngren, Foster, and Datar, 1997).

This study is the first to examine the relationship between strategy, interdependence and MAS. The study develops a theoretical model of the relationship between customization-interdependence and MAS. It builds on the work of Chenhall and Morris (1986). It investigates, both theoretically as well as empirically, the separate effects of customization and interdependence on the perceived usefulness of MAS characteristics, and assesses whether the effects of customization operate directly and or indirectly, whereby customization affects MAS via interdependence. In this way it is possible to explore the question of how customization and interdependence separately govern MAS, and to what extent customization

acts on MAS via interdependence. The relationships of interest are illustrated in Figure 1.

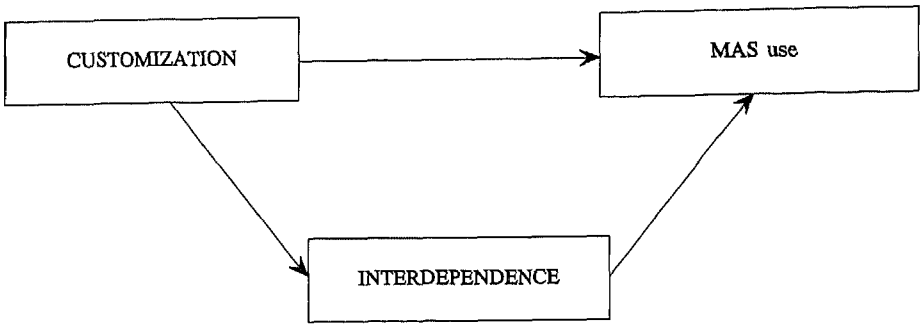

Figure 1.1: The Relationships

1.3 The design of the study

Most studies have not been selective in their choice of respondents. This study focuses on managers who are in charge of production and sales departments. Managers are asked to refer only to operational decisions, rather than to the many different types of decisions they make. The advantage of this design over others is that the conclusions of the study can be attributed to one level of management and one type of decision. Results are, therefore, not biased by management levels (differences in management levels are likely to embrace differences in the nature of problems to be solved) and type of decision (decisions on the budget differ from decisions to make a batch of 1,000 units rather than 10,000 units). The research is set in functionally differentiated business units, that is, in business units with separate sales and production departments. This setting controls for biases that might evolve in the results due to structural differences across organizations.

To empirically test the theory the three variables of interest are operationalized. Customization is measured at the business unit level, while interdependence and MAS are measured at the level of sales and production departments.

1.4 Practical relevance

While this study has been designed to contribute theoretically and methodologically to the research literature, it is anticipated that the findings will also be of interest to both the designers of management accounting systems and to senior management involved in the implementation of strategic change. An increasing number of firms have shifted in recent years from a strategy that focused on producing standardized products to a strategy that attempts to be customer responsive (Feitzinger and Lee, 1997; Upton and Macadam, 1997). Customers are now demanding that "orders to be fulfilled more quickly as well as products/services tailored to their specific needs" (Feitzinger and Lee, 1997). Top management believes that the ability to meet these demands is today's competitive weapon and indeed that it is critical to organizational survival (Gilmore and Pine, 1997; Kotha, 1995; Kotler, 1989; Pine, 1993; Upton and Macadam; 1997).

The pursuit of a customer responsive strategy such as customization poses challenges for the designers of organizational structures and information systems. Customization requires management to reconsider how best to manage work flows across functional units (Upton and Macadam, 1997). Firms are beginning to recognize that the most effective means of achieving this strategy is by developing structures and information system which encourage co-operation and co-ordination among functional units (Baldwin and Clark, 1997). In other words, organizations which are successful in the implementation of customization are doing so by breaking the functional mind-set (Majchrzak and Wang, 1996).

Management accounting systems have a critical role in facilitating the co-ordination of work flows. Majchrzak and Wang (1996) observe that successful organizations are implementing these systems to provide workers with information on customer, cost, and market data, and to encourages workers to use the reporting and tracking system to log problems and to comment on those that others have encountered. This is consistent with the empirical findings of Simons (1991). Baldwin and Clark (1997) and others (Drury and Tayles, 1998; Osborne and Ringrose, 1998; Swenson, 1997) illustrate how costing and other information systems are used to co-ordinate work flows in firms pursuing customization.

This perusal of the practitioner-oriented literature identifies some of the challenges facing senior management in the pursuit of customer responsive strategies such as customization. One of the challenges facing management accountants in practice will be in designing accounting systems to support this decision making context. It is hoped that the findings of this study will assist in that process.

1.5 The structure of the study

The following chapter defines the variables of interest in this study. Chapter 3 develops the theoretical model, leading to a formal statement of hypotheses to be examined. Chapter 4 describes the methods used to conduct the study. Chapter 5 discusses the psychometric properties of the variables that are included in the study. The final chapters report the results of the empirical analyses, and discusses the implication of the findings.

Chapter 2

The variables

2.1 Introduction

Chapter 2 defines the variables of interest and is structured as follows. Section 2.2 defines customization. Section 2.3 discusses the variable of interdependence. Section 2.4 defines Management Accounting Systems and describes MAS in the four dimensions of scope, integration, aggregation and timeliness. Section 2.5 summarizes the chapter.

2.2 Customization

In Chapter 1 it is argued that customization is an element of a differentiation strategy (Porter, 1980). It can be seen to be a functional strategy implemented by a firm to differentiate itself from its competitors. Customization is defined as:

> "the extent to which a business unit allows individual customers to affect the product/service attributes that it produces."

This section elaborates on the definition and describes the way in which customization is conceptualized in the study.

2.2.1 Types of customization

Parthasarthy and Sethi (1993) contend that customization involves competing on product variety and volume flexibility. Product variety refers to the product assortment from which the customer can choose. Volume flexibility refers to how fast customers can require the different products from the assortment. Competing in the two dimensions requires an organization to structure operations in a way that allows them to customize. Pine (1993) identified how organizations can implement a customization strategy. He argues that customized products can be produced by either combining standardized modules or by adding features on customer's request. These two alternatives provide a useful means to distinguish between two types of customization: mass customization and tailored customization. Combinations of standardized modules enable organizations to pursue a strategy of mass customization (Kotha, 1995; Pine, 1993). Mass customization means that product variations

can be offered to the customers without the necessity of changing existing production programs. Tailored customization exists when the organization is able to add client specific features on customer's request. Customization may vary from zero to 100 percent. Thus, customization represent points along a continuum, with traditional mass production at one end and tailored customization at the other, while mass customization is situated between the two extremes. Tailored customization represents a high degree of customization, while mass customization allows for a relatively high degree of standardization. Both mass customization and traditional mass production use standard modules in the production process. In that respect mass customization is more closely related to mass production than to tailored customization.

2.3 Interdependence

This study focuses on the interdependence between production and sales departments within a business unit. In his seminal work Thompson (1967) defines interdependence between departments as:

> "the extent to which departments depend upon each other to accomplish their tasks."

Interdependence arises when people jointly carry out activities to produce an output. For example, sales and production departments are both involved in the production of a final output. It is the separation of production and sales activities that creates interdependence between departments. Interdependence occurs as a consequence of a functional structure (Macintosh, 1995; Thompson, 1967). In other words, interdependencies between departments could be minimized by grouping individuals performing tasks relating to products or product lines into a single unit. In that case, each unit (department) could produce and sell products without reference to other departments.

Thompson's definition of interdependence is used throughout this study. This section elucidates how interdependence may surface. The level of interdependence differs dependent on the nature of the task performed. Tasks are performed to produce output with inputs. The process to transform inputs into output is referred to as the transformation process. This process may result in any output, like a final product delivered to the client, a letter to refuse a client's order, or a price offer. Thompson (1967) uses the term tasks to include all activities carried out in departments. This study focuses on the tasks associated with the ongoing production and selling of products and services. These tasks can be identified as operational tasks (Anthony, 1965) and primary tasks (Porter, 1980) rather than as strategic

or secondary tasks.[1] However, as this study examines the effect of an ongoing customization strategy on production and sales decisions, these decisions are more likely to pertain to operational and primary tasks than to strategic or secondary tasks. The study will, therefore, focus on workflows between departments that can be directly linked to producing and selling outputs.

In this study the term transformation process pertains to all tasks performed in the organization to produce a final output. An output is final when it leaves the organization. The transformation process of products/services involves all phases that an order follows from the moment an order is received (enters into the organization), until the product/service is actually delivered to the client (leaves the organization). A final product/service has gone through all the phases of the transformation process, and is thus delivered to the client. An intermediate product, in contrast, is a product that has to follow one or more phases of the transformation process. These next phases may be situated in the same and in other departments. The terms transformation process, final and intermediate product will be used in the above fashion throughout this study. The word product is used for both tangible product as well as for services.

2.3.1 Types of interdependence

Thompson (1967) distinguished three types of interdependence. If there is no exchange of intermediate products between sub-units, sub-units would be characterized as having pooled interdependence. This would be the situation for product line structures where the only type of interdependence is that related to the sharing of the corporate resources of the business unit. The business unit manager assigns responsibility to each production line and allocates resources to each line. Each product line operates independently of the other product lines. There is no interdependence in the task performed. Sequential interdependence involves a serial sequence of intermediate product transfers between functional sub-units until the final product is delivered to the customer. The intermediate product of a department is an input to the next department. The simplest situation in manufacturing is the one in which procurement delivers raw material to production and production delivers its intermediate product to the sales department. The transformation process is complete once a product or service is actually delivered to the client. The highest form of interdependence is reciprocal. In this situation, intermediate outputs move back and forth between departments several times until the final product is delivered to the client. As a consequence, an intermediate product may enter into a department more than once, until it becomes final. This kind of interdependence

[1] It should be emphasized, however, that it is not always possible or not even helpful to make a distinction between say, operational and strategic tasks (Anthony, 1965), or primary and secondary tasks (Porter, 1990).

is common in hospitals where patients move back and forth among departments, or in any other situation where there is a high degree of customization in the product required (Mia and Goyal, 1991; Macintosh and Daft, 1987). The very fact that the types of interdependence can be described with examples does not mean that a sub-unit can by characterized by only one type of interdependence. Thompson (1967, p. 55) made the following remark in that respect:

> ".. we believe the types of interdependence form a Guttman-type scale: all organizations have pooled interdependence; more complicated have sequential as well as pooled; and the most complex have reciprocal, sequential and pooled interdependence."

In other words, some work in the transformation process can be performed without reference to other departments, while other work involves sequential or even reciprocal interdependence. In this study it is expected that business units will have all three types of interdependence at the same time.

2.4 Management accounting systems

Recent textbooks of Drury (1996), Atkinson et al. (1997), and Horngren et al. (1997) use condensed definitions to identify the area of management accounting:

> Management Accounting: 'relates to the provision of appropriate information for people within the organization to help them make better decisions' (Drury, 1996);
>
> 'produces information that helps workers, managers and executives to make better decisions' (Atkinson, Banker, Kaplan, and Young (1997);
>
> 'measures and reports financial as well as other types of information that assist managers in fulfilling the goals of the organization' (Horngren, Foster, and Datar, 1997).

These definitions are consistent in that they identify management accounting as a system that provides information that is helpful in decisions making. However, each of them is too broad a definition because it is not clear how management accounting information differs from other information. In addition, non of the definitions distinguish between the two fundamentally different functions of MAS.

2.4.1 Accounting and other information

The issue addressed in decision making determines what kind of information system is used. Earl (1983) argues that a MAS are a sub-set of management information systems (MIS), which are designed to support decision making in general. He contends that each decision consists of more than one dimension, only one of which is financial. Different systems are required to cover the dimensions involved in a decision. The decision to hire a new employee, for instance, will engender a trade-off between the prospective salary and the expected organizational income. However, before a decision is made other issues need to be addressed as well. The human-resource-management (HRM) policy of the organization might prescribe that new employee's age should not exceed the average age of his prospective colleagues. Thus, two types of information are required to support the decision to appoint the applicant: one to make the financial trade-off, and one to compare the applicant's age with an average. Although the decision to employ new personnel includes more aspects than that already mentioned, the example serves to illustrate that a manager's decision requires consideration of more than one aspect. Demski (1980) considers these aspects sub-sets of the phenomenon. In the above example, the phenomenon 'appointing personnel' breaks down into a financial and a HRM aspect. Each phenomenon can be described in a set of descriptions (like, productivity figures, salary costs per employee, and average age of employees in the example). The set describes the phenomenon, while the aspects of the phenomenon are described in aspect systems (De Sitter, 1994) or alternative systems (Demski, 1980). The set of descriptions that focuses on the financial aspect of a phenomenon, is one alternative system with which a phenomenon is described.

Applying Demski's theory of information to the example: information to make the decision to appoint an employee is provided in two alternative systems. One to cover the financial and one to cover the HRM aspect of the decision. Clearly, it is the organization that defines the aspects to be considered in a decision, and hence the information that is required. In this vocabulary, MIS are the set of descriptions (of phenomena) managers use to make decisions. MAS are an aspect system of MIS because they describe only the financial aspect of the phenomena. MAS comprise the set of descriptions managers use to consider the financial aspect of decisions. This definition, however, is incomplete in that the nature of decisions is not clear. This issue is discussed below.

2.4.2 Functions of MAS

Demski and Feltham (1976) identified two functions of information in the organization: decision facilitating and decision influencing. This distinction is useful as it is closely related to the two managerial roles described by Fama and Jensen (1983): decision management and

decision control. Decision management consists of initiation and implementation. Decision control breaks down in supervision and ratification. Ratification of decisions results in the confirmation or denial of initiatives, while monitoring of decisions results in the assessment of implementation decisions. MAS are used to support decision management as well as decision control, and refers to these functions as accounting for decision making and accounting for control (Zimmerman, 1995). These notions are similar to that of Demski and Feltham (1976): accounting to facilitate (decision making) and accounting to influence (control) decisions. It is important to distinguish between these two roles of MAS because the nature of the decisions are different, and hence the information required. A choice has to be made because decision control and decision management require different sets of descriptions. As this study focuses on decisions that directly pertain to transformations, namely operational decisions, it is decided to study accounting for decisions making rather than accounting for control. For the purpose of this study, MAS is defined as follows:[2]

> 'MAS comprise the set of descriptions that managers use to consider the financial aspects in making decisions.'

Zimmerman (1995) points out that the two different roles of MAS may prompt conflicting MAS design decisions. Foster and Ward (1994) illustrate how MAS innovations that improve decision making are often not implemented by managers because the innovation would also affect their supervisor's use of MAS for decision control (i.e. in assessing their performance). As this study focuses on decision making it is essential to make this distinction. This requires two assumptions. First, it is assumed in the theory that is developed and tested in the chapters to follow that the control problem has been solved by the organization. This is important because the absence of a control system might make managers indifferent about the outcome of their decisions so that they would not be interested in the use of MAS to optimize their decisions. Secondly, it is assumed that decision control is not the dominant design variable of MAS. This is important, for if it were the case, management accounting systems would only differ because the control context differs, and not because of differences in the decision contexts. The following section defines the MAS dimensions from a decision perspective rather than a control perspective.

2.4.3 Dimensions of MAS

Management accounting systems produce information to which managers attach different levels of importance. Studies by Abernethy and Guthrie (1994), Chenhall and Morris (1986),

[2] If both decision making and control are involved, the definition would be: 'MAS comprise the set of descriptions that managers use to consider the financial aspects in making and controlling decisions.'

Mia and Chenhall (1994) found that managers attach different levels of importance to MAS characteristics due to differences in the decision context. Chenhall and Morris (1986) distinguished four MAS dimensions: scope, timeliness, aggregation, and integration (Table 1, Page 18). Mia and Goyal (1991) describe these four dimensions as follows.

> "Broad in Scope MAS information may be economic or non-economic, quantitative or non-quantitative, and may provide estimates of the likelihood of future events occurring. It may also relate to an organization's internal and external environment. Timely MAS information is available on request or without delay. Aggregated MAS information is provided by areas of interest or functions, and is consistent with formal decision models. Integrated MAS information provides specification of targets which account for the effects of interacting (interdependent) segments in the organization."

Scope of information

Broad scope information is typically provided to engender ideas about processing new inputs and producing new outputs. The scope of information is represented by points along a continuum, with narrow scope at one end and broad scope at the other. The dimension is characterized by three sub-dimensions: focus (external/internal), quantification (financial/non-financial), and time horizon (ex ante/ex post) (Chenhall and Morris, 1986; Gordon and Narayanan, 1984; Gordon and Miller, 1976; Gorry and Scott-Morton; 1971; and Larcker, 1981). Focus refers to where the information is collected: inside or outside the firm. Broad scope information has an external focus and emphasizes new inputs and outputs that are likely to appear at the organization's market. The quantification feature pertains to whether the information is financial or not. Broad scope information is considered to be partly non-financial because it is sometimes difficult or not helpful to provide decision makers with information in financial terms. For instance, information on the quality of new inputs is often difficult to quantify in dollars (Atkinson et al. 1997). Time horizon refers to the orientation of the information. Broad scope information is typically compiled of expectations (future oriented) rather than realizations. It is feedforward information as opposed to feedback information (Emmanuel et al. 1992).

Integrated information

Integrated information assists managers of different departments to assess each other's operations and constraints that apply to them. It helps departmental managers assess the effect of their decisions on activities carried out in interdependent departments. Integrated information is an important information dimension because it is impossible for managers to make congruent decisions without understanding the impact of their decisions on activities carried out in other departments. Anthony and Govindarjan (1995) and Atkinson et al. (1997)

consider integrated information important as organizations are necessarily compiled of interdependent activities.

The dimension of integration consists of: precise targets for activities, reporting on inter-unit interactions (Chenhall and Morris, 1986), and sub-unit information. 'Precise targets' informs managers about the (in)flexibility of departmental targets. Inter-unit interaction information provides managers with insight into how decisions of one department may affect other departments (e.g. information on which types of output the other department can process). Sub-unit information contains specific information relating to the interdependent department, such as cost and price information.

Aggregated information

The main property of aggregation is that it provides condensed information on the set of solutions that apply to problems the manager faces. Information can be aggregated by functional area (i.e., summary reports on activities of other business units, or other functions of the organization), by time period (e.g. month, year) or through decision models (supporting marginal analysis, inventory models, DCF, what-if-analysis, cost-volume-profit analysis) (Chenhall and Morris, 1986). Information aggregated at the functional level provides managers with information about the actual results that other departments realize with the choices they made. This may be condensed information on input factors (raw materials, personnel, machine deployment), outputs (which products were produced and price sold), or include profit and loss reports of responsibility centers. The use of decisions models requires information to be aggregated. However, the level of aggregation is dependent on the comprehensiveness of the decision model. For example, a simple CVP-model requires information on production capacity, price and variable costs only, so that volume decisions can be made. A comprehensive CVP analysis would require information to assess volume-price and volume-costs relationships. This would involve a detailed description of market responses to change in demand, and a detailed description of costs related to volume changes. More elaborate and hence less aggregated information on input-output relationships is required. Aggregation by time period enables managers to assess the results of their decisions over time. For instance, the result of a decision to introduce a new input, can be evaluated in terms of its effect on the business unit's efficiency and production quality. By aggregating this information over time periods, the choice of introducing inputs that are likely to be used for a longer period of time can be justified. Traditional accounting reports are high on the aggregation dimension. They provide information on past events in a summarized format.

Timeliness of information

The dimension of timeliness appears in two sub-dimensions: frequency of reporting and speed of reporting. The frequency sub-dimension refers to how fast information expires, while

speed pertains to the time permitted to make a new information available in the information system. If production processes change frequently, information is likely to be outdated faster than in a situation where the same processes/activities are repeated continuously. The more updates that are necessary to keep pace with relevant developments, the more timeliness becomes an issue in MAS design. Timely MAS information is available to the decision maker on request and without delay. Probably the words 'required updates' would better represent the notion at hand than the word timeliness. The notion behind timeliness involves the frequence by which the information updates are required, not whether information is provided on a timely basis.

The timeliness dimension has been identified as a critical feature in the design of MAS. It was this dimension that prompted Johnson and Kaplan (1987), to write *Relevance Lost.* Management accounting systems, they argued were no longer relevant as they provided information which was too late and thus irrelevant for decision making. It has been recognized that an organization can only exist to the extent that it is faster than its competitors in formulating and implementing solutions (Barnard, 1938). According to Williamson (1992), timeliness of information may to a large extent determine whether it is efficient to organize production in markets rather than in organizations (hierarchies). This suggests that organizations that systematically are unable to make timely decisions would be more likely to be subject to external takeovers than organizations that make timely decisions. These analytical works all suggest that timeliness of information is an important organizational issue. By providing timely information, management accounting systems support the decision process of intelligence, design and choice (Simon, 1960). The frequency of updates will depend on how quickly the information ages. However, it should be emphasized that updates cannot be provided at no cost. As a consequence organizations will make a trade off between what is desired for decision making, and the costs of an up-to-date accounting system (Scapens, 1985).

Relationships between the dimensions

Timeliness is an additional quality to the dimension of scope, integrated, and aggregated information as all these dimension may or may not require frequent and/or speedy updates. However, because the element of timeliness does not specifically belong to one of these dimensions, it is considered a dimension in its own right. There is also an overlap between the dimension of aggregation and the dimensions of scope and integration in that broad scope and integrated information can be provided in an aggregated form as well as in a detailed form. As a consequence the importance managers attach to one dimension may simultaneously vary with the importance attached to other dimensions. This, however, does not mean that managers do not distinguish between these dimensions, nor that it is useless to do so, it just signifies the coherence of the system of MAS. The distinction makes sense because under a

given context emphasis on dimensions may differ. For instance, integrative information may be evaluated as very important, while scope may be considered less important.

Sophisticated MAS
The importance managers attach to MAS dimensions is used to capture the degree of sophistication in the MAS. The degree of sophistication is conceptually consistent with Earl and Hopwood (1981). This implies that the more importance a manager places on each of the dimensions, the greater the level of MAS sophistication.

Several researchers have used some or all of these dimensions to characterize MAS (Abernethy and Guthrie, 1994; Fisher, 1996; Gul and Chia, 1994; Mia and Chenhall, 1994; Mia and Goyal, 1991; Chong, 1996). In this study the sophistication of MAS will be assessed on all dimensions. The users of MAS will be asked how important they consider each dimension of MAS to decision making.

Dimension	Characteristics
Scope	* Focus * Quantification * Time horizon
Integration	* Precise targets for activities * Sub-unit information * Inter-unit interactions
Aggregation	* Aggregation by time period * Aggregation by functional area * Analytical or decision models
Timeliness	* Frequency of reporting * Speed of reporting

Table 1: MAS dimensions [adapted from Chenhall & Morris, 1986]

2.5 Summary

This chapter defines the constructs of interest in this study, i.e. customization, interdependence and management accounting system (MAS). Customization is defined as the extent to which a business unit allows individual customers to affect the product/service attributes that it produces. Interdependence is defined as the extent to which departments depend upon

each other to accomplish their tasks, and is distinguished in three increasing levels of interdependence, i.e. pooled, sequential and reciprocal interdependence. MAS is defined as the set of descriptions that managers use to consider the financial aspects in making decisions. The notion of MAS sophistication is introduced to identify differences in use and design of MAS. These differences are described in terms of the four dimensions of MAS: scope, integration, aggregation and timeliness.

Chapter 3

Theoretical framework

3.1 Introduction

This study examines the effect of customization on management accounting systems (MAS). It is an endeavour to build on earlier findings examining the factors influencing the design of MAS (Abernethy and Guthrie, 1994; Hayes, 1977; Chenhall and Morris, 1986; Chong, 1996; Gordon and Narayanan, 1984; Gul and Chia, 1994; Macintosh and Daft, 1987; Mia and Goyal, 1991). Customization is argued to influence management accounting systems primarily in two ways. First, it has a direct effect on the uncertainty which managers face within departments and second, it has an indirect effect on uncertainty of decision making via interdependence created between functional department managers. To cope with this uncertainty managers seek information that will reduce uncertainty. One of the purposes of MAS is to provide managers with information so that they can deal with uncertainties, irrespective of whether these uncertainties are directly or indirectly caused by customization.

Chapter 3 is structured as follows. Section 3.2 describes how customization affects decision making within departments in that decisions are more difficult to make. Section 3.3 describes how increased customization results in higher degrees of interdependence between departments, and that this, in turn, increases uncertainty of decision making. Section 3.4 argues how organizations can respond to higher levels of uncertainty, induced by customization and interdependence. Section 3.5 provides a framework as to how MAS can be designed to provide the required information for decision making. Section 3.6 concludes with hypotheses drawn from the theory developed in the Sections 3.2 through 3.5, and section 3.7 summarizes the chapter.

3.2 Customization and intra-departmental uncertainty

3.2.1 Introduction

Recall from Chapter 2 that customization is the extent to which a business unit allows individual customers to affect the product/service attributes that it produces. To meet client's demand, customization does not allow the organization to produce a standardized product on

a continuous basis, but rather requires the organization to be capable and willing to make the necessary changes in its products to suit customers' preferences. It is argued that this increases the level of uncertainty in managerial decision making, which in turn, increases the demand for information.

3.2.2 The effect of customization on production processes

If customers want the organization to produce goods/services geared to their specific needs, and the organization wants to be responsive to this demand, it must have the ability to adjust the production processes to these needs. In that respect, Chapter 2 distinguished between two types of customization: mass customization and tailored customization. Mass customization allows the organization to produce product variations without the necessity of changing existing production programs. Tailored customization requires the organization to actually change the production programs in order to add new features on customers' request. Mass customization and tailored customization differ in the extent to which production processes can be programmed in advance. Pine (1993) and Kotha (1995) claim that organizations pursuing a mass customization strategy can maintain mass type-production processes, and hence there would be few changes in existing production programs. Customization in this form, is accomplished by combining a large array of standardized product features into a large variety of customized products. Any variety can be offered as long as the product is configured from its known components. Pine (1993) argues that organizations are now able to pursue mass customization strategies because of the advances made in technology (e.g., Computer Aided Manufacturing [CAM]) as well as new management methods (e.g., Just In Time management [JIT]). In the case of tailored customization, organizations have to continually change the production programs because products no longer (fully) consist of combinations of known components. Customers require the organization to add components which are specifically designed for one or a few customers. This not only requires the organization to be flexible within its existing programs, it also draws on the organization's capability of changing existing production programs in order to process new product features. These new features may involve both tangible and intangible attributes (e.g. a client specific service or a client specific component).

In conclusion, tailored customization requires the organization to be more flexible in that it is required to change existing production processes and hence its programs. Mass customization requires less flexibility because existing production processes and programs can be used.

3.2.3 Input/output relations and decision making

The extent to which organizations can follow a programmed production method determines to a large extent the nature of decision making. If it is known which input combination results in what output, one can make reliable predictions about input/output relationships. Decision making becomes what Emmanuel et al. (1990) refer to as "programmed." A programmed decision is one where: "the decision situation is sufficiently well understood for a reliable prediction of the decision outcome to be made" (Emmanuel et al., 1990). On the other hand, a non-programmed decision is defined as one that "has to rely on judgement of managers because there is no formal mechanism available for predicting likely outcomes" (Emmanuel et al., 1990). The idea of programmed decision making is similar to what Simon (1960) has called structured decision making, where the three phases of decision making: intelligence, design and choice, are all programmable (Burchell et al., 1980, Earl and Hopwood, 1981). For non-programmed decisions, however, it is not possible to program these three phases. It is unknown in advance where to look for alternative actions (intelligence), which alternative actions can be developed (design), and finally which of the alternative actions is the best (choice). Thompson and Tuden (1959) have called this uncertainty of cause and effect relations (i.e. input/output relations).

While numerous researchers have used the term uncertainty, few have defined it. In his book Galbraith developed a framework that links organizational structure to the demand for information. He argues that uncertainty is introduced into the organization if its structure or the way and the amount of information provision does not allow managers to make informed decisions. Galbraith (1973) provides a useful framework for considering the impact of uncertainty on decision making. He defines uncertainty as the situation where "the amount of information required to perform a task is less than the amount of information already possessed by the organization." Uncertainty influences the ability of decision makers to carry out their tasks efficiently. The amount of information necessary to make decisions is a function of (a) output diversity, (b) the number of different input resources, and (c) the difficulty of the level of performance required (Galbraith, 1973). The notion of uncertainty can be directly related to differences in decision making between the two types of customization. In the case of mass customization the organization produces many different products. In fact, given the number of different components it may be pure coincidence for two products to be exactly the same, even if all products from one year's production were considered. However, all inputs used to produce these products have been selected in advance. The decisions made to produce these products involve the selection of the right combination of these known inputs, in order to best produce the required output. This requires the decision maker to make the appropriate choice from a set of standardized inputs.

The notation for these sets are:

N = set of all possible solutions available to Department A to produce an output with standardized and non-standardized inputs.

N_p = set of all possible solutions available to Department A to produce an output with standardized inputs (i.e., mass customization);

Thus: $N_p \subset N$

Simon (1960) would regard this case of decision making as one where intelligence, design and choice, are all programmable. This situation is illustrated in Figure 3.1.

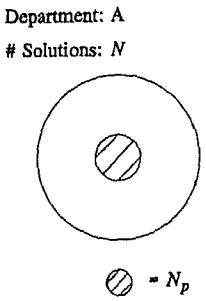

Figure 3.1: Decision space N of department A to produce an output in the case of mass customization ·

Tailored customization involves a much higher level of uncertainty. The inputs can no longer be pre-selected. On the contrary, to the extent that new components are required for a specified output they need to be designed and applied for this one occasion only. This increases the decision makers' information requirements in that they not only have to make choices from a range of alternatives, but they must also investigate and design alternative actions. This makes all three phases of Simon's (1960) decision making process unprogrammable. The manager must not only have information on how standardized inputs combine into required output, but also on how inputs not known before, affect the input/output relation. As a consequence, the decision context changes. The number of possible solutions changes as well as the nature of the solutions to produce the required output. As a consequence the size and the shape of N changes.

In conclusion, if an organization chooses not to use standardized inputs and to produce various outputs (tailored customization), they need to draw more on intelligence and design in regard to decision making, than an organization that uses standardized inputs to produce various outputs (mass customization).

3.2.4 Decision making within departments: information requirements

This study focuses on how departments cope with customization. Departments involved in a transformation process[1] will be affected by the level of customization. In other words, it is expected that the search for answers as to how input/output relations work, will occur in each department that is involved in the transformation process. If a transformation involves three departments (e.g. purchase, production, and sales), they will all have to decide which (combination of) inputs will best produce a desired output. If it is possible to pre-program the production process, each department will have complete knowledge as to which input(s) best produces the required output. Each department can rely on these programs in the decision making process, provided that information on these programs has been made accessible. This is not to say that these programs will deliver only one alternative. In fact, these programs may be used to choose one out of the number of alternative ways to produce the required output. What is important in this decision context, is that programs are available in advance to assist in the decision making process. On the other hand, if the inputs have to change to produce the required output, each department must ascertain the consequences of this change on their transformation process. Production, for example, must decide which input combination, from their perspective, best produces an output. This requires the departmental decision makers to be able to change or replace existing programs. Therefore, they must have access to information to go through the process of intelligence, design and choice. Information that only pertains to standardized inputs (i.e. N_p) will not suffice in these circumstances, for the product no longer consist of only standardized inputs. An information gap would be created if only information on standardized input were made available. The size of this information gap amounts to all possible solutions to produce an output with non-standardized inputs, which equals to the set $N \setminus N_p$ (see Figure 3.1).

In conclusion, mass customization allows the department managers to make programmed decisions, while tailored customization forces the department managers to make more enquiries to assess which alternative actions best fit the situation. If managers in both situations are provided with the same information (say, for example, N_p), decision making is more difficult in the case of tailored customization than it is in a situation of mass customization.

[1] Recall from Chapter 2 that the transformation process involves all phases that an order follows from the moment an order is received, until the product/service is actually delivered to the client.

All other things being equal, managers involved in tailored customization are exposed to more uncertainty than their mass customization counterparts. Although this conclusion oversimplifies the decision situation of mass customization it is clear from the arguments made above that mass customization requires less intelligence and design than tailored customization. This is not to say that mass customization does not involve any uncertainty in decision making. Indeed it is very likely that all departments will not have access to all information on N_p. Hence decision makers will only be partly informed about the size of their actual decision space. For this reason it is questionable the extent to which decision makers can make optimal choices. It is, however, reasonable to expect that if the same information is made available, decision making for situations of tailored customization will be more uncertain than it will be for mass customization.

The next sub-section elucidates how customization affects the relationship between departments. It will be argued that customization requires the organization to co-ordinate actions of decision makers involved in making the same output.

3.3 Customization, interdependence, and inter-departmental uncertainty

3.3.1 Introduction

Recall from Chapter 2 that interdependence is defined as: "the extent to which departments depend upon each other to accomplish their tasks" (Thompson, 1967). Increased customization makes it difficult for distinct activities within an organization to be performed independently. Sales and production, for example, will become increasingly interdependent as customization increases and thus will require more co-ordination between managers of these activities. The link between customization and interdependence, and how this affects uncertainty is discussed in the following sub-section.

3.3.2 Customization and interdependence

Assume that an organization makes standardized products, and that it can sell any amount of stock produced. Sales can sell production's products or other products, and production can deliver its products directly outside the company without mediation of sales. It is possible, in this case, for production and sales to operate virtually independent of each other, because production is not constrained by sales' capacity, and the products which sales require can be obtained from stock or from external suppliers. Thompson (1967) would classify this form of interdependence as pooled because production does not have to adjust their work whatso-

ever to that of the other department. Interdependence only exists because sales and production are separated functions that operate in one firm that thus share common resources. Consider now the case where production capacity exceeds market demand, and the organization is prepared to stock pile safety inventories only. In this situation, production and sales activities will have to be aligned, and occurs by preparing a sales plan which is then communicated to production. Aligning production volume with a sales plan is the most primitive form of adjusting to customer requirements. The sales plan is a reflection of an attribute of the market (i.e. its size). This situation would be classified as sequential interdependence because the output of one department (production) becomes the input of the next department (sales). The effect of the separation of functions surfaces now more intensively, because of the need to co-ordinate activities.

The next level of adjusting to customer requirements occurs when demand fluctuates during the year. Assume that the organization does allow inventories to be held. Increased co-ordination between production and sales will be required, and is likely to occur by developing a production plan which matches the sales plan. The sales and production plans now account for two customer requirements of the market (i.e. size and demand fluctuation). Lawrence and Lorsch (1967, p.98) give an example of how these two attributes are calibrated in the container industry:

> "Our job is to shape the material and wrap it around air, and the only way you can make dollars is to keep moving the product out the door. What happens is that we get the inventories dumped on us, as the customers won't store containers. The paradox is that you have to hold the inventories down, yet you can't make money unless you run the machines constantly. Therefore, sales and manufacturing are constantly at each other's throats. The integration of these conflicting circumstances is the critical management job.... The big issue is scheduling, and it is a matter of every day, all day. We either have too much product or too little."

Increased co-ordination is a consequence of increased interdependence between production and sales. Sales effort results in an output in terms of clients orders, while production effort result in output in terms of product/services. These outputs need to be co-ordinated so that production delivers the right quantity on time, and sales acquires the number of orders that matches production's capacity (using plans and stocks as a buffer). To the extent that sales' and/or production's actual amount of outputs differ from the plan, these plans need to be aligned, as exemplified in the Lawrence and Lorsch citation. However, co-ordination can to a large extent still take place through the planning process, because demand fluctuations are

predictable, and the organization can make products for stock which provides it with a safety buffer.

A still higher level of interdependence exists if the organization operates in a market where customers demand more than one product type. Production and sales plans must now reflect three customer requirements that characterize the market (i.e., size, demand fluctuation and product features). While adjustments to market size and demand fluctuations evolve from efficiency considerations, the point where customers can decide which product features are actually going to be produced, marks the shift to customization. In the case of mass customization, the plan can still be used as a means of co-ordinating production and sales activities. To that extent sales can make reliable predictions of which product features are in demand, production can produce with reference to the plan. It does not need to communicate these matters with sales. As mass customization often involves fast delivery (Pine, 1993), the organization must be able to produce the customized products swiftly. Demands for 'on time' delivery and fluctuation in demand increases co-ordination requirements. But in the case of mass customization these can usually be managed through sophisticated scheduling programs. These programs can be prepared because the organization uses standardized components to produce a variety of outputs.

Tailored customization increases departmental interdependencies. Production cannot make a specific product feature in advance, for it is not known if this feature will be required, as this will depend on the actual demand of customers, and decisions made by sales. To the extent that products consist of non-standardized components, production and sales interdependence is very high, because actions of sales determine directly what production must produce, and actions of production affect directly if sales can deliver to the customer. There exist no stock for customer specific products. If, at the extreme, each feature is unique, it is not possible for production to make any component in advance. Production can only commence to make the product required once sales has provided specifications demanded by the customers. As production has no possibilities to produce in advance, the department is to a large extent dependent on the activities of sales, as they determine which orders are to be filled. It is difficult to plan in this scenario because it is not known how much time it will take to produce a product with unknown product features. This can only be assessed once the client's order is received. Thus, tailored customization decreases the time span between production and production planning, as a plan cannot be made until the client has made his specifications known. In a scenario where all products are tailored to customer requirements departments will need to continually adjust their input mix. In this case sales and production will be totally interdependent (i.e. reciprocal interdependent). Reciprocal interdependence between departments typically exists where they "work jointly with co-dependent units on the same raw material, customer, client or project" (Macintosh,

1995). Sales can no longer acquire an order that is subsequently filled by production, but rather sales and production co-operate in acquiring and filling the order. This co-operation makes the input/output relationships of production and sales intertwined. That is, as increased levels interdependence cause production and sales activities to affect each other, the separate input/output relationships of production and sales shift into one input/output relationship.

If we are to place interdependencies on a continuum, then it can be argued that increased levels of customization cause interdependence to shift from pooled, through sequential to reciprocal. However, as suggested by Thompson (1967), there is likely to exist at any one time all three types of interdependence within departments, even if customization is described as tailored. In the case of tailored customization activities will to some extent be: pooled (e.g. production determines itself which technique is appropriate to produce an output); sequential (e.g. sales knows best which clients should be served); reciprocal (e.g. sales and production determine together whether an output can be produced by the organization). Should interdependence not exceed the level of sequential interdependence (likely to be the case in the scenario of pure mass customization), part of the interdependence would be classified as pooled to the extent that the departments can decide on their work without affecting the other department. In the case that customization is not an issue, the greater part of the work will be classified in the category of pooled interdependence. These three stylized situations are illustrated in Figure 3.2.

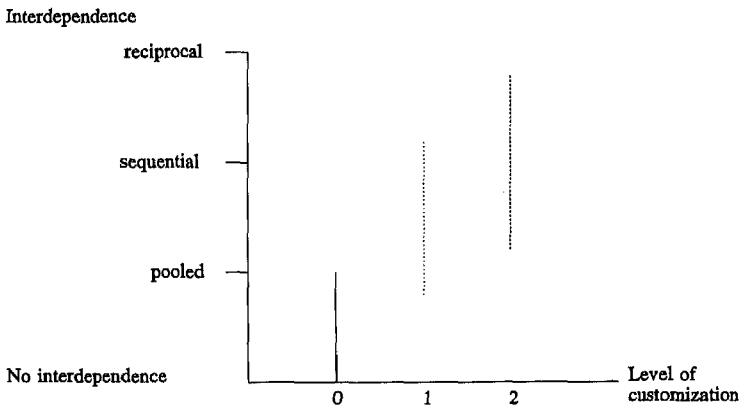

Figure 3.2: Relationship of interdependence with customization

In conclusion, interdependence exists because organizations are functionally organized. If a sales and a production department are established, they are dependent on each other, as production can only produce if sales actually sells products, and sales can only sell products that production makes. Customization augments the intensity of interdependence in functionally differentiated organizations because increased customization causes products to vary and it decreases the time span between when it is known what to produce, and when actual production takes place. In combination, customization and functional structures (separate sales and production department) affect interdependence (Figure 3.3).

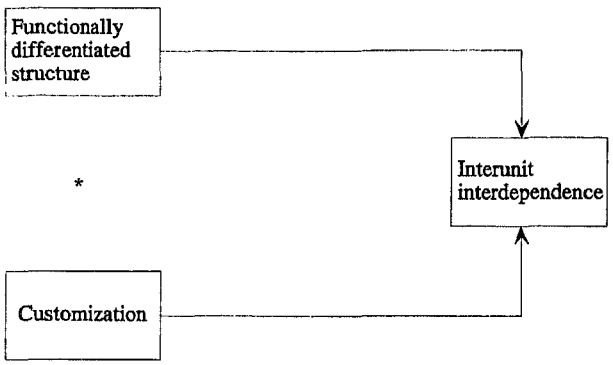

Figure 3.3: The relation of customization, structure and interdependence

Interdependencies between sales and production can be managed through the development of pre-specified plans. However, this can only occur if it is known in advance, what is to be produced. Tailored customization makes it very difficult to make such forecasts. This results in increased levels of interdependence. In the extreme case of 100 percent tailored customization, the input/output relationship for production and sales becomes a joint relationship. The two separate input/output relationships of each department will only exist with low levels of interdependence (i.e. pooled interdependence).

3.3.3 The effect of interdependence on decision making

Customization increases interdependence between departments. Interdependence has been recognized in the literature as an important source of uncertainty (Daft and Lengel, 1986; Galbraith, 1977; Lawrence and Lorsch, 1967, Macintosh, 1995; Thompson, 1967). Increased interdependence, whether or not caused by customization, augments the uncertainty of decision making in two ways. First, cause and effect relationships are not sufficiently understood to enable efficient decision making, and second it creates the potential for depart-

mental objectives to conflict, and thus increases the ambiguity in the decision making process.

Cause and effect relations
It has been argued earlier that input/output relationships become increasingly intertwined as interdependence increases. The effect of interdependence will not be confined within one department. Indeed, to the extent that interdependence becomes more intense, some effects will extend beyond departmental borders. As a consequence, in looking for solutions managers need to consider the extra-departmental effect of their decisions. The reason for this is that the receiving Department B must at least be able to process (the features of) outputs produced by Department A. This means that decisions that might work for the Department A, may not work for the Department B, because it is simply not able to process the kind of output produced by Department A. For example, if Department A can produce an output in $\#N$ ways, and $\#M$ ways can be processed by Department B, any solution that A produces will only work to the extent that there exists an overlap between N and M.

Returning to the set notation applied in section 3.2, this common decision space represents the intersection of N and M written as:

	$N =$	set of all possible solutions available to Department A to produce an output with standardized and non-standardized inputs;
	$M =$	set of all possible inputs Department B is able to process;
Thus:	$N \cap M, =$	set of all possible solutions for A to produce an output that B can process.

The solution space of Department A has obviously decreased from N to n because only solutions in M are viable (see Figure 3.4).

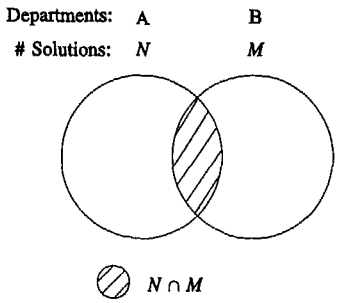

Figure 3.4: Common decision space of Departments A and B

The required information to deal with uncertainty of cause and effect relationships
The consequence of this situation is that, if two production departments are compared, Department D which has high levels of interdependence, and Department E without interdependence, and the same information is made available to both decision makers, the decision maker in D (the dependent situation) is likely to make more 'mistakes' than decision maker E, due to the inability to survey the situation the other department faces. So, even if managers have access to information that would reduce uncertainty at the departmental level, the manager in the interdependent situation will still be exposed to uncertainty as long as the solutions to produce an output do not match with the requirements of the other department. As each department approaches its specific technological constraints, the number of alternative input/output relations decreases: production (sales) cannot make (sell) any product. The common decision space is illustrated with the space identified as *N* in Figure 3.4, where both production and sales should be capable of making and selling the product(s) in demand.

All other things equal, managers exposed to interdependence will face more uncertainty than those who do not face interdependence, because outputs from one department might not be an appropriate input for the next department. In other words, interdependence requires departmental managers to co-ordinate their actions in a way that decisions on how and when to produce outputs, match with the technological constraints of both departments involved.

Disagreement over objectives
Following Thompson's (1967) argument, organizations establish departments to give them the opportunity to pursue specific objectives. Assume that the objective of production is to fill orders efficiently, and sales' objective is to optimize turnover. This means that production will undertake actions that result in an efficient production process from their point of view. However, this might be in conflict with the objective of sales. This conflict might involve disagreement over issues like: delivery times, types of products produced, or production run sizes. From production's point of view, it is more efficient to produce similar products in large batches than to produce each product in a separate batch. However, to optimize turnover, sales wants to minimize the time span between the client's order and the actual delivery. So, despite the fact that sales and production are able to change the time between order and delivery, they are not inclined to do so because of their own objectives. In other words, though there exist no limitations from a technological point of view (production run time can be changed), the solution is not viable because it does not meet the departments objectives.

In conclusion, the introduction of the variable of objectives reduces the number of viable options compared to the number of solutions that would be attainable if only technological constraints were to be met. The following set of notations can be used to express this

phenomenon:

N = set of all possible solutions available to Department A to produce an output with standardized and non-standardized inputs;

M = set of all possible inputs Department B is able to process;

N^* = set of all possible solutions for A to produce an output if technological constraints and objectives to which Department A is subject have been taken into account: $N^* \subset N$;

M^* = set of all possible solutions for B to produce an output if technological constraints and objectives to which Department B is subject have been taken into account $M^* \subset M$.

In conclusion, the reason for the decision space to shrink is that solutions that are technologically feasible may not be attainable if the departments' objectives are included as well. Hence the decision space shrinks from $N \cap M$ to $N^* \cap M^*$. As the objectives of the departments differ, there may exist no solution at all that match both the departments objectives and technological requirements ($N^* \cap M^* = \phi$). In that case there exist no overlap of N^* in M^*, as illustrated in Figure 3.5.

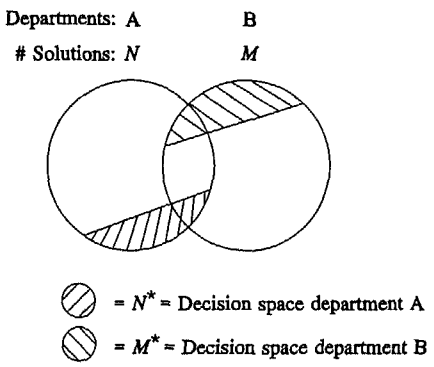

Figure 3.5: No overlap of the decision space due to differences of objectives between Departments A and B

A more favourable scenario would be the one where some solutions that work for Department A, also work for Department B ($N^* \cap M^* \neq \phi$). This situation is illustrated in Figure 3.6: N^* overlaps M^* in N^{**}. Department A and B can choose solutions from the common decision space (N^{**}), without violating any constraint to which both departments are subject.
In the first case ($N^* \cap M^* = \phi$), the two departments can only come to an agreement if managers are prepared to make compromises about the output(s) to be produced (Earl and Hopwood, 1981). In order to create an overlap, these compromises must involve a re-definition of the decision space, for one or all departments (see Figure 3.5 and 3.6). In effect, they would create a common decision space where both managers can choose solutions that match both departments' objectives. Once the common decision space exits, the two departments would negotiate a solution that best suits both departments' objectives (see Figure 3.6).

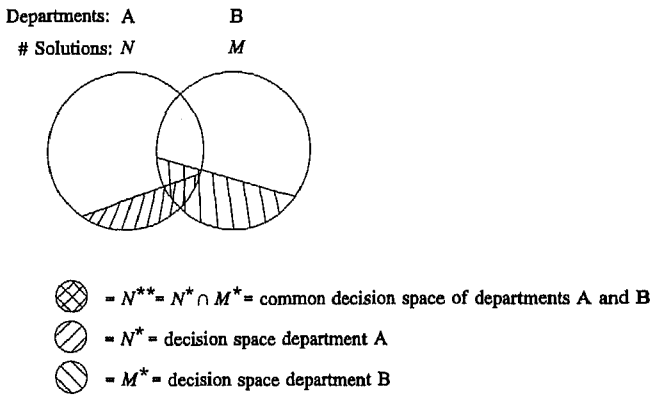

Figure 3.6: Overlap of the decision space of departments A and B

The required information to deal with uncertainty of objectives
Burchell at al. (1980) and Earl and Hopwood (1981) claim that disagreement over objectives is the same as uncertainty about objectives. In other words, if the number of viable solutions decreases because departments pursue their own objectives, there exist uncertainty about objectives. The above authors contend that this uncertainty can be mitigated with the help of information. This contention is built on the premises that if better knowledge exists on available solutions, and how the solutions will affect the other department, given its objectives, the chance is increased that suitable solutions will be chosen for both departments. This argument is particularly relevant to the framework being developed here. If the amount of information is held constant, and the decision space narrows, there is uncertainty of objectives. It then becomes more critical that decision makers identify all possibilities for producing a required output. This becomes more critical because it is important for the

departments involved to (a) bridge the disagreement over objectives if there exists initially no overlap between solutions to produce an output that meet both departments, objectives, and (b) produce a solution that best suits both department's objectives.

In summary, an increased disagreement over objectives between departments will induce the need to co-ordinate activities. The number of solutions that would be viable from a technological point of view is reduced because the viability of solutions is also subject to the objectives. This reduces the number of possible solutions to produce an output. As the number of solutions reduces, the chance of arriving at a viable solution can only be increased if the information that is made available engenders sufficient ideas to produce one or more solution that meet the objectives of the departments involved. Hence, the demand for information changes because departmental objectives have to be met.

3.3.4 Conclusion

In this sub-section, two sources of uncertainty have been identified: customization and interdependence between departments. Customization affects decision making in departments because cause and effect relations become less clear (i.e. there exists uncertainty about which decision to take) unless more information is made available to clarify these relationships. It has been argued in this section that customization directly increases uncertainty within departments, but also it increases uncertainty between departments via interdependence. Interdependence increases uncertainty in two ways. First it has an effect on the identification of cause and effect relations, and second it has an impact on how departmental outputs meet the different objectives within each department. This can also result in more uncertainty, unless more information is made available. This information pertains to: (a) bridging the disagreement over objectives, and (b) providing information on cause and effect relations that go beyond departmental borders.

3.4 Organizational responses to uncertainty

3.4.1 Introduction

This subsection highlights which role information plays in reducing uncertainty. As this is not the only and not an exclusive way of reducing uncertainty it will first be illustrated how the organizational structure and the introduction of organizational liaison devices assist managers to cope with uncertainty.

3.4.2 Structure

Galbraith (1973) argues that uncertainty can be reduced by (a) reducing the amount of information required for decision making, or (b) increasing the organization's information processing capabilities. To reduce the amount of information required, the organization should allow for 'slack resources' or change its structure. Both options are not necessarily viable. The creation of slack resources will inevitably result in idle capacity, while the change of structure may jeopardize economies of scope that are attainable only if the organization has a functionally differentiated structure. While changing the organizational structure can be a quite persuasive way of dealing with uncertainty, it is interesting to observe that many organizations use a functionally differentiated structure (De Sitter, 1994). The rationale for the persistence of a functionally differentiated structure is as follows. First, it confines problems to the department that can best solve these problems. It buffers the other departments from these problems (Thompson, 1967). Second, a functional structure facilitates specialization. Production and sales people are given the opportunity to develop special skills on production or on sales tasks. Third, this specialization allows the organization to use single production and sales processes to process different kinds of outputs (i.e. economies of scope are attained). As a consequence both functions are carried out more efficiently than they would, if they were not separated by departmental borders (Thompson, 1967, Macintosh, 1995).

3.4.3 Improving information processing capabilities

Given that it is often rational to maintain a functional structure, organizations must examine means of increasing their information processing capabilities to cope with uncertainty. One possibility is to simply improve the information provided to the manager. It is this option that is investigated in the current study. Improving information processing means that managers are provided with information that match the decision making context. This decision making context is determined by the number and the nature of solutions available to the decision makers. The number of solutions is constrained by the technological possibilities and the objectives to which the departments are subject. The information requirement can be fulfilled in two ways, establishing integrative liaisons between departments (Abernethy and Lillis, 1995, Galbraith, 1973), or with the provision of improved information through formal systems. The introduction of integrative liaisons involves the sharing of information among people that face the same problem (Macintosh, 1995). This study deals with the provision of information through formal systems. However, it should emphasized here that the improvement of information provided may occur simultaneously with the establishment of integrative liaisons.

3.4.4 Provision of information to cope with uncertainty

Uncertainty of cause and effect relationships and information
Recall that in subsections 3.2 and 3.3 uncertainty of cause/effect relations occurs as a result of both customization and interdependence. Cause/effect relations are affected both within and between departments. For the purpose of the arguments developed here, it is not necessary to make a distinction between intra- and inter departmental uncertainty. It is assumed that information reduces uncertainty of cause/effect relations, regardless of whether this uncertainty pertains to intra- or interdepartmental uncertainty.

In situations where cause and effect relationships between inputs and outputs are known, it is possible to provide decision makers with a predictive model. This model provides a "programmable solution" which enables decisions to be made that best suit the situation. As cause and effect relationships become unclear, however, predictive models become obsolete. Earl and Hopwood (1981) suggest that uncertainty of cause and effect relations changes the role of (accounting) information. Decision makers require information systems which can assist them in making 'judgements' of likely outcomes, rather than systems which provide them with ready-made answers. While Earl and Hopwood are not specific about the nature of judgmental decision making, Hofstede (1981) suggests that such decision situations occur when there is no established norm on which to base the decision. Thompson and Tuden (1959) argue that if three competent parties are asked to make a decision in an identical situation, each party may arrive at a different conclusion as to the best course of action. It is not possible in a judgmental context to impose a norm or program which decision should be made, nor to provide the decision maker with information that contains exact solutions. It is likely, therefore, that the types of information required to support the intelligence, design and choice processes in the judgmental decision context will differ from the programmed decision context. Hopwood (1974) contends that information systems can assist to structure a situation in two ways. Firstly it can assist the choose the best solution for the part of the problem of which input/output relations are recorded in the system, enabling the decision maker to focus on the part of the problem where cause and effect relationships are unknown. Secondly, the system may suggest a set of feasible solutions for the part of the problem of which cause and effect relationships are unknown prior to the investigation (Macintosh, 1985 and 1995). For example, information may be available on what will happen when a known input A is used to produce C (recorded input/output relationships), but what is not known is what input is suitable for the new output C". This type of decisions require information on how outputs similar to output C" are produced, as well as information on which inputs can be used to produce the required output.

It would be desirable if the information system could provide the manager with information about how to produce an output (C") that has not been produced before with inputs that have not been used before. However, as both inputs and outputs are new, it will be impossible to provide information that exactly quantifies cause and effect relations. This type of decision context requires a judgmental decision (Hofstede, 1981, Earl and Hopwood, 1981). Effective decision making will require the decision maker to use the information on the set of possible solutions to produce the (new) output. The set of possible solutions has been illustrated in Figure 3.1. In terms of Figure 3.1 information should extend beyond recorded input/output relationships (n_p). In fact, the decision space declines n_p to the extent that standard solutions do not result in a required output. As no standard has been set for this part of the problem this involves information on the set of possible solutions to produce an output (N). At the extreme the information on recorded standardized input/output relationships is obsolete.

In conclusion, when uncertainty about cause and effect relationships increases, the provision of appropriate information can mitigate this uncertainty. To the extent decisions become less programmable, managers will seek information that pertains to non-programmable solutions to produce an output.

Differences over objectives and information

Section 3.3.3. argued that the presence of objectives reduces the number of viable options compared to the number of solutions that would be attainable if only technological constraints were to be met. It was argued therefore, that cause and effect relations need not only be investigated from a technological point of view but also in its relationship to the objectives of the departments involved. To contemporaneously cope with uncertainty of objectives and of cause and effect relationships, Earl and Hopwood (1981) suggest that the information system should provide the decision maker with stimuli to produce ideas ("idea machines"). The more ideas managers generate from the information, the larger the chance that the decision makers will produce ideas consistent with their objectives. There are two complementary reasons for this. First, outside the information system, managers may simply not have information on the set possibilities which enable the production of outputs that match both departments constraints. Second, if there is disagreement over objectives, and there exists no *a priori* solution that matches both departments objectives, provision of information increases the chance of finding one or more solutions. In terms of Figure 3.6 provision of relevant information will highlight the set of possible solutions that are suitable to both departments (the overlap space N^{**} in Figure 3.6).

If there is disagreement over objectives and no common solution exists unless objectives are relaxed, managers will need to have access to information that will give them the opportunity to investigate which technical possibilities are available. In terms of Figure 3.4, this involves

information relating to all possible solutions within the technical constraints to which both departments are subjected, complemented with information on the extent that departmental objectives are exceeded. In terms of Figure 3.4 information is required on N and M.

In conclusion, inter-departmental uncertainty over objectives can be mitigated with information. Firstly, if a common decision space exists in terms of objectives and within technological constraints, then Manager A and B should both have access to information on this common decision space. Secondly, if there is no initial overlap between the objectives, Manager A and B should be informed about the technological possibilities available to both departments to produce output (intermediate or final).

The next sub-section will deal with information characteristics of management accounting systems to satisfy the requirements of increased information processing capability.

3.5 How do MAS help to cope with uncertainty?

3.5.1 Introduction

In the above sub-sections it has been argued that customization increases uncertainty either directly or indirectly via interdependence. Customization has a direct relationship with uncertainty due to its effect on the cause and effect relations regarding how inputs are efficiently used to produce outputs. The indirect link pertains to how customization increases interdependence, which in turn engenders uncertainty of cause and effect relationships and disagreement over objectives. The impact of uncertainty relating to cause and effect relationships extends beyond departmental borders as interdependence increases because individual departments can no longer produce an output without checking whether the other department is capable of processing that output. As a consequence cause and effect relationships not only need to be examined at the intra-department level (direct effect), but also at the inter-departmental level (indirect effect). Reconciliation of disagreement over objectives becomes an important issue as interdependence increases because outputs are produced jointly by the departments. The arguments developed below assume that at a given point in time less than the total amount of information that theoretically could be made available, actually will be made available, because it would be too costly to reveal all possible information (see Scapens, 1985). Managers will, therefore, only be informed about a part of their decision space (see sections 3.2 and 3.3). The argument developed here assumes that managers have incentives to seek information if uncertainty increases. It has been argued in Chapter 1 that managers will seek information in order to achieve outcomes that are satisfactory from both the organizational and the decision maker's point of view. This assumes that organizations have put systems into place to encourage this behaviour (see,

for instance, Brickley et al., 1997, Chapter 8). The argument developed below is based on this assumption.

This sub-section is organized as follows. Sub-section 3.5.2 gives a brief description of the four MAS dimensions. Sub-section 3.5.3 describes how increased emphasis on the four MAS dimensions of scope, integration, timeliness, and aggregation helps managers make more informed decisions. It will be shown how management accounting systems (MAS) can be used to mitigate the uncertainty associated with increased levels of customization and interdependence.

3.5.2 Decision making and MAS

Recall from Chapter 2 that this study uses the following definition of MAS.

> 'MAS comprises all sets of descriptions that managers use to consider the financial aspects in making decisions.'

The study focuses on MAS for decision making. Four dimensions of MAS are considered: scope, timeliness, aggregation, and integration. These dimensions have been defined by Mia and Goyal (1991) as follows.

> "Broad in scope MAS information may be economic or non-economic, quantitative or non-quantitative, and may provide estimates of the likelihood of future events occurring. It may also relate to an organization's internal and external environment. Timely MAS information is available on request or without delay. Aggregated MAS information is provided by areas of interest or functions, and is consistent with formal decision models. Integrated MAS information provides specification of targets which account for the effects of interacting (interdependent) segments in the organization."

Section 3.2 and 3.3 are developed under the assumption that the amount and type of information made available is held constant while information requirements change. Section 3.4 argues that changes in the information provided assist managers to cope with uncertainty, hence to make more effective decisions. Although there exist several alternative routes to acquire this information, it is argued here that the MAS dimensions of scope, integration, aggregation and timeliness play an important role in meeting information requirements. The arguments developed below are founded on two general assumptions: i) decision makers possess limited information processing capacity, ii) the time to make decisions is limited. Following Simon (1959) it is assumed that the computational complexity required for

effective decision making does not match the intellectual capacity of decision makers. The analyses undertaken by managers during the decision making process is therefore necessarily incomplete in that only a limited number of all possible decisions are assessed simultaneously before a final decision is made. This notion has been introduced into the literature as bounded rationality (Simon, 1959). Bounded rationality exists for two reasons: limited intellectual capacity to process information and time constraints. While limited intellectual capacity inhibits the simultaneous comparison of all possibilities to solve a problem, time pressure further narrows the problem. March and Simon (1958) called this 'the smaller span of attention.' Managers have generally limited time to make a decision. Thus managers will make trade-offs between the benefits of well (fully) informed decisions, and the cost associated with the delay of decisions. The time it takes to collect and process information required for a decision delays the decision making process. Having said this, it does not follow that managers exert no effort in collecting and processing information. However, it can be argued that managers cannot or are not prepared to exert the effort to process all possible information necessary to make optimal decisions.

It is argued below that accounting information facilitates the decision making process. There are two reasons to support this argument: i) MAS increases the number of alternatives that can be considered simultaneously, and ii) MAS decreases delay time. In terms of the first reason, MAS are designed to present information in a way that makes it easier to store and process information. MAS assist managers to store and process (i.e. use) information contemporaneously so that the problem is understood sufficiently, enabling them to make trade-offs between relevant possibilities contemporaneously.

The importance of reducing decision time has been widely recognized. Johnson and Kaplan (1987) argued that management accounting systems were irrelevant as the information came too late. Similarly, Williamson (1992) argued that it is the ability of organizations to make timely decisions that, to a large extent, determines whether it is more efficient to organize production in markets rather than in organizations (hierarchies). This suggests that organizational survival is dependent on the ability to make timely decisions. Support for this argument is also provided by Barnard (1938) who contends that organizations can only exist to the extent that they are faster than their competitors in formulating and implementing solutions. MAS can be used to reduce delay time in the decision making process.

MAS thus facilitates the decision making process by i) improving understanding of the decision context, and ii) reducing the time to assess the information required to make the decision. Provision of appropriate information improves the understanding of problems, and hence reduces uncertainty because it decreases the 'gap' between information required and that available to make a decision (Galbraith, 1973). Provision of information which reduces

delay time decreases uncertainty because it enables more alternatives to be assessed within a given time period.

While "understanding" and "delay time" are the rationale of information systems generally, the following sub-section elucidates how the MAS dimensions of scope, integration, aggregation, and timeliness are particularly important in serving these purposes under increasing levels of uncertainty. It does so by highlighting how MAS mitigate uncertainty of cause and effect relationships and objectives.

3.5.3 MAS dimensions and uncertainty

Introduction

Table 3.1 provides an abbreviated insight into the arguments developed below. Each cell contains the reason why a MAS dimension is expected to reduce each type of uncertainty.

MAS dimension	Uncertainty of Cause and Effects		Uncertainty of Objectives	
	Understanding	Delay Time	Understanding	Delay Time
Scope	Increases the number of alternatives that can be considered simultaneously	Not Applicable	Engenders production of alternative solutions to increase the probability that one or more solutions fits the objectives of all departments involved	Not Applicable
Integration	Learning from other department's chosen alternatives	Identification of the viable region to focus the decision process	Decreases the probability of rejection of decisions by interdependent departments	Presents common set of objectives to accelerate evaluation against objectives
Aggregation	Provides an overview of the decision context enabling managers to select the direction to search for alternative actions	Accelerates decision making by reducing the number of alternatives that need to be considered	Reduces time to make a decision in one department, leaving more time for other departments to pursue their objectives.	Increases time to weigh decision against multiple departmental objectives
Timeliness	Provides information that is more relevant for the current decision	No need to translate 'old' information into the existing situation	Provides information on latest objectives	Not Applicable

Table 3.1: Arguments why managers consider MAS dimensions useful

'Understanding' refers to why MAS are expected to augment simultaneous information processing capacity. 'Delay time' refers to why MAS are expected to assist managers to make decisions in time.

3.5.3.1 The dimension of scope

Recall from Chapter 2 that the broad scope dimension consists of three sub-dimensions: focus (external/internal), quantification (financial/non-financial), and time horizon (ex ante/ex post). Broad scope information has an external focus and is future oriented. For example, broad scope information would include data on future demand for outputs and the inputs required to produce that outputs. In terms of Figure 3.1, it would provide the decision maker with information on the set of possibilities the organization has to produce an (until then unknown) output with unknown inputs (N), rather than on the set of possibilities to produce standardized outputs (given as N_p in Figure 3.1).

There exists considerable empirical support for the positive relationship between broad scope information and uncertainty (Abernethy and Guthrie, 1994; Chenhall and Morris, 1986; Chong, 1996; Gordon and Narayanan, 1984; Fisher, 1996; Gul and Chia, 1994; Mia and Chenhall, 1994). The work of Abernethy and Guthrie (1994) supports the idea that sources of uncertainty are counterbalanced with the use of broad scope MAS information. Chong (1996) has shown that under high task uncertainty increased broad scope information improves managerial effectiveness. Both Chenhall and Morris (1986) and Gordon and Narayanan (1984) found a positive association between broad scope information and increased environmental uncertainty. Chia (1995), Fisher (1996), Gul and Chia (1994), and Mia and Chenhall (1994) found a positive relationship between broad scope MAS and performance when managerial decisions were subject to high environmental uncertainty. Further support for the argument is found in Larcker (1981). He hypothesized and found support for the argument that broad scope information is particularly important in the intelligence and design phase of capital budgeting decisions (i.e. where decision making is uncertain), and less important in the programmable phase of choice.

The way in which broad scope information reduces uncertainty is discussed below.

Uncertainty of cause and effects

Organizations producing standardized products face little uncertainty of cause/effect relationships. Narrow scope information is likely to be appropriate in this setting (Abernethy and Guthrie, 1994; Macintosh, 1995; Brownell and Merchant 1990; Govindarajan, 1988). This type of information engenders standard solutions (given as N_p in Figure 3.1). In

contrast, where organizations are pursuing a strategy of customization, information on standard solutions loose their relevance. Managers in this decision context require information on the properties of 'new' inputs and future demands for output in order to determine the optimal mix of inputs and outputs. Broad scope information (given as information on *N* in Figure 3.1), which is externally focused, future oriented and non-financial can fulfil this need. It can reduce uncertainty of cause and effects by providing more relevant information for decision making. The argument for broad scope information can be elucidated with the following examples. Information on production technologies used externally will further the manager's knowledge on alternatives to produce new outputs (external non-financial information). It is also likely that a combination of financial and non-financial information will be required to pursue intelligence and design activities (e.g. prices and opportunities to employ new materials). Future oriented information (e.g. sales forecasts) helps managers to make inferences about the products which will be required in the near future. The importance of the future orientation dimension of broad scope has received considerable support (Gordon and Miller, 1976; Parthasarthy and Sethi, 1993; Simons,1990). This research argues that organizations that have to frequently adapt to environmental changes require information (management accounting) which engenders ideas so that the organization can continually meet the changed demand with respect to price, quality and other product features.

Understanding

Broad scope information increases understanding in that it engenders ideas of how an output may be produced in an alternative way, or which alternative inputs are available to produce a 'new output.' While narrow scope information focuses on current production norms, broad scope information facilitates the development of new ways of producing (current or new) outputs. This feature of broad scope becomes particularly relevant if producing according to existing norms are no longer sufficient to produce the outputs required. Changes in demand often necessitates managers to look for solutions that extend beyond the current range of technologies. It is, therefore, conducive to look outside the organization for information on alternative actions. The provision of this information by MAS, enables managers to focus their attention on assessing how the given alternatives may fit in the organizational processes. This focus is made possible because the manager is not required to allot scarce information processing and storage capacity to the decision making phase of intelligence. This information is stored and processed by the system. This enables manager to allot more storage and information processing capacity to the other phases of the decision making process (i.e. design and choice). As a consequence the manager is able to consider more alternatives simultaneously than would be possible if the manager was to compile his own information. This increases the probability that managers gain insight as to how to produce new products.

In summary, uncertainty of cause and effect relationships is reduced with the provision of broad scope information because it facilitates managers to consider a larger number of alternatives than without this information. This feature results in a greater probability of formulating an alternative that best fits the problem facing the decision maker.[2]

Uncertainty of objectives

Broad scope information helps managers to define a solution within a set of given objectives. Solutions viable from a technological point, are not necessarily also viable when objectives are considered (see Figure 3.5). Consideration of objectives requires solutions to fit technological constraints as well as objectives. This extra constraint requires more alternatives to be evaluated, and hence increases the information required to make the assessment.

Understanding

The very existence of two or more departments in an organization means that they purposely pursue their own objectives (Thompson, 1967). If managers in interdependent situations want to make co-ordinated decisions they need to take their own as well as other departmental objectives into consideration. This can engender ambiguity of objectives in that solutions consistent with one department's objectives may conflict with those of interdependent departments. Uncertainty of objectives is to be considered an additional constraint on top of technological constraints in that it reduces the viable set of possibilities available to produce an output. Therefore, inclusion of objectives makes it more critical for managers to have access to information that engenders ideas (Earl and Hopwood, 1981). If, for instance, 10 possibilities are viable to each department from a technological point of view, it would be sheer coincidence if all those solutions matched the objectives of the departments involved (see also section 3.3.3). In a situation where only technological considerations are relevant, it would suffice if the information reveals only one out of the ten solutions. In the scenario that objectives are to be considered as well, the information should reveal at least one solution that matches both technological possibilities as well as objectives. The probability that managers find a solution that matches both departments objectives can be increased with information that is richer in the dimension of scope. In summary, broad-scope information reduces uncertainty of objectives because it enhances the probability of developing ideas within the constraints of all departments involved in a decision.

To summarize, it is argued here that broad scope information will be useful for managers facing a decision context where there is uncertainty of cause and effects and objectives. First, broad-scope information increases the number of alternatives that can be understood to assess

[2] 'Best fit' is used in the fashion of satisfactory (March and Simon, 1958).

cause and effect relationships because it is richer than narrow-scope information. Secondly, it increases the probability of developing ideas consistent with the objectives of the departments involved.

3.5.3.2 The dimension of integration

Chapter 2 described integrated information as having three characteristics: precise targets for activities, reporting on inter-unit interactions, and sub-unit information. 'Precise targets' inform managers about the flexibility of departmental targets. Inter-unit interaction information provides managers with insight into how decisions of one department may affect other departments (e.g. information on which types of output the other department can process). Sub-unit information contains specific information of departments, which is provided to interdependent departments, such as cost and price information.

Integrated information assists managers of different departments to assess each other's operations and the constraints that apply to them. The dimension of integration informs managers of different departments about their common decision space. This involves information about production processes as well as information about departmental objectives. Integrated information helps departmental managers assess the effect of their decisions on activities carried out in interdependent departments. Integrated information includes other department's cost and price data, and information on which types of output the other department can process. Integrated information is an important information dimension because as interdependencies increase it is impossible for managers to make congruent decisions without understanding the impact of their decisions on activities carried out in other departments.

The importance of integrated MAS information has been recognized for some time. Anthony (1965) and others (Baumler, 1971; Galbraith, 1973, 1977; Gordon and Miller, 1976; Thompson, 1967) have argued that "a rapid flow of accurate, detailed information among interdependent units" is important to ensure that viable solutions can be defined. Bruns and McKinnon (1993) found that production managers require daily information from sales departments as it enables them to make more effective production decisions. The importance of integrated information increases with interdependence (Chenhall and Morris, 1986; Mia and Goyal, 1991). As a matter of fact, the results of these studies indicate that the relation between integration and interdependence is higher than any other dimension. Chenhall and Morris (1986) also found uncertainty to be positively associated with integrated information. Under conditions of increased uncertainty Chia (1995) found integrated information to improve managerial performance.

Uncertainty of cause and effects

Each department of an organization produces outputs. When there are interdependencies between departments, they exchange intermediate outputs, and thus the performance of one department affects performance of interdependent departments. Interdependence between departments necessitates the manager's awareness of the technological constraints to which interdependent departments are subject. These constraints not only constitute limitations in a negative sense, but also reveal in which direction managers may look for solutions. In terms of cause and effect relationships integrated information can be argued to have two effects.

Understanding
First, the provision of integrated information provides the potential for what Argyris (1977) refers to as double-loop learning. This form of learning has the potential to reduce uncertainty by facilitating the development of "new ideas". Integrated information enables departmental managers to 'learn' how to adjust products and production methods both within their own departments and in other departments. Integrated information allows sharing of information among departments which improves managers' capability to assess consequences of their activities on the activities of other departments (Atkinson et al., 1997). This information exchange enhances problem solving capabilities (Walton and Dutton, 1969). In summary, integrated information reduces uncertainty of cause and effect relationships because it enhances organizational learning.

Delay time
Knowledge of what other departments can technologically process precludes managers from looking for alternatives that are viable for their department but which may not be viable for the other department. Integrated information facilitates the focus of attention to solutions that are viable to all departments involved in the transformation process. As such it structures the decision situation (Hopwood, 1974). This allows managers to dedicate the scarce resource of managerial decision time to the relevant issues. Uncertainty is then reduced because it enables the manager to process a larger amount of information that is relevant to the situation in the given time frame. In summary, integrated information reduces uncertainty by focusing managerial attention on relevant issues and thus facilitates timely decision making.

Uncertainty of objectives

Uncertainty of objectives is mitigated with the provision of integrated management accounting information in two ways. First, it assists managers to define solutions within or near to the given constraints of objectives. Second, integrated information provides a common language

that enable managers to make timely decisions consistent with the set of objectives.

Understanding
Ambiguity in the decision-making process occurs when objectives are conflicting (Daft and Lengel, 1986). Integrated information is required to resolve these conflicts and/or to reduce the ambiguity (Earl and Hopwood, 1981). Integrated information requires a focus on horizontal information flows rather than vertical flows of information. It is the horizontal flow of information that facilitates co-ordination or reconciliation of objectives (Hopwood, 1974). Integrated information can serve this purpose in that the information content makes managers of interdependent departments aware of (other) objectives, and facilitates the investigation of decisions and their consequences on other department's activities. It encourages sharing of information between departments and thus develops understanding of the different objectives which exist within separate decision units (Atkinson et al., 1997 and Walton and Dutton, 1969). The sharing of information enables managers to make trade-offs among alternative ways to operate within the given set of objectives. In terms of decision space, the information unfolds the set of possibilities to produce an output. This set identifies the alternatives that fit the objectives of all departments involved in a decision, given as the intersection of N and M, in Figure 3.5.

The availability of integrated information enables managers to consider possibilities that are consistent with the current objectives of the other department. In summary, integrated information reduces uncertainty by focusing the manager's attention on viable alternatives so that the probability is increased that the decision is accepted by all parties involved.

Delay time
Integrated information also facilitates decision making because it uses sets of descriptions common to all managers that use MAS. The common language used in MAS in general, and with integrated information in particular, helps managers to communicate about joint issues (Daft and Lengel, 1986). Pentland and Rueter (1994) contend that a common language facilitates decision making because it makes it easier for managers to communicate. Integrated information serves this role particularly well in that it enables managers to evaluate the effects of decisions against objectives stated in consistent terms. All managers can use the same set of definitions to exchange information or to make a decision (e.g. the cost price of an intermediate product produced by the other department). Departments can communicate using a uniform set of definitions as a common reference. This makes it easier for managers to evaluate alternative actions, and hence decision making will be more timely. In summary, integrated information provides a common set of definition which facilitates evaluation against given objectives, and this enhances timely decision making.

The four arguments relating to integrated MAS information can be summarized as follows. Firstly, integrated information reduces uncertainty relating to cause and effect relationships within departments as it encourages learning and the generation of ideas. Secondly, it helps to focus on the viable regions of the set of possibilities to produce output, so that decision making can be more timely. Thirdly, it decreases uncertainty of objectives because it assists the reconciliation of objectives. Lastly, integrated information reduces uncertainty as the common set of definitions facilitates rapid comparison of alternatives against objectives and thus enhances timely decision making.

3.5.3.3 The dimension of aggregation

Aggregation has three sub-dimensions: organizational level (summary reports on activities performed in other business units of the organization), decision models (supporting DCF, what-if-analysis, cost-volume-profit analysis) and time period (e.g. month, year). It is argued below that aggregated information mitigates uncertainty of objectives and cause/effects because it provides an efficient means of conveying information.

The studies of Chenhall and Morris (1986) and Mia and Goyal (1991) provide evidence that aggregated information reduces uncertainty. In terms of the decision space available to managers of departments (*N/M*), aggregated information can be used to both consider decision situations that pertain to the separate departments as well as to co-ordinate between departments. There is also evidence to suggest that aggregated information improves performance in more uncertain situations (Chia, 1995; Gul and Chia, 1994).

Uncertainty of cause and effects

It has been argued in the preceding sections that increased levels customization and interdependence require organizations to assess more often input/output relationships. The computational complexity associated with these assessments creates a decision context where a manager is no longer capable of surveying all existing relationships (March and Simon, 1958), or it is no longer efficient to process the necessary information to make that assessment (Bolton and Dewatripont, 1995).

Understanding

A transformation process can involve a vast amount of interrelated activities, particularly when these activities are performed in more than one department. Aggregated information does not provide detail about the content of the relationship between activities, but rather about how these activities are performed in conjunction to each other. For instance, a profit and loss report of a business unit informs other business units about the success of the

activities performed in that business unit. Highly aggregated information provides the decision maker with an overview of the transformation processes. However, the level of detail is shallow. For example, a cvp analysis is an over simplification of the 'true' cause and effect relationship. The manager acquires a general impression of the decision situation, but gets no insight into the nature of the cause and effect relationship. In other words, aggregated information provides the means to conduct a so called "quick and dirty analysis." Such an analysis, however, is very functional when there exists uncertainty over cause and effect relationships as the information provides managers with a first, albeit not precise, insight into relationships of interest. This gives the manager the opportunity to compare situations at a high level of abstraction. The function of this information is then to identify the areas which require more elaborate investigation. For example, a comparison of business unit profit and loss accounts may prompt a manager to conduct a detailed investigation of working methods performed in other business units.

Aggregated information provides an overview of the transformation process or sets of transformations and thus provides the decision maker with a starting point for further analysis. The information can be used as a screen in the decision process to partial out the relevant from the irrelevant areas to investigate. The importance of aggregated information for decision making has been recognized for some time. Ackoff (1967) contends that managers face information overload if information is not aggregated, which in turn results in poor decision making. Pitz, Downing and Reinhold (1967) found managers who face information overload will evade decision making as much as possible. According to Samuelson and Zeckhauser (1988), this occurs because managers are unable to process the necessary information. March and Simon (1958) argue that aggregation of information is an effective means to narrow the problem the decision maker faces, and thus reduce the potential for information overload. Managers can set aside the irrelevant issues and focus on the relevant set of alternatives. In summary, aggregated information reduces uncertainty of cause and effect relationships because it provides an overview of the decision context enabling managers to select the direction to search for alternative actions.

Delay time

A second reason for information to be aggregated is that decision making can become more timely. It is inefficient for decision makers to process all the information available as this would take more time than that available for the decision. The decision would be too late. Aggregated information enables managers to consider more options, and more quickly selects areas which require further investigation. This enables the manager to make decisions more timely and better informed. In other words, managers provided with aggregated information, are capable of making more decisions, or to make more comparisons in a given time frame (Otley, 1987). Hence, aggregated information reduces uncertainty of cause/effects because

it accelerates decision making by enabling managers to consider more alternatives.

Uncertainty of objectives

It has been shown in Section 3.3.3 that the number of viable solutions decreases because each department pursues goals that may cause conflicts to arise between departments. Although it is assumed that departments are goal congruent with reference to business unit objectives, conflicts may still arise because of differences in orientation (Macintosh, 1995). Aggregated information summarizes the objectives to which other departments are subject, so that decision makers can use this information as a reference for their decisions.

Understanding
Aggregated information provides managers with a necessary overview of the consequences of alternative actions they consider. The provision of aggregated information gives managers the possibility to assess more alternatives contemporaneously than would be possible without this information. While it may be impossible for a manager (specialized in say production or sales activities) to acquire a detailed insight into the consequences of an alternative action to an other department, aggregated information gives a general idea about these consequences. CVP information, for instance, gives a sales department information about the possible consequences of selling more of one product and less of another. This information can be studied in its consequences to sales as well as to production departments (e.g., machine usage). Aggregated information helps managers to evaluate alternative actions against objectives of other departments. Hence, aggregated information about activities carried out in interdependent departments highlights lines of actions consistent with objectives of all departments involved.

Delay time
Complying with other departments objectives increases delay time in that it takes more time to arrive at a solution. Aggregation may decrease this delay time by providing managers with a tool to consider the objectives of other departments faster than would be possible without aggregated information. This is because interdependent departments cannot take a decision until the preceding department has completed their decision process. Suppose the organizational response time to fill an order is given. If only one department is involved in the decision, this department can consume the total given time. However, if a second department is also involved and it cannot make a decision until the preceding department has made his decision, the situations has changed. According to Brickley et al. (1997, Chapter 10) and Thompson (1967), employees in functionally differentiated departments are oriented to their own processes. As a consequence each department will take as much time as possible to make a decision that best suits the situation. Within the given total organizational response

time, this practice leaves subsequent departments with less decision time. The availability of aggregated information increases the chance that all managers involved have time to consider alternatives because, as argued before, aggregated information assists managers to speed up the decision making process. As a consequence the provision of aggregated information decreases the probability that managers of preceding departments impede the decision making process at consecutive departments, and hence violate the pursuit of their objectives.

In summary, aggregated information reduces time to make a decision in one department, leaving more time for other departments to pursue their objectives.

To summarize, it is argued that aggregated information enables managers to consider all the necessary alternatives, both in terms of simultaneous processing capacity, as well as in terms of time available to make decisions. Firstly, aggregated information reduces uncertainty of cause and effect because it provides an overview of the decision context enabling managers to select the direction to search for alternative actions. Secondly, aggregated information reduces uncertainty of cause/effects because it accelerates decision making by enabling managers to consider more alternatives in a given time. Thirdly, it reduces uncertainty of objectives because aggregated information about activities carried out in interdependent departments highlights lines of actions consistent with objectives of all departments involved. Fourthly, aggregated information reduces time to make a decision in one department, leaving more time for other departments to pursue their objectives.

3.5.3.4 The dimension of timeliness

Timeliness of information pertains to how frequently information is provided and the speed by which new information is provided by the system. The importance of the timeliness dimension is dependent on how fast information expires. If production processes change frequently, information is likely to be outdated faster than in a situation where the same processes/activities are repeated continuously. The more updates necessary to keep pace with relevant developments, the more timeliness becomes an issue in MAS design.

Information is timely when it is available to the decision maker on request, and without delay. Anthony (1965) states that "if a report is due on the fifth working day of the month, it should be published on that day." Timeliness is associated with the three dimensions already discussed (scope, integrated, and aggregated information) as all these dimension may or may not require frequent updates.

Organizations will not necessarily invest in systems that provide up-to-date information in all respects. Organizations will make a trade off between what is desired for decision

making, and the costs of an up-to-date accounting system (Scapens, 1985). Gorry and Scott-Morton (1971) argue that up-to-date accounting systems will be particularly important for organizations that face rapid changing environments. This proposition is supported in four subsequent empirical studies. Chenhall and Morris (1986) found a strong association between environmental uncertainty (rapid changing environments) and timeliness. Mia and Goyal (1991) and Fisher (1996) again confirmed this relationship. Chia (1995) found a positive association between timely information and performance under conditions of increased uncertainty. Bruns and McKinnon (1992) found the more general result that timely information is one of the most valued characteristics information.

Uncertainty of cause and effects

It has been argued in section 3.2 to 3.4 that customization and interdependence require more frequent consideration of cause and effect relationships. Customization necessitates more frequent consideration of whether new outputs require alternative inputs, and which alternative inputs can be used best to produce the required output.

Understanding

The provision of 'old' information can distort decisions. Suppose managers of one firm base their decisions generally on outdated information, while managers of their competitor in general make decisions based on the latest information. Decisions by the latter category of managers are likely to be better than those of the first group as this group would more often make wrong decisions compared to the latter group. They make more wrong decisions because their decisions are exposed to more random error than those of the competitor. Outcomes of decisions based on outdated information deviate, on average, more from the expectation at the time of the decision than decisions based on up-to-date information. Managers that systematically base their decisions on 'old' information are, therefore, expected to be more uncertain than colleagues who face the same decision context, but have timely information. Johnson and Kaplan (1987) demonstrate how managers make wrong decisions trusting old information. Their analysis is consistent with Ronen and Livingstone (1975).

Delay time

If the circumstances change with respect to cause and effect relationships it becomes important for managers to have access to information so that they need not translate information into the current state of affairs. When, for instance, salaries have changed it would require managerial time if MAS provided them with information based on 'old' salary levels. In this case it would be necessary for the manager to translate the outdated salary scale into the new salary scale prior to making a decision. As a consequence, the manager would

require more time to make a decision, than if he had been provided with up-to-date information. To summarize, timely information improves the decision making process as it enables management to focus on the decision, rather than translating 'old' information into the current situation.

Uncertainty of objectives

Understanding
Reconciliation of objectives becomes increasingly difficult if production and sales activities have to adapt to input and output diversity on a frequent basis. If the information provided is obsolete, departmental decisions are more likely to be inconsistent with the objectives of other interdependent departments. For example, suppose that the sales department has information about future demands of particular products. The sales department will adjust its objectives in terms of sales mix and expected revenue. In that case production needs to know which product features are required from the sales department point of view, so that it can adjust its facility to the needs of the customer and hence to that of sales. If this information is not made available until the demand actually surfaces on the production floor, decisions consistent with 'old sales trends' about the deployment of the production capacity may have been taken already. As a consequence production can not meet the new demand. This situation will not occur if production receives recent updates so that alternative production possibilities are evaluated against the latest information. This facilitates decisions which are consistent with the other department's objectives. Thus, the provision of timely information reduces uncertainty of objectives because it enables managers to base their decisions on the latest information with respect to input-output relations and objectives.

In summary, providing managers with timely information reduces uncertainty of cause and effect relationships because managers can better rely on that information, and they need not dedicate time to translate 'old' information into the new situation. Uncertainty of objectives is reduced because timely information assists managers to define solutions within constraints given by the latest objectives.

3.5.4 Conclusion

It is expected that uncertainty in decision making, triggered by customization, can be mitigated if the appropriate information is provided. It has been argued that management accounting systems can help managers in resolving the uncertainty that would be associated

with decision making if the information was not made available.[3] Interdependence is both an intermediate variable between customization and MAS, and a variable that influences the use of MAS in its own right. It has been argued in Section 3.3 that increased interdependence influences the decision making process because input-output relationships need to be examined on a more frequent basis. It is argued in this sub-section that the dimensions of scope, integration, aggregation, and timeliness are all relevant to making decisions. For all dimensions it has been illustrated why they help to overcome uncertainties of cause and effects and objectives. It appears that the help of MAS is twofold. Firstly, it enables manager to better understand the problem at hand from both a technological point of view and from the perspective of meeting objectives. Secondly, MAS assist in making timely decisions, thus enabling managers to consider more relevant alternatives than would be possible without the information provided by MAS. The arguments are summarized in Table 3.1.

3.6 Hypotheses

3.6.1 Introduction

This study focuses on the use of information by managers for decision making. It is recognized that information is not costless (Gul, 1991; Gul and Chia, 1994; Milgrom and Roberts, 1992; Tushman and Nadler, 1978) and that information will only be provided when there is a net benefit derived. This research adopts this positive approach, and assumes that managers will only use more sophisticated information when it is functional to do so. Moreover, it is assumed in this study that organizations have control systems in place to promote goal congruent decisions. That is, the managerial orientation is geared to the wealth of the business unit, rather than to the manager's or the department's wealth. The hypotheses formulated below are based on these assumptions.

3.6.2 Customization and interdependence between departments

Section 3.4 argues that increased customization will result in increased levels of interdependence. This is the case because customization causes input/output relationships to be intertwined, with the effect that decisions in Department A cannot be made in isolation from Department B.[4] The following hypotheses can be drawn from this theory.

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[3] This is not to say that the information could not be made available from other sources. This study assumes that the provision of information via accounting systems assists managerial decision making, which does not rule out other means of information collection.

[4] For simplicity, it is assumed in this and subsequent analyses that there exist only two interdependent departments.

Hypothesis 1
There is a positive effect of customization on interdependence.

3.6.3 Interdependence and MAS

Increased interdependence between departments involves a greater need to co-ordinate activities, because decisions made in one department affect activities performed in other departments. This is the case for two reasons. First, departments are interdependent in that outputs of one department become inputs of other departments. Thus, it is important that the outputs (i.e. intermediate product) produced by Department A can be processed by the dependent Department B. Secondly, the intermediate product, while satisfying the objectives of one department may conflict with the objectives of other departments. To enable managers to make congruent decisions it is necessary to assess their decision's effect on dependent departments. Without such information they would not be able to assess the impact of their decisions on the other department. In other words it would make managers uncertain about the result of their decisions. Uncertainty regarding cause and effect relationships and objectives can be mitigated with MAS. Broad scope information is required because this information enables the managers to generate the necessary ideas to formulate a solution that matches both departments' objectives (section 3.4 and 3.5). Integrated information is necessary to ensure that the intelligence, design and choice are consistent with both departments' objectives and technological constraints. Timely information is important because if something changes within Department A, it has immediate consequences for Department B. Timely information is a necessary condition for optimal solutions. Information must also be more aggregated as interdependence increases, enabling manager A to relatively quickly survey the effect of a decision on Department B.

The following hypothesis can be drawn from these arguments.

Hypothesis 2
There is a positive direct relationship between interdependence and the MAS dimensions of (i) scope, (ii) integration, (iii) aggregation and (iv) timeliness.
The above hypothesis will be tested for each dimension separately.

3.6.4 Customization and MAS

Section 3.2 argued that customization increases uncertainty concerning cause and effect relationships within departments. Uncertainty is increased because standardized programs can no longer be used to manage activities as an organization shifts to tailored customization. To cope with uncertainty managers require more information in order to ascertain the cause and

effect relationships that apply to the customized products. Three MAS dimensions will be particularly important when customization increases. Firstly, managers will require broad scope information to develop new insights into how to produce new products. Broad scope information facilitates the development of new ideas. Secondly, more aggregated information is required as this enables the manager to consider contemporaneously larger parts of the set of possibilities available to produce a product. Thirdly, it is expected that information requires updates more frequently when customization increases, because the continuous addition of new product features requires the organization to remain up to date with the latest developments in terms of the market for inputs and outputs.

It is not expected that customization will directly affect integrated MAS. Integrated information is particularly useful for departments to make decisions consistent with operations carried out in other interdependent departments. It is, therefore, expected that integrated MAS will not vary with higher levels of customization in its own right, but rather that the relationship between customization and integrated MAS will act solely indirect *via* interdependence.

The following hypothesis can be drawn from the arguments developed in Section 3.2 and 3.5.

Hypothesis 3a
There is a positive direct relationship between customization and the MAS dimensions of (i) scope, (ii) aggregation and (iii) timeliness.

Hypothesis 3b
There is no direct relationship between customization and the integrated MAS dimension.

The above hypotheses will be tested separately for each MAS dimension.

3.6.5 Indirect relations of customization and MAS

Hypothesis 3a specifies a direct effect of customization on the use of sophisticated MAS. However, to the extent that customization augments interdependence, it is entirely possible that customization acts on MAS via interdependence, hence indirectly. In fact the theory developed above assumes this relationship for all MAS dimensions. Dillon and Goldstein (1984), defines an indirect effect as:

> 'The situation where an independent variable affects a dependent variable through a third variable, which itself directly or indirectly affects the dependent variable'.

Together, the direct and the indirect effect represent the total effect of an independent variable on a dependent variable. It is, therefore, conceivable that an indirect effect accounts for the complete relation of the independent variable with the dependent variable. In our case this would mean that customization has no direct effect on the demand for sophisticated MAS, but rather it acts solely through interdependence on the demand for sophisticated MAS. Given the theory developed in the above sections this would be too bold an assumption, except for the dimension of integration where there is no reason to expect a direct relationship. It is, therefore, expected that both direct and indirect effects will be apparent. The indirect effect of customization on demand for sophisticated MAS, acting through interdependence is expected because customization covaries with interdependence (H1), and it is the association with interdependence that influences MAS. If interdependence directly affects MAS use, and interdependence is augmented by customization, it is expected that the simple correlation between customization and MAS use will be either partly or totally accounted for by the indirect effect. In the case of scope, aggregation and timeliness it is expected that there will be a direct and an indirect effect, while it is expected that there will be no direct effect of customization on the dimension of integration.

The above arguments are summarized in the following hypothesis:

Hypothesis 3c
There is a positive indirect relationship between customization and the MAS dimensions of (i) scope, (ii) integration, (iii) aggregation and (iv) timeliness, acting through interdependence.

Hypothesis 3c will be tested for each dimension separately.

The hypotheses to be tested are presented in Figure 3.7.

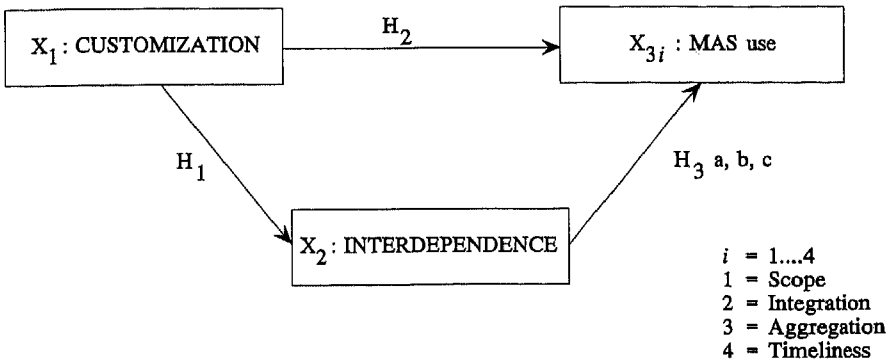

Figure 3.7: The Research Framework

3.7 Conclusion

This chapter argues that increased levels of customization induce uncertainty of decision making in departments. The argument developed contends that this is the case because organizations cannot maintain existing production programs if they want to meet customer demand. These changes make it more difficult for managers to consider input/output relationships which in turn results in uncertainty about cause and effect relationships. This uncertainty is reduced by providing the appropriate information. The second effect of customization is that it increases interdependence between departments. Interdependence is associated with uncertainty in two ways. First, input/output relationships can no longer be determined for each department in isolation from what is occurring in other interdependent departments. This creates uncertainty because it is not known in advance how one department's decisions will affect the activities of other departments. Information is thus required to assess these effects. Second, it is not possible for interdependent departments to pursue their own objectives without considering each other's objectives. Objectives need to be reconciled to ensure a co-ordinated response to customer demands. These co-ordination requirements induce uncertainty in decision making if the required information is not made available.

Basically four solutions are available to reduce increased levels of uncertainty. One solution is to decrease the need to process information by changing the organizational structure into self-contained groups. This could be achieved by amalgamating sales and production departments. The second is to create slack resources in the organization. The third is to

increase information processing capacity through the use of integrative liaison devices which facilitates communication. Fourthly, it has been argued here that more sophisticated information can be used to decrease uncertainty associated with decision making. This study investigates the use of MAS in functionally differentiated organizations. It has been argued that organizations are inclined to maintain this structure for reasons of economies of scope. They can maintain this structure to the extent that they are capable of processing the information necessary to make decisions that deal with the effects of customization and interdependence (i.e. uncertainty). It is argued that MAS information that is more sophisticated in the dimensions of aggregation, scope, timeliness and integration will facilitate the reduction in the uncertainty facing managers by providing decision makers with more information on cause and effect relations, as well as with information to reconcile differences over objectives.

Chapter 4

Method

4.1 Introduction

This chapter discusses how the research was conducted. It breaks down into four parts: (4.2) design of the study, (4.3) the instruments, (4.4) method of data collection and (4.5) conclusions. The design section discusses at which organizational level the study was conducted, and why production and sales departments were chosen. Section 4.3 discusses which instruments were used to measure the variables customization, interdependence and management accounting systems. It also provides a justification for using these instruments. The data collection section discusses the choices that were made in terms of organizations, respondents, and in the way the data collection actually was carried out. Section 4.5 summarizes the chapter.

4.2 Design of the study

4.2.1 Introduction

It is the purpose of this study to investigate how different levels of customization influence MAS use (a) directly and (b) indirectly via interdependence. In this sub-section it is argued that business units rather than firms decide the level of customization to be pursued. Its effects can, therefore, only be studied within business units. Also it is argued in this sub-section that sales and production departments, in particular, have to deal with the effects of customization.

4.2.2 Organizational level

Decisions on customization: business unit

Recall from Chapter 2 that customization is the operational means of implementing a strategy of differentiation (Murray, 1988; Parthasarthy and Sethi, 1993). It is the level of strategy that affects the control system (or elements of it). Corporate strategy, business unit strategy and manufacturing strategy will also have differing effects on the control system design. For example, the corporate-level strategy will affect the way reports are prepared on the corporate level. However, organizations that pursue a uniform corporate strategy do not put

uniform control mechanisms in place for all the business units of the organization. Govindarajan and Gupta (1985) provide evidence that business units pursuing distinct strategies, use control mechanisms that suit that business unit strategy.

As customization is the operational means of implementing a strategy of differentiation at the business unit level (Porter, 1980), it can be argued that it is the business unit level where customization strategies are defined and implemented. The effect of customization is thus best studied within business units, that is, at the functional departmental level.

Individuals that cope with customization: production and sales managers
The effect of customization can be studied through the tiers of the business unit, varying from the business unit manager to employees carrying out the direct production activities. This study sought to examine how customization affects decision making within production and sales departments. This choice has been made because it is these departments that directly implement the customization strategy. It is recognized that either functional units, such as R&D, engineering, product design will also be influenced by customization. However, for the purposes of this study the sample was limited to production and sales managers. Production and sales managers must make decisions that are consistent with their own objectives, but contemporaneously with the objectives of other departments, which might be affected by their decisions. It is the departmental manager who is responsible for bringing about co-ordination within and between production and sales. A successful implementation of the customization strategy in functionally differentiated organizations is dependent on the level of co-ordination they realize within and between departments. Therefore, it was decided to study how customization affects production and sales manager's use of MAS.

4.2.3 Level of measurement

Customization
There exist two different approaches to study the effect of customization on departmental managers. The first is to let production and sales managers assess the perceived level of customization. The second is for the business unit manager to assess the level of customization being pursued. The advantage of allowing production and sales managers to differ in their opinion on the level of customization is that it can be argued that the perceived level of customization directly affects the manager's perceived uncertainty, and hence the choice of how to use MAS. However, it is questionable whether this approach captures the level of customization or whether it captures the variety of work that needs to be accomplished to fill orders. If it is the latter, then this may reflect the solutions implemented within the departments to cope with levels of customization rather than customization itself. Secondly, the manager's perception may not reflect how customized the product is, but rather how

managers perceive their contribution in the total transformation (which includes both sales and production activities). In other words, it is not customization that is being measured, but the variety in activities necessary to produce intermediate outputs.

A pilot study that was conducted to develop the customization instrument revealed this difference. A sales manager and a production manager of an insurance company stated the following.

> The sales manager
> 'The back office (production department) can only provide us with standardized contracts, and process and execute them. We adjust these contracts to some extent but frankly we sell standardized products.'
>
> The production manager
> 'In terms of insurance contracts we provide sales with a large array of contract variations that are consistent with given procedures, we would consider these contracts to be customized because the client decides what is in the contract, and we price each component the client demands.'

It is clear from these opinions that they both have a different perception of the level of customization. Sales perceives products to be standardized, and production considers the products to be customized. The interview with the business unit manager of the organization indicated a deliberate strategy to sell standardized products because this was their competitive advantage.

It is the purpose of this study to investigate how a business unit strategy of customization influences the use of MAS by sales and production managers. Based on the findings of the pilot study it was decided to measure customization from the business unit manager's perspective. The advantage of this approach is that an objective measure can be used to assess the level of customization. There are two reasons to support this statement. The business unit manager is responsible for the strategy formulation and implementation. These decisions determine what decisions and work the business unit manager expects departmental managers to carry out, and thus the use of MAS by departmental managers. The unilateral decision can only be measured at the business unit managers level. Measurement at the departmental level would reflect only interpretations of this unilateral decision.

The second reason is related to the first. The hierarchical position of business unit managers allows them to simultaneously consider the activities carried out in production and sales (i.e. complete transformations). As they are not involved specifically in production or sales

activities their ratings will not be influenced by a departmental bias as illustrated above. In doing so, the measure can be argued to be objective in that it represents the business unit's customization strategy. This objective measure of customization can now be argued to be a proxy of the customization to which sales and production managers are subject. What is measured then is how customization introduced by business unit managers affects the use of MAS by production and sales managers.

Dealing with the effects of customization on departments

The theory developed in Chapter 3 contends that uncertainty of decision making exists because of two design decisions: strategy (customization) and (functional) structure. Both choices affect the relationship between activities performed within the business unit in that they create uncertainty of cause and effect relations within, between departments, and uncertainty of objectives, the latter two being a consequence of interdependence. As production and sales managers are responsible for organizing the work, and make decisions for their respective departments, they deal with uncertainties associated with choice of strategy and structure. It is the way these managers deal with customization and the functional structure that governs how they experience the level of uncertainty, and how they use MAS. Dealing with uncertainty means that managers (are able to) make choices in using different sources of information to make decisions consistent with departmental objectives. As a consequence managers can use MAS differently though they are dealing with equal levels of uncertainty. In particular dealing with uncertainty of interdependence means that managers have a choice as to the extent to which they make decisions consulting other departments. As a consequence, each department may experience different levels of interdependence. This can occur because each department has a separate role in the transformation process, and thus attributes that constitute the perceived level of interdependence may be calibrated more heavily by one department than by the other. For instance, if acquiring and communicating client orders constitutes 40 percent of the work of sales, and production dedicates 70 percent of its work in filling these orders, different experiences of interdependence may occur.

As customization might produce these different perceived levels of interdependence it was considered important to assess the production and sales manager's perception of interdependence. In summary, the constructs MAS and interdependence are measured at the production and sales level, while customization is measured at the business unit level. Each of the measures are discussed in section 4.3.

4.3 Measurement instruments

4.3.1 Introduction

This sub-section describes the instruments used to measure customization, interdependence and MAS.

4.3.2 Customization

Development of the instrument
Although customization can be argued to represent a new concept in MAS-studies, it was operationalized in the organizational literature back in 1969 (Pugh et al., 1969). Brownell and Merchant (1990) used a similar construct to that of Pugh et al. (1969) to capture product standardization. This study employed an adapted version of the Pugh et al. (1969) instrument. The categories of Pugh et al. were adjusted because in the testing of the instrument respondents had difficulties in distinguishing item (b) from (c) (see questions below). Therefore, it was decided to adjust the instrument slightly. The instrument is in Table 4.1.

Products/services are	
a	completely standardized
b	basic models which are customized according to organizational specifications
c	basic models which are customized according to client's specifications
d	completely customized
e	None of the above descriptions fits our situation (please specify)

Table 4.1: Customization instrument

It is unlikely for products to exactly fit into one of the four categories a to d. Continuous scales of a Guttman type (percentages) are used, giving respondents the possibility to elicit the distribution over all five categories (for instance, the ratings over the categories a to d may amount 10, 20, 40, and 30 percent). This was done because Brownell and Merchant (1990) reported that their fully anchored categories produced only little variance throughout the sample. The use of these scales forced respondents to asses the average level of customization, rather than the distribution over all the categories involved. This problem was solved in a study conducted by Govindarajan and Gupta (1985). To measure business unit strategy they allowed respondents to rate a percentage on four categories adding up to 100 percent. They report an amount of variance that does allow them to assess the relationships

under investigation. The scaling Govindarajan and Gupta (1985) used was applied in this study. In conclusion it was decided to use categories similar to the ones of Pugh et al. (1969), because they did produce variance over the categories, and to use the scaling introduced by Govindarajan and Gupta (1985), because it prevents the respondent to determine the average level of customization. The instrument is in Appendix 4.1.

4.3.3 Interdependence

Development of the instrument
Following Thompson's (1967) notions of 'pooled', 'sequential' and 'reciprocal' interdependence, the instrument developed by Van de Ven et al. (1976) to capture these three forms of interdependence was employed. Their instrument used drawings to illustrate the three kinds of interdependence, as well as a description of each dimension. The instrument asks respondents to rate the extent to which their work falls into each of the three categories, permitting them to rate on all three categories. It is important that all categories are available because the work carried out will at least to some extent be pooled, because each department will perform some task relatively independently. To some extent work will be sequential in that departments will produce intermediate outputs, that will be sent to the next department, but which will not return to them to be worked on again. Some work will be reciprocal to the extent the output is produced in conjunction with other departments. To capture the levels of interdependence on each of the three dimensions, respondents can rate on scales ranging from "almost nothing" to "all". In a subsequent study Macintosh and Daft (1987) report that they used the instrument successfully. It consists of the following items.

a) *Independent Work Flow Case*. Where work and activities are performed by your department independently and do not flow between them.
b) *Sequential Work Flow Case 1*: from you to them. Where work and activities flow between your department and the other department, but only from your to the other department.
c) *Sequential Work Flow Case 2*: from them to you. Where work and activities flow between your department and the other department, but only from their to your department.
d) *Reciprocal Work Flow Case*. Where work and activities flow between your department and the other department in a reciprocal "back and forth" manner over a period of time until the work is done.

This study uses an adapted form of the Van de Ven et al. instrument in that sequential interdependence is represented by two questions rather than one. The first question (b) asks how much work goes from the respondent's department to the other department, and the second question (c) asks how much work goes from the other to the respondent's department. This had to be done because compared to the original instrument, two rather than three

departments are involved. As a consequence asking them to rate the amount of work flowing from 'one to the other' would exclude work that flows from 'the other to them'. In the original instrument this was not a problem as it was clear from the drawing that work could go in either direction.

The instrument used is in Appendix 4.2.

4.3.4 MAS

Development of the instrument

The instrument for the MAS construct was designed to capture the extent of use for decision making rather than for decision control. It was also designed to capture all dimensions of MAS identified in Chapter 3, in order to facilitate comparison of the results with earlier studies. The instrument that best matches these requirements is that used by Chenhall and Morris (1986). This instrument focuses on decision making and incorporates the dimensions of scope, integration, timeliness and aggregation. The use of this instrument also facilitates comparison with prior research (Mia and Goyal, 1991). The Chenhall and Morris (1986), Chia (1995), and Mia and Goyal (1991) studies provided similar factor constructs consistent with the dimensions of MAS that are of interest in this study. However, as Chia (1995) aggregated the factor scores of items, his presentation of the results did not allow for a comparison with other studies. Later studies did not measure all dimensions but rather used the items to identify the dimension of scope (Abernethy and Guthrie, 1994; Chong, 1996; Gul and Chia, 1994; Mia and Chenhall, 1994), of aggregation (Gul and Chia, 1994) and of timeliness (Fisher, 1996). All these studies produce results to confirm the reliability of the instrument. Given that the instrument suits the research question and that it produced reliable results in the past, it was decided to use an adapted form of the instrument. Changes were made in the wording so that it could be used in both the manufacturing and service industry. Item 20 of the below list was added to capture the dimension of integration, asking respondents about cost information of other departments. The instrument included the following items (the numbers between brackets refer to the number the question had in the questionnaire, see Appendix 4.3).

Scope

1. (1) Information which relates to possible future events (for example new legislation).
2. (18) Quantification of the likelihood of future events occurring (e.g. probability estimates).
3. (20) Non-economic information, such as customer preferences, employee attitudes, labor relations, attitudes of government and consumer bodies, competitive threats, etc.

4. (19) Information on broad factors external to your organization, such as economic conditions, population growth, technological development, labor market, etc.
5. (6) Non-financial information that relates to the following areas:
   (a) Internally-oriented information such as efficiency, output rates, employee absenteeism, etc.
   (b) Market information such as market size, growth share.

Timeliness

6. (2) Requested information to arrive immediately upon request.
7. (8) Information supplied to you automatically upon its receipt into information systems or as soon as processing is completed.
8. (16) Reports are provided frequently on a systematic, regular basis; e.g. daily reports, weekly reports (for less frequent reporting, mark lower end of a scale).
9. (10) There is no delay between an event occurring and relevant information being reported to you.

Aggregation

10. (11) Information provided on the different sections or functional areas in your organization, such as marketing and production, or sales, cost, or profit centers.
11. (12) Information on the effect of events on particular time periods (e.g. monthly/quarterly/annual summaries, trends, comparisons, etc.).
12. (5) Information which has been processed to show the influence of events on different functions, such as marketing or production associated with particular activities or tasks.
13. (14) Information on the effect of different section's activities on summary reports such as profit, cost, revenue reports for:
    a) your particular department .....
    b) the overall organization .....
14. (4) Information in forms which enable you to conduct "what-if" analysis.
15. (15) Information in formats suitable for input into decision models (e.g. discounted cash flow analysis or incremental/marginal analysis).
16. (9) Costs separated into fixed and variable components.

Integration

17. (17) Information on the impact that your decision will have throughout your business-unit, and the influence of other individual's decisions on your area of responsibility.
18. (7) Presence of precise targets for the activities of all sections within your department.
19. (13) Information that relates to the impact that your decision have on the performance of other departments.
20. (3) Cost and price information from other departments of your business unit.

Compared to the original instrument (Chenhall and Morris, 1986) this study made a major change in the wording of the questions asked to the managers. Chenhall and Morris asked whether an information item "would be useful..", and did not capture whether the information currently made available was used. In a subsequent study Mia and Chenhall (1994) changed this question in "how much managers used MAS information" of the given characteristics. This change was made because they selected organizations providing broad scope MAS, and wanted to know whether this information was actually used by the managers. As it is the purpose of the current study to investigate how customization and interdependence affect MAS use, it was decided to ask managers to rate how important the currently provided information is in the decisions they make. This is a departure from prior use of the instrument by Chenhall and Morris (1986), but is consistent with the wording of Chia (1995), Gul and Chia (1994) and Mia and Chenhall (1994). Likert-type 5 point scales ranging from "little importance" to "extremely important" were used to capture the importance production and sales managers attach to the items. This is consistent with prior research using the instrument.

4.4 The method of data collection

4.4.1 Introduction

Data were collected via a closed interview using a survey questionnaire. The respondents were typically sales department managers, production department managers, controllers and business unit managers, and amounted to 288 managers comprising 85 business unit observations. The interviews were conducted either by the researcher or by university students. The questionnaires were handed to the respondents. The interviewers were not allowed to elucidate the questions. Interviewers were there to make sure that the questionnaire was completed by the right person, and to ensure that the production and sales managers knew that the questionnaire pertained to their operational decisions. The direct contact with the respondent was expected to achieve a much more positive response than that of a questionnaire delivered by mail. Some respondents were asked to give their opinion on

the subjects under study. These data were considered useful in the event that findings were different than expected. All the 'aftermath interviews' were conducted by the author.
The data were collected between January 1996 up to September 1996. All business units had functional structures, that is, production and sales activities were carried out in separate departments. This was necessary because it is the very core of this study to investigate how uncertainty within departments and between department is managed in terms of MAS use.

4.4.2 Selection of organizations

Type of organization
As there exists no prima facie expectation that organizations differ in terms of the effect of customization and interdependence on MAS use, it was decided to include both manufacturing and service industries. However, three criteria were used so that the data obtained would be comparable. The first criterion was that production and sales activities were carried out in two separate departments. Secondly, each business unit was part of a firm that comprised of more than three business units. Third, the business unit should employ at least 150 people. The first criterion was set because of the nature of the study, which involves the use of MAS in functionally differentiated organizations. The second criterion and third criterion were invoked to ensure that the organizations included in the study would be sufficiently large to ensure that a MAS was put in place (Mia and Chenhall, 1994).

4.4.3 Respondents

The business unit, sales and production manager of each business unit were interviewed. To check for the validity of the customization instrument, the controller was interviewed as well in 1/3 of the cases. Special care was taken to prevent a high non-response rate. Frankel (1983) and Sudman (1983) described that a lack of response can severely bias the results in that the respondents are not a cross-section of the population. The chance for non-response in this study was assumed to be very high because each observation required at least three respondents from one business unit. It was, therefore, decided to contact organizations directly by phoning business unit managers and controllers. Organizations that were contacted were either members of the Institution for Financial and Economic Managers in the Netherlands (FINEM), or were contacted because access had previously been obtained.

Besides the researcher, students conducted the interviews. Thus, the method used to collect data is not strictly random as the organizations included are either found on the FINEM list, or had been previously contacted by the University. There was also a concern that responses might differ in the data collected by the researcher and the students. Tests of differences were conducted to check whether systematic differences existed between data collected by

students and the researcher. The results of these tests are in Table 4.2, and indicate that there was no systematic bias due to the data collection mode.

	Data collection mode						
	Collection by students			Collection by the researcher			
Variable	N	Mean	Std Dev.	N	Mean	Std Dev.	t#
Customization	42	0.33	0.33	43	0.29	0.30	-0.51 (ns)
Interdependence	42	0.73	0.14	43	0.71	0.15	-0.44 (ns)
MAS Scope	42	24.71	4.52	43	25.86	5.16	1.09 (ns)
MAS Timeliness	42	28.95	5.26	43	29.05	4.84	0.09 (ns)
MAS Integration	42	28.33	7.55	43	28.09	7.66	-0.15 (ns)
MAS Aggregation	42	28.95	3.93	43	27.79	4.62	-1.25 (ns)

t test of significance of difference between means

Table 4.2: t test to check for response bias due to data collection mode (students/researcher)

A total of 112 organizations were approached. If it was not possible to establish contact the first time, three more attempts were made to talk to the business unit manager. After the business unit managers had agreed to participate, the other managers were contacted separately. This was done so that managers lower in the hierarchy would not feel obliged to participate, and potentially influence the results negatively. Confidentiality was guaranteed to all respondents. Interviews were only conducted if all respondents agreed to participate. The sample amounts to 85 observations comprising 255 business unit (production and sales) managers, and 33 controllers (to check for validity). The reasons by organizations for not participating (27), were as follows.

1. Time constraints (12 cases).
2. The business unit manager was not prepared to talk to the researcher (seven cases). Typically the secretary of those managers excused their boss because he was too busy.
3. Re-organization (three cases).
4. Impossible to fix a date because of time constraints (three cases).
5. Policy not to participate (two cases).

	Contacted	Four* managers interviewed	Three** managers interviewed	Business unit observations
Number	112	33	52	85
Percentage	100	29.5	46.4	75.9

* observations comprised of business unit, production, and sales manager, controller added to check for validity customization instrument.
** observations comprised of business unit, production and sales manager.

Table 4.3: Questionnaire returns for 85 business units in the sample

4.5 Conclusion

The study controls for differences across managerial levels, and type of decisions. This ensures that the results can be attributed to a distinct managerial level and decision. To measure customization, this study employed an adapted version of the instrument Pugh et al. (1969) introduced in the literature. Following Thompson's (1967) notions of 'pooled', 'sequential' and 'reciprocal' interdependence, the instrument developed by Van de Ven et al. (1976) to capture these three forms of interdependence was employed. MAS is measured by the instrument Chenhall and Morris (1986) introduced into the literature.
Data are collected via a closed interview using a survey questionnaire.
The respondents were typically sales department managers, production department managers (to measure interdependence and MAS use), business unit managers (to measure customization), and controllers (to check for reliability and validity) and amounted to 288 managers comprising 85 business unit observations. The interviews were conducted either by the researcher or by students. During the interview respondents were asked to refer to operational decisions so that the results could be attributed to that particular decision rather. No systematic bias exists between data collected by the researcher or the students.

There exists no prima facie expectation for organizations to differ in terms of the effect of customization and interdependence on MAS use, hence it was decided to include both manufacturing and service industries. However, three criteria were used so that the data obtained would be comparable. The first criterion was that production and sales activities were carried out in two separate departments. Secondly, each business unit was part of a firm comprised of more than three business units. Third, the business unit should employ at least 150 people.

The first criterion was set because of the nature of the study, which involves the use of MAS in functionally differentiated organizations. The second criterion and third criterion were invoked to ensure that the organizations included in the study would be sufficiently large to ensure that a MAS was put in place (Mia and Chenhall, 1994).

Chapter 5

Psychometric properties of measurement instruments

5.1 Introduction

This chapter discusses reliability and validity issues associated with the constructs of interest. The chapter is organized as follows. Section 5.2 describes ways of testing for reliability and validity, and the tests conducted in this study. Section 5.3 describes the results of the reliability and validity tests. Section 5.4 describes the measures and Section 5.5 draws conclusions on the findings on the instruments.

5.2 Reliability and validity of the instruments

5.2.1 Definitions

Reliability concerns the extent to which the variance of an observed variable is due to noise, or that the same variance will surface with repeated measurement, while validity is whether the measured construct is the one intended. As an illustration of the difference between reliability and validity, Brownell (1995) gives the example of the association between the number of school age children per household and the related construct number of children per household. One can contend that a positive and significant correlation between the two instruments provides evidence that school age children were measured correctly (reliably). This does not mean, however, that the construct 'children of a household' covers the construct 'school age children of a household' (validity), (i.e. whether the instrument used to measure the 'school age children of a household,' actually produces the right number of children that fall into this group). It is argued, therefore, that, while reliability and validity are to a large extent related, they both need to be tested (Brownell, 1995). In this chapter tests for reliability and validity are administered on the customization, interdependence, and MAS measurement instruments.

5.2.2 Reliability

There exist two methods to assess reliability (Abernethy, 1988): (1) determining whether the instrument produces consistent results on repeated measurements, and (2) determining if the items comprising the instrument produce consistent results.

The first approach was followed to assess the stability of the customization measure, and involved comparing business unit managers' with controllers' ratings on the customization instrument. Comparison of sales and production managers' ratings was used to assess the reliability of the interdependence instrument. This method was considered adequate because the repetition was made at one point in time. This overcomes the time bias argued to occur with the test-retest method (Runkel and McGrath, 1972). The second way of assessing reliability was to use factor analysis. This test can be used for assessing reliability and validity, provided the instrument is compiled of more than one item. Heise and Bohrnstedt (1971) suggested this approach, and the test was conducted for the MAS instrument. After the factor model was determined, Cronbach (1951) alpha coefficients were calculated to confirm the reliability of the instrument.

5.2.3 Validity

Bohrnstedt (1983) distinguishes theoretical from empirical validity, where the first is defined as "correlation between the underlying, latent construct and the observed measure", and the second as "the correlation between the observed measure and some other criterion."[1] Theoretical validity differs from empirical validity in that the former refers to whether the measurement instrument adequately captures the underlying construct, while the latter refers to whether the measurement instrument is associated with some other observed criterion. In other words, theoretical validity can be thought of as the correlation between the observed and the underlying (unobserved) construct, while empirical validity is the correlation between two observed constructs. The distinction between the two types of validity is considered useful as empirical validity refers to whether a construct is being measured with an instrument, while assessment of theoretical or construct validity refers to whether the measurement instrument captures the underlying construct.

5.2.4 Empirical validity

Empirical validity (or criterion related validity) refers to the correlation between the observed measure and some other observed criterion (Bohrnstedt, 1983). It can be tested by comparing the results obtained with the instrument with the results produced with another measure. This test requires that the similar measure is one that has already been validated. Such a measure does not exist for customization, and it is for that reason that empirical validation of the customization instrument was sought by assessing if respondents distinguish between

[1] It is argued that a third dimension of validity exists, content validity. However, Bohrnstedt (1983) considers assessment of content validity a necessary step for the assessment of theoretical validity, where content validity is defined as the extent to which the full domain of meanings that can be attached by different people to a phenomenon is captured by the measure. This view is followed in this research.

standardized and non-standardized products. 'Standardized product' is a common notion in business organizations and is considered to be the obverse of customization. As the first item of the customization instrument involves standardized products, a negative correlation with the three other items of the instrument would indicate that respondents distinguish between standardized and non-standardized products correctly, and that the items that compile the measure show concurrent validity.
From the literature it appears that alternative instruments exist to measure interdependence. Chenhall and Morris used a measure developed by Pugh et al. (1969), which is similar to the Van de Ven et al. (1976) measure. Abernethy (1988), used an instrument developed by Mohr (1971), which also captured the three dimensions of interdependence. However, it was decided not to perform such a test, as this would have required an extension of the questionnaire, and there were concerns that prospective respondents would restrain from participation in a more extensive questionnaire due to time constraints. For this reason it was decided to rely on the results of validity tests provided by Van de Ven et al. (1976), and Macintosh and Daft (1987) using the same measure. However, the instrument itself provides the possibility of assessing empirical validity by way of calculating whether managers distinguish between reciprocal/sequential interdependence and pooled interdependence. Again, negative correlations would suggest that managers are able to make the distinction between the notions.

The MAS measure has not been tested in the past for empirical validity because it is the first to capture MAS so comprehensively. As no similar MAS instrument exists to assess empirical validity, it is impossible to conduct a test for criterion related validity unless a related instrument was developed for this purpose. As this would require a vast extension of the questionnaire, this was not considered a viable option.

5.2.5 Theoretical validity

Theoretical validity (or construct validity) is an assessment of the relationship between the items that compile the measurement instrument, and the underlying (unobserved) construct. There is strong support for testing theoretical validity with a multitrait/multimethod approach (Bohrnstedt 1983; Brownell, 1995; Campbell, 1953 and 1956; Lawler III, 1967). It is argued that theoretical validity is supported if different methods are used to measure an underlying construct, and the different individuals attach equal meaning to the observed construct. Further support for validity is sought by contrasting the construct of interest with constructs that theoretically differ from the construct of interest. The application of the multimethod test on these different constructs should prompt respondents to agree about the difference between

the construct of interest and the other construct.[2]

The multitrait/multimethod approach consists of three related stages. The first stage, labelled as 'different traits/different raters', compares scores on one instrument (or trait), rated by one type of respondents (e.g. product standardization rated by business unit managers) with the rating of another type of respondents on an instrument measuring a related construct (e.g., customization rated by controllers of the same business unit). The second stage, labelled as 'different traits/single rater', is to compare one respondent's ratings on two related instruments (e.g., customization and product standardization rated by the business unit manager). The third stage, labelled as 'same trait/different raters,' compares the ratings of the different respondents on one instrument. For instance, ratings of business unit managers and controllers are compared on the trait 'standardized products'. The significance of the correlations of subsequent stages of the multitraits/multimethod test follow an ascending order (Brownell, 1995). Stage one tests whether respondents agree that constructs differ, while stage two tests whether the instrument of interest discriminates from a related construct from the point of view of one respondent (discriminant validity), and thus one expects relatively low correlations. In the last stage, which tests the relationship between two quite different measurement methods on a given trait (convergent validity), high correlations are expected.

This study used the multitrait/multimethod approach to validate the customization and the interdependence instruments. Two theoretically related instruments were developed to facilitate these tests. The distinction between the different traits (the four MAS dimensions of scope, aggregation, integration and timeliness) was assessed with factor analysis. The multimethod approach was also used to validate the MAS instrument. This was possible because the same questions on MAS use were administered to both production and sales managers.

5.3 Results of reliability and validity tests

5.3.1 Reliability

Customization

The reliability test for customization was carried out by splitting the sample into the two dimensions that comprised the instrument. The instrument was considered reliable if both business unit managers and controllers similarly discern standardized/mass customization

[2] Arguable, this approach also tests for empirical validity as different constructs are included to assess validity. However, as it is the main aim to test whether different respondents agree on the meaning of the construct it should be considered a test for theoretical rather than for empirical validity.

products (question 1a and 1b of the customization instrument in Appendix 4.1) from the items that were associated with tailored customization (question 1c and 1 d). The items 'a and b' were collapsed for the test and labelled as 'mass products', because they are opposite to (semi) tailored products (see Chapter 3). The hypothesis of the test is that business unit managers and controllers produce the same mean and variance on the two dimensions of the customization scale. This was carried out with a chi-square test, which calculates the maximum likelihood to test the goodness of fit of the parallel (items of the) model. The results are in Table 5.1.

	mass products (Q. 1a and 1b Appendix 4.1)	(semi) tailored products (Q. 1c and 1d Appendix 4.1)
chi square (probability), 2 df	3.43 (0.18)	4.80 (0.09)

Table 5.1: Reliability test customization items [business unit managers and controllers, N = 33]

From the test it appears that controllers and business unit managers to a large extent (probability 91 percent) agree about (semi) tailored customization. As this measure is used for the hypotheses tests, this is the most critical. Agreement about mass products is lower (82 percent). Given the fact that one cannot expect these two managers to perceive customization issues exactly the same, the instrument was considered sufficiently reliable for the purposes of this study.

Interdependence

A chi-squared test was administered to assess whether production managers and sales managers similarly rate pooled, sequential and reciprocal interdependence. The results of this test are in Table 5.2 (the instrument is in Appendix 4.2).

	Pooled interdependence (Appendix 4.2)	Sequential interdependence	Reciprocal interdependence
chi square (probability), 2 df	11.30 (0.00)	17.43 (0.00)	2.80 (0.25)

Table 5.2: Reliability test interdependence instrument [production and sales managers, N = 85]

The test gave high confidence levels for sequential and pooled interdependence. Reciprocal was the least. As the measure for the hypotheses tests is compiled of the sum of sequential and reciprocal interdependence, the probability of this measure is 99.65 percent (which is the

pooled interdependence result). The instrument was thus considered reliable. The results of the reliability test of the MAS instrument will be reported in the validity section.

5.3.2 Validity of the instruments

5.3.2.1 Customization

Empirical validity
Increased levels of customization should be associated with lower levels of standardization. It is inconceivable that completely standardized products are positively correlated with either semi-tailored or tailored customization. To test whether business unit managers consistently made this distinction, correlations were calculated between semi-tailored and tailored customization (Q. 1c and 1d of the customization instrument in Appendix 4.1), and 'mass products' (Q. 1a and 1b). The correlations (significance levels) are -0.67 (0.00) and -0.66 (0.00) for semi-tailored and tailored customization respectively. It appears that the instrument is able to adequately distinguish between the two dimensions, and thus the instrument was considered empirically valid.

Theoretical validity
The multitrait/multimethod approach was used on the items that comprised the customization instrument. The criteria used to evaluate the instrument were adopted from Lawler III (1967), and are as follows. Correlations of different traits (instruments) assessed by different raters should be the lowest. This association is referred to as DT/DR. Correlations between different traits assessed by a single rater should be higher than DT/DR. This association will be referred to as DT/SR. DT/SR, in turn should produce lower correlations than the associations of the same traits assessed by different raters, referred to as (ST/DR). In conclusion $r_{(DT/DR)} < r_{(DT/SR)} < r_{(ST/DR)}$. These tests are carried out to evaluate whether results acquired with one instrument discriminate from the results produced with an associated instrument. In the literature this is referred to as discriminate validity. If the test is met, this does not guarantee that the instrument is valid. This is accomplished in the convergent validity test, where it is judged whether the correlations between the same traits rated by different respondents are sufficient. There exists no absolute norm to evaluate convergent validity (Bohrnstedt, 1983). Following Lawler III (1967), Brownell (1995) considered that the data supported convergent validity if conventional levels of significance are met between the same traits, and correlations (significance) prove to be higher than the single rater/different traits test.

The following four customization-related items were developed to perform the multitrait test.

(a) we always use the same process;
(b) on each occasion the process is switched into a pre-specified mode;
(c) on each occasion the process is switched partly into a pre-specified mode and partly into a unique mode;
(d) a new process is designed for every product/service/client.

This instrument was measured with the same scale as the customization instrument, i.e. respondents were asked to attach a percentage to each of the four categories. This instrument is not the same as customization, because it captures the production process rather than the products actually delivered to the client. Yet, it is related to customization because it is expected that increased levels of customization result in more changes to the production process. The instrument is in Appendix 5.1.

To carry out the multitrait test, the correlations of interest are those that represent similar items. For instance, the items '1a products are completely standardized' (customization instrument) and '2a we always use the same process' (production standardization instrument) are considered similar, while '1a products are completely standardized' and '2d a new process is designed for every product/service/client' are dissimilar. Identical items are compared for the multimethod test. This chapter (see table 5.3) only reports correlations between similar (1a with 2 a, etc.) and identical items (1a controller, with 1a business unit manager). The tables in Appendix 5.2 (A5.1 to A5.6) present the correlations between all items of both instruments.

The different traits and different raters test compares correlations between items of the customization instrument with similar items of the production standardization instruments, rated by business unit managers (DT/DR I) and vice versa (DT/DR II). The different traits/single rater test compares correlations between customization and production standardization rated by business unit manager (DT/SR II) and controllers (DT/SR II). The same trait different raters test (ST/DR) compares business unit managers ratings on the 'customization' instrument with the ratings on the same instrument by controllers. It is expected that DT/DR is smaller than DT/SR, which in turn is expected to be smaller than ST/DR. Because 33 controllers participated, this test was conducted with only the matched set of business unit managers and controllers.

The results of the test of the customization instrument are as follows.

(1)	(2)	(3) Item a[1]	(4) Item b	(5) Item c	(6) Item d
(I)	Different traits/different rater I (DT/DR I) Customization instrument: Business unit manager, bu1a..d Production standardization instrument: controller, co2a..d	bu1a/co2a 0.01 (0.96)	bu1b/co2b -0.25 (0.17)	bu1c/co2c 0.01 (0.95)	bu1d/co2d 0.26 (0.14)
(II)	Different traits/different rater II (DT/DR II) Customization: controller, co 1a..d Production standardization: business unit manager, bu 2a..d	bu2a/co1a 0.18 (0.31)	bu2b/co1b 0.17 (0.33)	bu2c/co1c 0.37 (0.03)	bu2d/co2d 0.29 (0.10)
(III)	Different traits/single rater I (DT/SR I) Controller: Customization 1a..d/Production standardization 2a..d	co1a/co2a -0.13 (0.48)	co1b/co2b 0.07 (0.72)	co1c/co2c 0.10 (0.59)	co1d/co2d -0.08 (0.64)
(IV)	Different traits/single rater (DT/SR II) Business unit manager: Customization, 1a..d/Production standardization, 2a..d	bu1a/bu2a 0.43 (0.01)	bu1b/bu2b 0.12 (0.51)	bu1c/bu2c -0.08 (0.66)	bu1d/co2d 0.25 (0.16)
(V)	Same trait/different raters (ST/MR) Customization: Controllers 1a..d/BU manager 1a..d	bu1a/co1a 0.74 (0.00)	bu1b/co1b 0.52 (0.00)	bu1c/co1c 0.28 (0.12)	bu1d/co1d 0.66 (0.00)

[1] Questionnaire items:
Customization (instrument is in Appendix 4.1):
Item **1a**: standardized products, item **1b**: mass customization, item **1c**, semi-tailored product, item **1d**: tailored products

Production standardization (different trait, instrument is in Appendix 5.1):
Item **2a**: always use the same process, item **2b**: switching production to pre-specified mode, item **2c**: semi-unique mode, item **2d**: unique mode.

Table 5.3: Multirater/multitrait test for the validity of the customization instrument [N = 33]: Correlations/(significance levels) between items.

Discriminant validity

The relatively low correlations and significance levels presented in row (I), (II), and (IV) support the hypothesized distinction controllers and business unit managers make on the two traits of customization and product standardization (i.e. discriminate validity is supported by the data). While it was predicted that rows (III) and (IV) would show larger correlations than rows (I) and (II), there is not much difference between the size of the correlations. This result suggests that controllers and business unit managers discriminate between the traits quite similarly. However, controllers distinguish more explicitly between the two notions than business unit managers (DT/SR I, row III), as demonstrated by the almost zero correlation

between the two traits. More detailed inspection of this relationship (Table A5.2 and A5.4, Appendix 5.2) shows that controllers associate the trait 'standard products' (item 1a) with 'changing to pre-specified production process modes' (item 2b), and 'unique production process modes' (item 2d) with 'semi-tailored customization' (item 1c). This means that, the controller's view on production standardization has more in common with the business unit manager's view on customization, than with their own view on customization. This, however, has no bearing on the test for validity as this requires managers to make a distinction between the constructs. Because of the relative low correlations between the different traits of the instruments, and the relative absence of any correlation between the two constructs, it is concluded that the data support the expectation that the customization instrument is different from the production standardization instrument (i.e. the discriminate validity argument is supported by the data).

Convergent validity

The ST/MR test on customization (Table 5.3, Row V) confirms that the construct is interpreted in much the same way by business unit managers and controllers (i.e. the correlations are relatively high and significant for each item of the measurement instrument). The confirmation is particularly high at the two extremes (products completely standardized, Column 3 and products completely tailored, Column 6). The associations between managers are not as high on the middle categories and item c (column 5) is insignificant at conventional levels. However, the correlations are still high in terms of conventional standards (0.52 and 0.28), and they are much higher than the ones found in the different trait tests. Correlations were also calculated between the sum of the items 'a' and 'b' and the sum of item 'c' and 'd' to assess whether controllers and business unit managers agree on mass products versus customized products (the theory of Chapter 3 suggested items 'c' and 'd' are considered customization, while 'a' and 'b' are not). The results of this test are in Table 5.4.

	Mass products (sum of items a and b of the customization instrument)	Customization (sum of items c and d of the customization instrument)
Convergent validity controller and business unit manager	0.62 (0.00)	0.66 (0.00)

Table 5.4: Multimethod/same trait test for the validity of the customization instrument [N = 33]: Correlations/(significance levels) between items

The high correlations between the collapsed items confirm that controllers and business unit managers agree about customization on a more aggregated level. This evidence, together with the result that the average correlation of the same trait/different rater test was the highest

supports the construct validity of the customization instrument. It is concluded that the customization instrument is validated by the evidence presented in this sub-section.

5.3.2.2 Interdependence

Empirical validity

The theory suggests that increased levels of sequential and/or reciprocal interdependence requires pooled interdependence to decrease. It is thus inconceivable, that high levels of pooled interdependence will be positively correlated with high levels of sequential and or reciprocal interdependence. It is expected that the relationship will be negative. Empirical validation of the instrument is acquired if managers distinguish between the notions of pooled and sequential/reciprocal in a manner consistent with the theory. The correlations (significance levels) between pooled and sequential, and pooled and reciprocal are -0.80 (0.00) and -0.50 (0.00) respectively, providing support for the validity of the instrument.

Theoretical validity

To test for discriminant and convergent validity of the interdependence instrument, the answers on perceived interdependence of sales and production managers were compared.
An instrument adapted from Hayes (1975) was used to assess discriminate validity of the interdependence instrument. Production and sales managers were asked to indicate how much of the total ideas, suggestions, and other information in regard to the department's work, moved between production and sales, using the same figures as the ones used to visualize the workflows. This instrument is not the same as workflow, but rather a derivative of that: it is the direct communication between production and sales concerning the work. The measure is presented in Appendix 5.3.
Consistent with the test of the customization instrument, this sub-section only reports correlations between similar (different traits test) and identical (same trait test) items. Correlations are calculated for pooled, sequential and reciprocal interdependence. The main results of the tests are in Table 5.5. The tables in Appendix 5.4 (A5.7 to A5.12) present the correlations between all items of the instrument.

(1)	(2)	(3) Pooled	(4) Sequential	(5) Reciprocal
(I)	Different traits/different rater I Information: Sales manager (IS) Work: Production manager (WP)	IS/WP 0.61 (0.00)	IS/WP 0.31 (0.03)	IS/WP 0.17 (0.12)
(II)	Different traits/different rater II Information: Production manager (IP) Work: Sales manager (WS)	IP/WS 0.66 (0.00)	IP/WS 0.41 (0.00)	IP/WP 0.38 (0.01)
(III)	Different traits/single rater I Production manager, information (IP) and work (WP)	IP/WP 0.58 (0.00)	IP/WP 0.46 (0.00)	IP/WP 0.45 (0.00)
(IV)	Different traits/single rater II Sales manager, information (IS) and work (WS)	IS/WS 0.76 (0.00)	IS/WS 0.63 (0.00)	IS/WS 0.43 (0.01)
(V)	Same traits/ different rater I Workflows: Sales (WS)/production manager (WP)	WS/WP 0.63 (0.00)	WS/WP 0.41 (0.00)	WS/WP 0.34 (0.01)
(VI)	Same traits/ different rater II Information flows: Sales (IS)/Production manager (IP)	IS/IP 0.86 (0.01)	IS/IP 0.40 (0.00)	IS/IP 0.45 (0.01)

Table 5.5: Multi rater/multi trait test for the validity of the interdependence instrument [N = 85]: Correlations/(significance levels) between items

Discriminant validity

Theoretically it was expected that the correlations found in row (I) and (II) (Table 5.5) would be lower than the ones presented in rows (III) and (IV) because different raters were involved in the different rater/different traits test. Also it was expected that the correlations between the construct of work and communication would be relatively low. The differences between rows (I) and (II) are, compared to rows (III) and (IV) very small, and also the correlation of the constructs of communication and work are high, suggesting that the type of work flow and direct communication between departments are to a large extent associated. It is concluded, therefore, that the communication instrument did not provide the expected contrast to the workflow instrument.

Convergent validity

To pass this test, correlations between identical items should be higher than correlation between similar items, and the correlations should be significant. From the results presented

in Table 5.5 (compare row (V) with row (III) and (IV)), it is concluded that the correlations are about the same. It appears that the instrument developed to check for convergent validity (direct communication flows) performs best (compare row (VI) with row (III) and (IV)). This does not imply that this instrument should be used to test the hypotheses rather than the work measure of interdependence. The workflow instrument measures the state of interdependence associated with production of goods and services, while the communication flow instrument measures the direct exchange of information between departments. It is the former construct which is of interest in this study.

There are three arguments to support the validity of the workflow instrument. In the first place, the fact that the two instruments do not discriminate from each other, prompts a different expectation about the correlations of DT/SR versus ST/DR. If there exists only a minor difference between the instruments, one would expect the correlation between similar traits (e.g. correlation of pooled information and work flows) and identical traits (e.g. correlation of pooled work rated by production and sales managers) to be high. Table 5.5 shows that the correlations are relatively high. A second argument in support of validity is the distinction production and sales managers make in the notions of pooled and the combined measure of sequential and reciprocal interdependence. With the assessment of empirical validity, it has already been shown that production and sales managers have a concurrent view on how sequential/reciprocal differs from pooled interdependence. As the test of the hypotheses will be carried out with interdependence measured by the sum of the items sequential and reciprocal, it is important that production and sales managers make a similar distinction between pooled interdependence on the one hand and sequential/reciprocal on the other. A further test for convergent validity would be if correlations were calculated between the ratings of the two groups of managers on pooled and the combined measure of sequential/reciprocal interdependence. These correlation should be negative and significant. The results of this test are in Table 5.6., and it appears that production and sales managers agree to a very large extent about the distinction between pooled interdependence and the combined measure. Comparison with Row V of Table 5.5 suggests that while they do not agree totally on the type of interdependence (sequential or reciprocal), they do make the same distinction between levels of pooled interdependence and the combined measure of interdependence (sequential and reciprocal), the correlation is -0.63 in both cases.

	Production manager's assessment of pooled interdependence work flows	Sales manager's assessment of pooled interdependence work flow
Sales manager's assessment of sequential and reciprocal interdependence work flows	-0.63 (0.00)	
Production manager's assessment of sequential and reciprocal interdependence work flows		-0.63 (0.00)

Table 5.6: Multirater/multitrait test for the validity of the interdependence instrument [N = 85]: Correlations/(significance levels) between items

A third argument to support validity is in the use of the interdependence instrument in other studies. The instrument was validated by Van de Ven et al. (1976), who calculated high correlation and significance levels between the current instrument and Mohr's (1971) interdependence index. Subsequent use of the instrument gives further support for its validity (Macintosh and Daft, 1987).

In summary, it is concluded that the workflow instrument passed the validity test. In particular the high correlation between sales and production managers assessment of the construct provides support for the use of the measure.

5.3.2.3 Management Accounting Systems

Each MAS dimension (scope, integration, timeliness and aggregation) comprises of more than one item. Bohrnstedt (1983) argued that the examination of the reliability and the validity of such instruments can be carried out best with factor analysis, implying that reliability and validity are tested simultaneously. This approach was followed for this study. The data were factor analyzed jointly and separately for production and sales managers. The separate analysis was conducted to check for convergent validity of the MAS instrument.

Validity of the MAS instrument

The 22-item measure that comprises the MAS instrument is theoretically associated with the four different dimensions of MAS. There is some suggestion in the literature, however, that types of managers may differ in the attribution of items. However, the instrument was originally developed so that it applied universally, that is, it was expected that respondents would attribute the same items to the same dimensions (traits) in any setting. In the case of this study two quite different managers were asked to rate the importance of MAS. If the

dimensions are universal, production and sales managers are expected to attribute identical items to MAS dimensions.
The validity test assessed the extent to which this occurs. It was carried out in two distinct steps. First, an initial varimax rotated factor analysis was run which included all MAS items for the two groups of managers separately. The factor structure of the two groups produced six rather than the expected four factors. However, the dimension of timeliness appeared in the initial solution identically for both production and sales managers, and so did the dimension integration and scope except for one item, 11 and 6B respectively. Production and sales managers disagreed about the items that comprised the dimension of aggregation. As loadings on a different factor suggest that the items are interpreted differently by production and sales managers, it was decided to remove all these items from the sample. This treatment reduced the number of items of the instrument from 22 to 15, and produced four factors, confirming an unidimensional solution. The result of the procedure was that a shift took place for one item. Question 7, precise targets, attributed to integration in the Chenhall and Morris study was related to the aggregation dimension in this study. From a theoretical point of view this shift can be justified, because question 7 refers to departmental rather than to interdepartmental goals. Chenhall and Morris excluded Question 14b (summary reports, which is considered an aggregation item), from the sample. This question appears as an integration item in this study. The 'shift' from the aggregation item 14b to integration can be justified as the question pertains to the effect actions have on the organization (i.e. the information facilitates integration between functional units). The fact that these reports are summaries (aggregations) does not stop managers considering them to be primarily integrated.

Subsequently, it was investigated whether production and sales managers considered each of the removed items unidimensional on one of the four factors. This procedure was followed because some of the removed items might load on one of the four MAS dimensions as well as on the two unexpected factors that were found in the initial solution. This was carried out by adding each of the initially removed items separately to the four factor solution. This procedure was followed for each item separately, resulting in supplementing one aggregation item. Then this procedure was repeated for the 16 item solution, but no items could be added to the solution. Eventually the analysis of the MAS measure resulted in the removal of 6 of the 22 original items. Two removed items (6a and 6b of the questionnaire in Appendix 4.3) were theoretically attributed to scope, four to aggregation (4, 5, 9, 11).

The adjustments to the MAS measure in this study is somewhat supported by a comparisons of the factor structure provided in the Chenhall and Morris study (1986), and the factor structure used here. Table 5.7 compares the two sets of results and provides some insights as to why respondents attribute items differently. Inspection of that table suggests that four out of the six excluded [EX] items produced relatively low factor scores in Chenhall and

Morris's study (< 0.5), suggesting that these items were only marginally related to the factor.

As a final test for convergent validity and construct validity, a factor analysis was run on the 16-item measure for the whole sample comprising the 170 production and sales managers simultaneously. The total percentage of variance explained in the model amounts to 61.6 percent (production managers), 63 percent (sales managers), and 61 percent (total level).

Factor	I			II			III			IV		
	CM	PM	SM	CM	PM	SM	CM	PM	SM	CM	PM	SM
I. Scope												
external information (19)[@]	**0.74**[a]	**0.77**	**0.82**	0.11	0.01	0.14	-0.04	0.04	0.14	-0.06	0.03	-0.10
noneconomic information (20)	**0.59**	**0.75**	**0.82**	-0.09	0.15	0.08	0.08	0.02	0.17	0.13	-0.03	0.19
future-oriented (1)	**0.47**	**0.69**	**0.51**	-0.03	0.20	-0.01	0.11	0.22	0.16	-0.07	0.08	0.16
non-financial market (6b)	**0.44**	**EX**	**EX**	-0.13	EX	EX	0.16	EX	EX	0.04	EX	EX
probabilistic (18)	**0.42**	**0.64**	**0.75**	0.02	-0.20	0.20	0.39	0.07	-0.01	0.05	0.33	0.04
non-financial production (6a)	**0.40**	**EX**	**EX**	-0.09	EX	EX	0.21	EX	EX	0.07	EX	EX
II. Timeliness												
speed of reporting (2)	-0.07	0.04	0.19	**0.79**	**0.79**	**0.63**	0.04	-0.01	0.16	0.09	0.11	0.13
frequency of reporting (16)	0.04	-0.05	-0.09	**0.71**	**0.77**	**0.77**	0.10	0.05	-0.08	0.05	0.14	0.01
automatic receipt (8)	-0.02	0.04	0.06	**0.47**	**0.78**	**0.80**	0.06	0.15	0.08	-0.03	0.17	0.20
immediate reporting (10)	-0.12	0.25	0.26	**0.32**	**0.67**	**0.71**	0.15	0.23	-0.13	0.02	0.27	0.33
III. Aggregation												
separate fixed/variable costs (9)	-0.06	EX	EX	0.01	EX	EX	**0.89**	**EX**	**EX**	-0.09	EX	EX
summary reports (14a)	0.09	-0.01	0.27	-0.05	0.03	-0.13	**0.71**	**0.87**	**0.72**	0.29	-0.07	0.13
sectional reports (11)	0.05	EX	EX	-0.03	EX	EX	**0.62**	**EX**	**EX**	0.36	EX	EX
temporal reports (12)	0.07	0.02	0.27	0.12	-0.00	-0.02	**0.58**	**0.87**	**0.83**	-0.02	0.02	-0.02
decision models (15)	0.14	0.21	-0.05	0.06	0.14	0.18	**0.53**	**0.48**	**0.43**	-0.08	0.21	0.23
what-if statements (4)	0.17	EX	EX	0.02	EX	EX	**0.49**	**EX**	**EX**	-0.05	EX	EX
effect of events on functions (5)	0.11	EX	EX	0.09	EX	EX	0.36	**EX**	**EX**	0.31	EX	EX
summary reports-organization (14b)	0.09	0.02	0.12	0.02	-0.08	0.04	0.21	0.41	0.11	0.31	**0.67**	**0.85**
IV. Integration												
precise targets (7)	-0.09	0.20	0.05	0.07	0.25	0.03	0.17	**0.53**	**0.79**	**0.71**	0.13	-0.06
organizational effects (17)	0.04	0.13	0.06	0.01	0.40	0.34	0.09	-0.03	0.03	**0.53**	**0.72**	**0.75**
inter-unit interaction (13)	0.11	0.13	0.13	0.03	0.41	0.33	0.31	0.15	-0.02	**0.44**	**0.72**	**0.80**
cost/price information other department (3)[f]	na	0.04	0.03	na	0.22	0.03	na	-0.10	0.10	na	**0.80**	**0.84**
Percentage of variance	37.82	8.60	10.9	17.71	28.7	16.2	15.7	11.0	8.4	7.31	13.3	27.5

[@] numbers in parentheses refer to Appendix 4.3; [f] question 3 added compared to the original study; [a] Bold prints refer to the dimension the item belongs to according to results.

Table 5.7: Comparison factor loadings MAS dimensions Chenhall and Morris, 1986 (CM), production managers (PM) and sales managers (SM)

Reliability

To check for the reliability of each of the dimensions of the MAS instrument, a Cronbach (1951) alpha coefficient was computed. The results are presented in Table 5.8. The relatively low alpha's on the aggregation dimension are consistent with the factor analysis that produced relatively large distances (low factor scores) between the items that comprise the instrument. However, the alpha coefficients for each dimension are all at a level considered acceptable (Nunally, 1967).

	CM (n=68)	PM (n=85)	SM (n=85)	Total level (n=170)
Scope	0.76	0.71	0.73	0.75
Timeliness	0.71	0.80	0.76	0.78
Aggregation	0.81	0.69	0.66	0.68
Integration	0.73	0.79	0.86	0.82

Table 5.8: Comparison of Cronbach alpha coefficients for the MAS dimensions between the Chenhall and Morris (1986) study [CM], the current study's production managers [PM], sales managers [SM], and the aggregate of production and sales managers

5.4 Summary of measures used in the analytical model

The results presented above provide confidence in the psychometric properties of each of the measures employed in the study. The measures' descriptive statistics are presented below, as well as a test on the measures' properties relating to the analytical models that are used to test the hypotheses.

Customization

The customization measure consists of the items 'c' and 'd' of the questionnaire (Appendix 4.1):

product/services are:

c. basic models which are customized according to client's specifications;

d. are completely customized). The two categories were labelled in this chapter as semi-tailored and tailored customization. The ratings on the categories 'c' and 'd' were summed. Weighing the categories was not considered, because any choice would be arbitrary (Van de Ven et al. 1976).

Interdependence

The measure of interdependence is compiled by summing the ratings associated with sequential and reciprocal workflows. Both types of interdependence are weighted equally, which is consistent with the treatment of the measure in either Chenhall and Morris (1986), and Macintosh and Daft (1987).

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The items comprising the four MAS dimensions are in Table 5.9.

1. Scope * external information (19) * noneconomic information (20) * future-oriented (1) * probabilistic (18)	**2. Integration** * organizational effects (17) * inter-unit interaction (13) * cost/price information other department (3) * summary reports-organization (14b)
3. Aggregation * summary reports (14a) * temporal reports (12) * Decision models (15) * precise targets (7)	**4. Timeliness** * speed of reporting (2) * frequency of reporting (16) * automatic receipt (8) * immediate reporting (10)

Table 5.9: Items comprising the MAS dimensions: scope, timeliness, aggregation, and integration (question numbers used in the original instrument are in parenthesis, Appendix 4.3 provides a complete list of the items in the instrument)

The measures of the MAS dimension to test the hypotheses are comprised of the original scores, and are unweighted. Weighing by factor scores was considered, as they give the projection of the location of items in the common factor space. However, as the common factor model produces estimated rather than calculated factor scores, these scores are nonunique, and it is questionable whether using these scores as a weight produces suitable measures for subsequent secondary analysis (Dillon and Goldstein, 1984).

Descriptive statistics and correlations between the independent variables

The descriptive statistics of the measures are in Table 5.10.

	Mean	Std Dev.	Possible range Min	Possible range Max	Observed range Min	Observed range Max
Customization (item c and d)	0.31	0.32	0.00	1.00	0.00	1.00
Interdependence work production manager	0.74	0.17	0.00	1.00	0.38	0.94
Interdependence work sales manager	0.69	0.15	0.00	1.00	0.38	0.92
MAS scope production manager	11.41	3.33	4	20	4	20
MAS scope sales manager	13.88	3.21	4	20	4	20
MAS timeliness production manager	14.35	3.17	4	20	6	20
MAS timeliness sales manager	14.65	2.95	4	20	7	20
MAS aggregation production manager	13.89	3.00	4	20	4	20
MAS aggregation sales manager	14.47	2.69	4	20	8	20
MAS integration production manager	14.11	3.78	4	20	5	20
MAS integration sales manager	14.53	3.60	4	20	5	20

Table 5.10: Descriptive statistics of the customization, interdependence and MAS measures

The hypotheses tests will be conducted with a structural equation model. Such a model assumes correlations between independent variables (i.e. customization and interdependence). However, as the hypotheses tests relating to MAS use were executed with a multiple regression model, diagnoses of the data were performed to assess if there are any violations in the assumptions required for the use of such models. One issue of concern is multicollinearity. Multicollinearity is defined as "a condition of high or near perfect correlation among the independent variables in a multiple regression equation" (Bohrnstedt et al, 1988). The problem of multicollinearity surfaces in the standard error of regression coefficients. Mansfield (1983, p. 488) contends that multicollinearity is a problem if correlation coefficients of independent variables are close to 1 (or -1).

The correlation matrix is in Table 5.11.

	Interdependence workflows production managers N=85	Interdependence workflows sales managers N=85	Interdependence workflows All managers N=170
Customization	0.32 (0.00)	0.38 (0.00)	0.35 (0.00)

Table 5.11: Correlations (significance) of independent variables

Given that correlations are well below unity, multicollinearity is not considered to be a problem for the analysis. The positive and significant correlation between the independent variables is consistent with the theory developed in Chapter 3. A second issue of concern is normality of the data. To address this issue standardized residuals for each multiple regression model were plotted as histograms. The residuals approximated a normal curve, and showed no visual evidence of skewness, multiple modes, or heavy-tailed distributions. A second test was performed on the observed against the expected standardized residuals for each model. Plots of this test showed for all models that the observed cumulative probability approximated the expected cumulative probability closely. Finally, a scatterplot was made for each model featuring residuals against the corresponding fitted values. These plots did not raise concerns about linearity or changing spread, as residuals were equally distributed over and under the fitted values, approximating equal widths.

On the evidence of these procedures it was accepted that the assumptions of multiple linear regression methodology were satisfied by the data, allowing the hypothesis to be tested with linear models.[3]

5.5 Conclusion

This chapter provides evidence of the psychometric properties of the customization, interdependence and MAS instruments. The chosen constructs were investigated on their reliability and validity. The reliability of the customization instrument was assessed by comparing means and variances which business unit managers and controllers make between mass products and customized products. The interdependence instrument was tested by comparing production and sales managers' opinions on interdependence. Both tests produced stable results, and it is concluded that both instruments are reliable.

The validity of customization and interdependence was assessed in two ways. First, a test was conducted to assess empirical validity and subsequently construct validity was assessed using a multitrait/multimethod approach. The empirical validity test of customization was carried out with the calculation of correlation coefficients of mass products items with customization items of the instrument. The empirical validity test for interdependence correlated pooled with sequential interdependence and pooled with reciprocal interdependence, rated by each manager. The construct validity tests were conducted with instruments specifically designed for this test. 'Customization' was contrasted with 'production standardization,' and 'interdependence of workflows' with 'direct communication' between production and sales. The customization instrument passed the test in that the correlations

[3] Plots of each test can be acquired from the author.

between the instrument's items in the subsequent tests (different traits/different raters; different traits/same rater; same traits/different raters) followed the required ascending order. This indicated that managers distinguished between customization and the related construct production standardization, and that the managers agree on the meaning of customization.

The results of the different trait tests were inconclusive for interdependence, in that production and sales managers made no significant distinction between the workflow and the communication construct. However, as Van de Ven et al. (1976) validated the instrument by comparing its result to Mohr's (1971) index, it cannot be concluded that the instrument is not valid, but rather that the 'communication instrument' does not provide the required contrast to discriminate it from workflows. As the discriminate (multitraits) test was not met, the norm to pass the convergent validity test was reset, because, if the 'communication between departments' only discriminates from 'workflows' to a limited extent, the results of the multimethod test should produce about the same results as the multitrait test. This norm was satisfied by the data. A subsequent test confirmed that managers distinguish between pooled and other forms of interdependence. From these results, the conclusion is drawn that the instrument to measure workflow interdependence is sufficiently valid for hypotheses testing.

The validity and the reliability test for the MAS instrument was carried out with factor analysis. However, this test was carried out in a rather unconventional mode in that factor models derived from production and sales managers' ratings were compared. The four factors identified by Chenhall and Morris (1986) surfaced only after six items of the 21 had been removed. The eventual factor model consists of 16 items, four for each dimension (one item was added to the instrument by the researcher). As a final test, the reliability of each of the four dimensions was assessed by calculating Cronbach alpha coefficients. According to Nunnally's norms (1967) each dimension of the MAS instrument passed this test.

The descriptive statistics of the measures show a sufficient spread over the ranges that were set in the questionnaire. This indicates that managers indeed rated the constructs differently, which is an important feature for subsequent analysis of the data. Interdependence between the independent variables is not expected to cause multicollinearity, as correlations are relatively low. Additional tests were conducted to assess whether requirements of normal distribution and linearity were met allowing multiple regression analyses. These tests did not raise concern about the appropriateness of the data to conduct multivariate analysis with ordinary least squares (OLS).

Chapter 6

Results of the hypotheses tests

6.1 Introduction

The hypotheses to be tested in this investigation involve the explanatory variables of customization and interdependence. The dependent variable is the use of MAS by production and sales managers. The theory supporting the hypotheses is in Chapter 3. This chapter discusses how the hypotheses are tested, and the results of the actual tests. The chapter is organized as follows. Section 6.2 presents the structural model and equations derived from the theoretical model. Section 6.3 discusses the results of the tests, followed by a summary of the findings.

6.2 The design of the tests

6.2.1 Introduction

The following hypotheses are to be tested.

Hypothesis 1
There is a positive effect of customization on interdependence.

Hypothesis 2
There is a positive direct relationship between interdependence and the MAS dimensions of (i) scope, (ii) integration, (iii) aggregation and (iv) timeliness.

Hypothesis 3a
There is a positive direct relationship between customization and the MAS dimensions of (i) scope, (ii) aggregation and (iii) timeliness.

Hypothesis 3b
There is no direct relationship between customization and the integrated MAS dimension.

Hypothesis 3c
There is a positive indirect relationship between customization and the MAS dimensions of

(i) scope, (ii) integration, (iii) aggregation and (iv) timeliness, acting through interdependence.

Hypotheses 2, 3a and 3c will be tested for each separate dimension of MAS.

Statistical tests are used to determine the significance of associations. The term 'significance' must be interpreted cautiously. The convention in the empirical MAS literature is that hypotheses are stated positively. The null hypothesis for each of the above hypotheses, except for 3b, is that there is no relationship. That implies that the null hypothesis is implicitly tested. This test calculates the probability of an association differing from zero. Tests are carried out using the standard 5 percent level of significance.

6.2.2 The path model

Hypothesis 1 can be tested with the calculation of the simple correlation between customization and interdependence. A significant correlation supports the hypothesis. However, as it is hypothesized that customization will partly affect MAS use through interdependence in Hypothesis 3a and 3b, it is not sufficient to determine simple correlations between customization and MAS use to test Hypotheses 2 and 3. These correlations need to be further analyzed by way of decomposing the direct from the indirect effect of customization on MAS use. Such an analysis is known in the literature as path analysis. This analysis uses a system of structural equations to model the relationships between the variables. Path analysis can be used to decompose an observed relationship between two variables in terms of simple correlations (in this case customization and MAS use) into two components: (a) that attributable to paths acting through an intervening variable (in this case interdependence of production and sales departments), (b) that representing the direct relationship (i.e. customization and MAS).

Path models are causal models. They analyze correlations in a hypothesized causal system. However, it should be emphasized that the paths obtained from the analysis, do not prove the existence of a causal relationship. Cause and effect relationships are derived from theory, not from statistics. Sir Ronald Fisher (1946) conveyed this argument as follows:

> "If .. we choose a group of social phenomena with no antecedent knowledge of the causation or absence of causation among them, then the calculation of correlation coefficients, total or partial, will not advance us a step toward evaluating the importance of the causes at work."

Figure 6.1 illustrates the theoretical relationships among the variables.

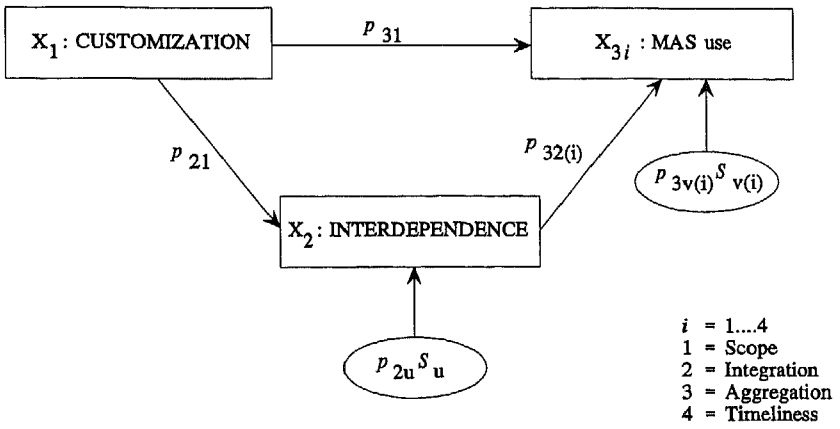

Figure 6.1: The research framework

Equations and solution of the structural path model

The equations of the structural path model are written as:

$$X_2 = p_{21}X_1 + p_{2u}S_u \quad (1)$$

$$X_{3(i)} = p_{31(i)}X_1 + p_{32(i)}X_2 + p_{3v(i)}S_{v(i)} \quad (2)$$

where,

X_1 = Customization

X_2 = Interdependence

$X_{3(i)}$ = MAS

p_{fg} = path coefficients explanatory variables (p_{21}, p_{31}, and $p_{32(i)}$)

p_{2u} and $p_{3v(i)}$ = path coefficients unexplained variance

and i = 1..4;

1 = Scope

2 = Integration

3 = Aggregation

4 = Timeliness

S_u and S_v = Error variables

The path coefficients in the model are denoted as p_{fg}. Path coefficients of the residuals in the equations are represented by p_{2u} (the relationship customization/interdependence) and by $p_{3v(i)}$ (the relationship customization/interdependence/MAS use). The path coefficients are computed as follows. The path coefficient of the relationship customization/interdependence is determined by regressing X_2 on X_1. This suffices when a variable is dependent on a single

independent variable and residual, which is the case for X_2, as it is assumed in the model that only customization (X_1) determines interdependence. Path coefficients of $p_{31(i)}$ and $p_{32(i)}$ are calculated by regressing $X_{3(i)}$ on X_1 and X_2 contemporaneously. If, as assumed here, residuals of the explanatory variables X_2 and $X_{3(i)}$ are uncorrelated, and all variables (including S_u $S_{v(i)}$) are standardized, then the path coefficients can be estimated using an ordinary least square procedure (Brownell and McInnes, 1986). The calculated betas (regression coefficients) are in this case equal to the path coefficients.

The structural equation system can be used to test the "fit" of the model in terms of the variance explained (Dillon and Goldstein, 1984). While earlier MAS studies (e.g. Brownell and McInnes, 1986; Chenhall and Brownell, 1988) reported only the variance explained on the dependent variable with equation (2), this study reports the total variance explained by the system of structural equations (1) and (2). This was considered important as the "fit" of the data is sought with reference to the whole system of equations [i.e. equations (1) and (2)] rather than to the "fit" of only a part of the system [i.e. equation (2)]. The total variance explained can be obtained as follows. If the endogenous variable's variance explained is denoted as R_1^2 to R_s^2, then the variance explained by the full model (1) and (2) is written as follows:

$$R_{m(i)}^2 = 1 - (1-R_1^2)(1-R_{2(i)}^2)\ldots(1-R_{s(i)}^2) \quad (3)$$

$R_{m(i)}^2$ = sum of the variance explained by the full model (m) for each (i)
where i = 1..4;
1 = Scope
2 = Integration
3 = Aggregation
4 = Timeliness

As the current model only contains two variables, equation three can be rewritten as:

$$R_{m(i)}^2 = 1 - (1-R_1^2)(1-R_{2(i)}^2) \quad (4)$$

R_1^2 and $R_{2(i)}^2$ are the explained variance of X_2 and each of the four $X_{3(i)}$, hence $R_{m(i)}^2$ can be written as:

$$R_1^2 = p_{21}^2, \text{ and} \quad (4a)$$

$$R_{2(i)}^2 = p_{31(i)}^2 + p_{32(i)}^2 + 2p_{31(i)}\, p_{32(i)}\, p_{21} \quad (4b)$$

$$R_{m(i)}^2 = (R_1^2) + (R_{2(i)}^2) - (R_1^2)*(R_{2(i)}^2) \quad (4c)$$

The residual path coefficients in the model can be written as:

$$p_{2u} = [1-R_1^2]^{1/2} \quad (5)$$

$$p_{3v(i)} = [1-R_{2(i)}^2]^{1/2} \quad (6)$$

Second, by using the calculated path and correlation coefficients, the total effect of one variable on the other variable of the model can be decomposed into direct and indirect effects. If r_{fg} represent correlation coefficients, the current model can be analyzed as follows:

$$r_{12} = p_{21} \quad (7)$$

$$r_{13(i)} = p_{31(i)} + p_{32(i)}p_{21} \quad (8)$$

$$r_{23(i)} = p_{32(i)} + p_{31(i)}p_{21} \quad (9)$$

In the model, the second term on the right hand side of equations (8) and (9) captures the indirect and the spurious effects[1], while the first term captures the direct effect of X_1, and X_2 on $X_{3(i)}$.

Hypothesis 1 to 3c are supported by the data if for each of the four dimensions the following results can be produced:

Hypothesis 1: if r_{12} is significantly greater than zero;
Hypothesis 2: if $p_{32(i)}$ is significantly greater than zero for all four MAS dimensions;
Hypothesis 3a: if $p_{31(i)}$ is significantly greater than zero for the MAS dimensions of (i) scope, (ii) aggregation and (iii) timeliness;
Hypotheses 3b: if $p_{31(2)}$ is not significantly different from zero;
Hypotheses 3c: if hypotheses 1 and 2 are supported for the MAS dimensions of (i) scope, (ii) integration, (iii) aggregation and (iv) timeliness.

Significance
The significance of a variable in the model is tested by the ability of the parsimonious model to reproduce the original correlation matrix **R**. The original model given in the equations (1) and (2) is called a 'just identified' model. This means that the number of equations is equal to the number of parameters to be estimated. In terms of the variance explained, the relationship between the parsimonious ($R_{p(i)}^2$) and the just identified model ($R_{m(i)}^2$) can be established as follows:

[1] Spurious effects pertain to the effects of common antecedent variables on the correlation between two other variables, (i.e. customization is an antecedent for both interdependence and MAS) (Dillon and Goldstein, 1984).

$$0 \leq R_{p(i)}^2 \leq R_{m(i)}^2 \quad (10)$$

where i = 1..4;
1 = Scope
2 = Integration
3 = Aggregation
4 = Timeliness

It follows from equation (10) that $R_{p(i)}^2$ equals $R_{m(i)}^2$ whenever the parsimonious model exactly reproduces the just identified model (Dillon and Goldstein, 1984). When paths are fixed at value zero (considered non-existent) resulting in a significant difference between $R_{p(i)}^2$ and $R_{m(i)}^2$, it means that the excluded path(s) do have explanatory power. Fixing insignificant paths does not imply that the independent variable is unrelated to dependent variables in the system of structural equations, but rather in that particular relation of the system. In other words, it is necessary to determine whether variables are statistically significant in the system of structural equations. An index of fit can be formed that compares the fit of the full model ($R_{m(i)}^2$) with the result of the parsimonious model ($R_{p(i)}^2$).

$$Q_{(i)} = [1-R_{m(i)}^2]/[1-R_{p(i)}^2] \quad (11)$$

where,
$Q_{(i)}$ = index of fit

The significance of the paths can be tested with a Wald test for the independent variables (Dillon and Goldstein, 1984; Hodap, 1984; Specht, 1975). Tests related to the Wald test are the well known F and t tests. While the t test produces the square result of an F test carried out with one variable, the Wald test is an asymptotic version of the F test, used when the distribution of the error terms is unknown. The argument for using a Wald test rather than the t or F test is in its formulation. The Wald test ascertains the significance of paths in the system of equations, rather than the significance of relationships within the individual equations of the system. In other words, the t test investigates the local level significance of variables, while with the Wald test it is ascertained whether a significant path exists on the global level. For large samples, the Wald test follows a chi-squared distribution (Specht, 1975, Dillon and Goldstein, 1984). The test compares the original model with a parsimonious model that exclude the linkages through a variable.

$$W_{(i)} = -(N - d)\ln Q_{(i)} \quad (12)$$

where,
N = sample size
d = number of excluded paths compared to the just identified model.

The interpretation of the probability produced with the Wald statistic is equal to that of a t statistic. A 5 percent level of significance suggests that with a probability of 5 percent the sample evidence of the population (calculated beta) could have arisen from random sampling. With the caesura set at the 5 percent level, the existence of paths are assumed to be supported by the data if significance levels are calculated at or under 5 percent. When a path that exceeds the critical value has been removed, the model will not fit the data, and thus will reproduce **R** imperfectly. The current model comprises three paths: customization/MAS, - customization/interdependence, and interdependence/MAS. A parsimonious model, for example, might exclude the path (or direct relationship) customization/MAS ($p_{31(i)}$). However, if the data support such a removal it does not imply that the variable of customization is unrelated to MAS, for that would require both the paths customization/interdependence/MAS ($p_{32(i)}|p_{21}$) and customization/MAS ($p_{31(i)}$) to be insignificant. It should be emphasized here that the chi-squared tests have received considerable critique (see Godfroy, 1991). The argument against the test is that it unjustly rejects true relationships (Evans and Savin, 1982; Breusch, 1979). Following Breusch (1979), this study will carry out a Monte Carlo simulation to ascertain the risk of rejecting true relationships.

6.3 The test of the hypotheses

6.3.1 Introduction

This subsection is organized as follows. The first hypothesis is tested with the calculation of the simple correlation between customization and interdependence. Then it will be tested whether production and sales managers perceive interdependence differently from each other in relation to customization. This test was conducted because there is some evidence in the literature to suggest that they differ (Hayes, 1975 and Mia and Chenhall, 1994). Differences in perceived interdependence may partly explain MAS use differences among production and sales managers. This test is conducted by comparing the F-statistics of 'just identified' models against parsimonious models. The data are also tested to determine if production and sales managers differ in MAS use.

Path analysis is then used to test whether hypotheses 2 to 3c are supported by the data. These tests are conducted by regressing the four MAS dimensions on customization and interdependence. To illustrate the findings in regard to hypotheses 2 to 3c, the effects of customization and interdependence on MAS will be decomposed into the direct and the indirect relationship of customization and MAS, and the direct and the spurious effects of interdependence on the use of MAS.

6.3.2 The relationship between customization and interdependence

The relationship customization/interdependence is tested using simple correlations. Three correlations are of interest: customization and interdependence perceived by all managers, customization and interdependence perceived by production managers, and customization and interdependence perceived by sales managers. The latter two are of interest as production and sales managers might have different perceptions as to how customization affects interdependence (Mia and Chenhall, 1994). The correlations are calculated between the business unit manager's rating of customization and the corresponding subunit manager's perception of interdependence. The correlations are presented in Table 6.1.

	PM (n=85)	SM (n=85)	Total level (n=170)
Customization/interdependence	0.32	0.38	0.35
Significance	(0.00)	(0.00)	(0.00)

Table 6.1: Correlations (significance levels) between customization and interdependence perceived by production managers [PM], sales managers [SM], and the aggregate of production and sales managers.

The evidence presented in Table 6.1, supports Hypothesis 1 in that customization does affect interdependence positively.

6.3.3 The effect of type of managers on the results

The management accounting literature provides some evidence that production and sales managers have different opinions as to how they use MAS (Hayes, 1977; Mia and Chenhall, 1994). The causes of these differences might be due to systematic differences in the effect of customization on interdependence as perceived by sales managers compared to production managers. In the light of these prior studies, it was considered important to investigate whether systematic differences on perceived interdependence between production and sales managers exist due to interaction between customization and 'type of manager.' These difference are tested with the help of the fourth variable X_4, labelled as 'type of manager.'

The test for differences between production and sales was performed comparing two models, one that considers production or sales manager to have the same perception on customization affecting interdependence and one which assumes that the perceptions differ. The second

model assumes an interaction between customization and 'type of manager.' The test involves a comparison between a model that assumes an interaction between 'type of managers' and customization (just identified model), and a (parsimonious) model that does not assume such an interaction. It is important to assess the significance of the interaction term as this will indicate that uniform levels of customization will engender significantly different levels of interdependence for different types of managers. This, in turn, may prompt differences in MAS use for different 'types of managers.' If the just identified model produces significantly less error than the parsimonious model, interaction exists. If X_4 in equation (13) and (14) below represents the type of manager (1 = production manager, 0 = sales manager), the non-interaction (13) and interaction models (14), can be written as follows:

$$X_2 = a + \beta_{21}X_1 + \beta_{24}X_4 + \epsilon \quad (13)$$

$$X_2 = a' + \beta'_{21}X_1 + \beta'_{24}X_4 + \beta_{25}X_4{*}X_1 + \epsilon' \quad (14)$$

Equation (13) represents the general effect of 'type of manager' on interdependence. That is, in comparison with equation (1) it captures how much more variance is explained when the model is extended with variable 'type of manager.' Equation (14) specifically models the effect of the interaction between customization (X_1) and type of manager (X_4) . Equation (14) is the 'just identified model', while equation (13) is a 'parsimonious model.' When there is no interaction, β_{25} will turn out to be insignificant (while a', β_{21}, β'_{24} will be nearly equal to a, β_{21}, β_{24}). The following F-test can be constructed to test whether a significant interaction exists (j = just identified, p = parsimonious models):

$$F = (SSE_p - SSE_j)2^{-1}/MSE_j \quad (15)$$

The statistical test of the interaction hypothesis has a F distribution with r and $(n\text{-}k)$ degrees of freedom, where r, n, k represent the number of restrictions, observations and variables. If the null hypothesis holds, the F statistic follows an F distribution.

It would not suffice to compare (13) with (1) or (14) with (1), because the first comparison would only capture the variance explained by the 'type of manager', and not its relationship to customization in particular. The second comparison would compare a 'just identified' model with a parsimonious model that assumes that there is no relationship of 'type of manager' to interdependence at all. By excluding the relationship 'type of manager' in general, significant results on the comparison of equation (13) and (1) would only justify the conclusion that 'type of manager' matters, not that it matters in relation to the variable of customization.

	Interdependence
R^2_j just identified model	0.15
R^2_p parsimonious model	0.15
$F_{2,164}$ statistic	0.00#
Significance p=0 <##	0.99

Calculated with equation (15)

probability that the association equals zero

Table 6.2: Comparison of the interaction and non-interaction of customization and 'type of manager' in relation to interdependence

The result of the F test support the hypothesis of no interaction between customization and 'type of manager.' In other words, customization affects perceived interdependence for both production and sales managers similarly.

6.3.4 The effect of type of managers on MAS use

Subsection 6.3.3 tested whether customization interacts with 'type of manager' such that a significant difference in perceived interdependence is due to this relationship. The fact that no significant interaction has been found does not imply that MAS use is equal also for production and sales managers. It is entirely possible that there exists interaction terms between 'type of manager' and customization and/or 'type of manager' and interdependence that explain MAS use. Therefore, a separate test is conducted to investigate the interaction between 'type of manager' and customization, and 'type of manager' and interdependence in relation to MAS use. This test involves comparison of parsimonious and just identified models with reference to equation (2) rather than (1). In the light of the studies of Hayes (1977) and Mia and Chenhall (1994), it was considered important to investigate whether systematic differences on MAS use between production and sales managers were apparent, especially because the theory developed in Chapter 3 does not hypothesize such differences. Formally, the test involves a comparison between models that assume an interaction between 'type of managers' and customization/interdependence (just identified model), and a (parsimonious) model that does not assume such an interaction. This interaction term matters as this model reveals whether customization and/or interdependence prompt different 'types of managers' to differ in MAS use.

If the just identified model produces significantly less error than the parsimonious model, interaction exists. If X_4 in equation (16) and (17) below represents the type of manager (1 = production manager, 0 = sales manager), the non-interaction (16) and interaction models

(17), can be written as follows:

$$X_{3(i)} = a + \beta_{31}X_1 + \beta_{32}X_2 + \beta_{34}X_4 + \epsilon \quad (16)$$

$$X_{3(i)} = a' + \beta'_{31}X_1 + \beta'_{32}X_2 + \beta'_{34}X_4 + \beta_{35}X_4{*}X_1 + \beta_{36}X_4{*}X_2 + \epsilon' \quad (17)$$

Equation (16) represents the general effect of 'type of manager' on MAS use. That is, in comparison with equation (2) it captures how much more variance is explained when the model is extended with the variable 'type of manager.' Equation (17) specifically models interaction between the two variables of interest (customization (X_1) and interdependence (X_2)) and 'type of manager.' Equation (16) is the 'just identified model', while equation (17) is a 'parsimonious model.' If there is no interaction, both β_{35} and β_{36} will be insignificant (while a', β'_{31}, β'_{32}, β_{34} and a, β_{31}, β_{32}, β_{34} of both the equation (16) and (17) will be nearly identical). These models can be compared using the F test given in equation (15).

Analogous with the argument used in 6.3.3 it would not suffice to compare (16) with (2) or (17) with (2), because the first comparison would not capture the relationship 'type of manager' with customization and/or interdependence in particular. The second comparison would compare a 'just identified' model with a parsimonious model that assumes that there is no relationship between 'type of manager' and MAS use. By excluding the relationship 'type of manager' in general, significant results on the comparison of equation (16) and (2) would not justify the conclusion that 'type of manager' matters particularly in relation to the variables of customization and/or interdependence. The models are tested for all four MAS-dimensions, using F-values, and the results are presented in Table 6.3.

	Aggregation	Integration	Scope	Timeliness
R^2_j just identified model#	0.19	0.35	0.12	0.25
R^2_p parsimonious model	0.19	0.34	0.12	0.23
$F_{2,164}$ statistic##	0.00	0.06	0.00	3.02
Significance p=0 <###	0.99	0.98	0.99	0.05

Calculated with equation (3)
Calculated with equation (15)
probability that the association equals zero

Table 6.3: Comparison of the models including and excluding interaction between customization and interdependence and 'type of manager'

Inspection of Table 6.3 suggests that the model including production and sales as an explanatory variable has a significant better explanatory power than the parsimonious model only for the timeliness dimension, that is, systematic differences in MAS use are only found

for timeliness. Therefore, it is decided to test the hypotheses for production and sales managers separately for timeliness only.

6.3.5 Results[2]

The tests of the hypotheses are organized as follows. First, the model is run for each MAS variable separately, using equations one and two. The results of these tests are presented in Table 6.4. Subsequently the effects of the independent variables in the model are calculated in their composites with equation (7) to (9). These results are presented in Table 6.4.[3]

6.3.5.1 Direct effects

The results will be discussed in view of the general theory developed in Chapter 3. The significance of paths are assessed with statistical tests under the assumption that either $p_{31(i)}$ or $p_{32(i)}$ are zero rather than its calculated beta. Both the Wald statistic and the t test are used to assess whether the relationships customization/MAS and interdependence/MAS are significant in the system of equations. The results of these tests are in Table 6.4. The path coefficients are shown to illustrate the effect of the explanatory variables on MAS dimension. The standard errors in the table show how far the estimated values of MAS are dispersed from the observed values. The Wald value and its corresponding p value are shown, illustrating the significance of paths. The last two columns of Table 6.4 show the t values and their corresponding p values. There exist no contradictions between conclusions on significance levels relying on the Wald test or the t test.[4] $R^2_{m(i)}$, as well as its components in terms of the residual path coefficients (p_{2u} and $p_{3v(i)}$), are shown at the bottom of Table 6.4 to identify how much of the variance in MAS use is explained by the system of structural equations. The F value and its corresponding probability (p value) is at the bottom of Table 6.4 to illustrate whether the error variances are constant for all observations.

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[2] Prior to the path analysis, data were assessed to ascertain whether the fundamental theorem of path analysis is met. This requires the error terms in equations (1) and (2) to be uncorrelated (see Appendix 6.1).

[3] In Appendix 6.1 it is analysed whether the data are suitable to carry out a path analysis in the way that is proposed at the beginning of the chapter.

[4] A Monte Carlo simulation is performed to ascertain whether the Wald test would indeed reject associations more often than the t test. The results of this test are in Appendix 6.2.

Type of Manager (p/s)	*MAS dimension*	*Beta coef ficient*	*Value*	*Std. error*	*W*	p=0# =<	*t*	p=0 =<
Production+Sales	Aggregation	p_{31}	0.11	0.08	1.94	0.15	1.39	0.17
		p_{32}	0.19	0.08	5.66	0.03	2.39	0.02
	Integration	p_{31}	0.13	0.07	3.07	0.10	1.75	0.08
		p_{32}	0.43	0.07	32.46	0.00	5.95	0.00
	Scope	p_{31}	0.03	0.08	0.14	0.80	0.38	0.71
		p_{32}	0.02	0.08	0.08	0.80	0.28	0.78
Production	Timeliness	p_{31}	0.26	0.10	6.80	0.01	2.63	0.01
		p_{32}	0.36	0.10	12.75	0.00	3.66	0.00
Sales	Timeliness	p_{31}	-0.06	0.11	0.32	0.60	-0.56	0.58
		p_{32}	0.36	0.11	10.00	0.00	3.22	0.00

Aggregation	R^2_m=0.18; p_{2u}=0.94; p_{3v}=.97; $F_{2,167}$= 5.64, p=0 < 0.00
Integration	R^2_m=0.33; p_{2u}=0.94; p_{3v}=.87; $F_{2,167}$=25.90, p=0 < 0.00
Scope	R^2_m=0.12; p_{2u}=0.94; p_{3v}=.998; $F_{2,167}$= 0.17, p=0 < 0.84
$Timeliness_{production}$	R^2_m=0.29; p_{2u}=0.95; p_{3v}=.86; $F_{2,82}$= 14.80, p=0 < 0.00
$Timeliness_{sales}$	R^2_m=0.23; p_{2u}=0.92; p_{3v}=.94; $F_{2,82}$= 5.45, p=0 < 0.01

p=0 is the probability that association equals zero (i.e. P(beta) = 0).

Table 6.4: Results of the path analysis

Hypothesis 2

Hypothesis 2 predicts a positive direct relationship between interdependence and all four MAS dimensions. Support for this hypothesis requires a positive and significant relationship for $p_{32(i)}$. The data support this relationship for the dimensions of aggregation, integration and timeliness at conventional levels of significance.

No support is found for the relationship of interdependence with the dimension of scope.

Hypothesis 3a

Hypothesis 3a predicts a positive direct relationship between customization and the MAS-dimensions of aggregation, scope and timeliness. The data support this hypothesis for production managers on the dimension of timeliness (p_{31}=0.26; p=0.01) only. No other direct relationships are found within conventional levels of significance. While there is some indication of a direct relationship between customization and aggregation the results of the Monte Carlo simulation (Appendix 6.2) indicate that the critical t is exceeded in only 33 percent of the cases.

6.3.5.2 Indirect effects

The conclusion of the joint results in Hypotheses 2 and 3a is that, except for the MAS dimension timeliness (production managers), managers require more sophisticated MAS to deal with problems of interdependence. Because Hypotheses 1 and 2 are supported within the conventional level of confidence, calculation of the indirect effects is warranted. To illustrate the indirect effect of customization on MAS use conveyed in Hypothesis 3b and 3c, Table 6.5 presents the decomposed effects of customization on MAS use. The magnitude of the spurious effect of interdependence on MAS use are presented as well.

As no support whatsoever is found for the dimension of scope, Table 6.5 does not specify direct and indirect effects for this MAS dimension.

Type of Manager (s/p)	*Linkage*	*Direct*	*Indirect/ Spurious*	*Total'*	p=0 =<
Sales+Production	Customiz./Interdependence (X_1/X_2)	0.35		0.35	0.00
	Customiz./Integration (X_1/X_{32})	0.13	0.14	0.27	0.00
	Interdepend./Integration (X_2/X_{32})	0.43	0.04''	0.47	0.00
	Customiz./Interdependence (X_1/X_2)	0.35		0.35	0.00
	Customiz./Aggregation (X_1/X_{33})	0.11	0.07	0.18	0.02
	Interdepend./Aggregation (X_2/X_{33})	0.19	0.04''	0.23	0.00
Production	Customiz./Interdependence (X_1/X_{2p})	0.32		0.32	0.00
	Customiz./Timeliness (X_1/X_{34p})	0.26	0.12	0.38	0.00
	Interdepend./Timeliness (X_2/X_{34p})	0.37	0.08''	0.45	0.00
Sales	Customiz./Interdependence (X_1/X_{2s})	0.38		0.38	0.00
	Customiz./Timeliness (X_1/X_{34s})	-0.06	0.13	0.07	0.49
	Interdepend./Timeliness (X_2/X_{34s})	0.36	-0.02''	0.34	0.00

' = zero order correlation
'' = spurious relationship

Table 6.5: Decomposition of the effects of customization and interdependence on MAS use

Hypothesis 3b

Integration

Hypothesis 3b predicts that there exists no significant direct relationship between customiza-

tion and integrated MAS. As can be seen from Table 6.4 there is a significant direct relationship between integration and customization ($p_{31(2)}$ = 0.13) at the 10 percent level of significance. The Monte Carlo simulation (Appendix 6.2) revealed that, the critical 5 percent value is exceeded in more than 50 percent of the cases. The critical value of 10 percent is in the simulation exceeded in 67 percent of the cases. These results suggest that the path coefficient of 0.13 cannot be considered noise, but is too weak to warrant a definitive conclusion. The evidence with respect to Hypothesis 3b is considered inconclusive.

Hypothesis 3c

Hypothesis 3c predicts that (part of) the observed correlation between customization and the dimensions of (i) scope, (ii) integration, (iii) aggregation and (iv) timeliness is due to the indirect relationships *via* interdependence. As indicated in Table 6.4, there was no relationship between customization and scope and thus no further analyses were performed with respect to this dimension. The results of testing Hypothesis 3c with respect to the dimensions of aggregation, integration and timeliness are as follows.

Integration

It would appear from the path coefficients calculated in relation to customization and integration that the observed correlation between customization and integration is partly direct and partly indirect via interdependence. According to Table 6.5 there is a significant zero-order correlation between customization and integration (r_{13} = 0.27, p=0.01). As both Hypothesis 1 is supported and Hypothesis 2 is supported for the dimension of integration it is concluded that the data support Hypothesis 3c. After controlling for the direct effect of customization on integrated MAS (0.13), an indirect effect remains of 0.14. The indirect effect of 0.14 is calculated by multiplying the association of interdependence and customization with the direct effect of interdependence on integrated MAS, i.e., 0.35*0.43 (r_{12}*p_{32}). Indeed almost 52 percent (0.14/0.27) of the zero-order correlation is related to the effect of customization on integration *via* interdependence. These results lends support for the acceptance of Hypothesis 3c for the dimension of integration.

Aggregation

The zero-order correlation between customization and aggregation amounts 0.18 (p=0.02 see Table 6.5). According to Table 6.4 the path coefficient between interdependence and aggregation is significant ($p_{32(1)}$ = 0.19, p=0.02). This, in combination with the support for Hypothesis 1, justifies the conclusion that customization indirectly influences use of aggregated MAS information. The indirect effect amounts 0.07 of a zero-order correlation that amounts 0.18. The indirect effect is calculated by multiplying r_{12}*p_{32} for aggregation (0.07 = 0.35*0.19). The indirect effect amounts 39 percent (0.07/0.18) of the total effect of customization on aggregated MAS use. Hypothesis 3c is accepted for aggregation.

Timeliness production
Table 6.4 shows that the path coefficient between interdependence and timeliness (for production managers) is highly significant ($p_{32(4)}$ = 0.37, 0.01 significance). This, in combination with the support for Hypothesis 1 justifies the conclusion that customization indirectly influences use of timely MAS information. Table 6.5 shows that of the 0.37 association of timeliness with interdependence, 0.12 is accounted for by the effect of customization on interdependence. The indirect effect amounts 31 percent (0.12/0.38) of the total effect of customization on timeliness.

Timeliness sales
The information in Table 6.4 lends support for the conclusion that customization indirectly influences timeliness as far as sales managers are concerned. There is a significant path coefficient between interdependence and timeliness (for sales managers) ($p_{32(4)}$ = 0.36, p=0.01 significance). Together with the support for Hypothesis 1 it can be concluded that an indirect effect exists. This effect amounts to 0.13. However, this conclusion should be interpreted cautiously as the zero-order correlation between customization and timeliness is insignificant. This not only means that a direct effect between customization and timely MAS is absent, but it casts also some doubt on the indirect relationship. Albeit cautiously, on the evidence it is concluded that for sales managers the indirect relationship exists as all conditions were met by the data.

Spurious relations
Table 6.5 shows indirect effects of interdependence on MAS use. Strictly these are to be interpreted 'spurious' effects in that they arise from the antecedents that MAS use and interdependence have both in common: customization. The size of the spurious effect is determined by the direct relationship between customization and MAS use ($p_{31(i)}$), multiplied by the correlation of interdependence with customization (p_{21}).

6.4 Summary and conclusions

The analyses of the data are conducted with a structural equation model that allows for an analysis of path coefficients. The analyses are allowed only if the error terms produced with each equation separately are uncorrelated. This has been tested and is confirmed by the data (Appendix 6.1). An F test is used to determine whether production and sales managers have significant differences in regard to the relationships customization/interdependence, and customization/interdependence/MAS use. It appears that this is only the case for customization/interdependence/timeliness. For this reason, separate analyses were performed only for this dimension of MAS.

A summary of the results of the tests of the Hypotheses 2 to 3c is presented in Table 6.6

Hypothesis	Relationship	MAS dimension: Scope	MAS dimension: Integration	MAS dimension: Aggregation	MAS dimension: $Timeliness_p$	MAS dimension $Timeliness_s$
2	I/MAS	rejected	supported	supported	supported	supported
3a	C/MAS	rejected	not applicable	rejected	supported	rejected
3b	no direct C/MAS	not applicable	inconclusive	not applicable	not applicable	not applicable
3c	C/MAS via I	rejected	supported	supported	supported	supported

C=customization; I=interdependence; $Timeliness_{p/s}$ = Timeliness production or sales manager

Table 6.6: Summary results of the hypotheses tests

There is support for Hypothesis 1 which implies that customization increases interdependence between production and sales departments. The second hypothesis, which predicts a direct relationship between interdependence and MAS use, is strongly supported for both production and sales managers on the dimension of timeliness. Strong support also exists for the dimension of integration. There is weak support for the aggregation dimension ($p=0.10$). The hypothesis is rejected for the dimension of scope. Hypothesis 3a, predicting a direct relationship between customization and (i) scope, (ii) aggregation and (iii) timeliness is only supported within conventional levels of significance for timeliness/production managers. Hypothesis 3b, that assumes the absence of a direct relationships between customization and integrated MAS information is rejected by the data. Hypothesis 3c predicting an indirect relationship between customization and MAS, acting via interdependence is supported for all MAS dimensions, except scope.

The implications of the results are discussed in Chapter 7.

Chapter 7

Discussion and conclusions

7.1 Introduction

This thesis has investigated the effect of customization on the level of interdependence between production and sales departments, and MAS use. The theoretical framework developed in this study incorporates the four dimensions of MAS identified originally by Chenhall and Morris (1986) - scope, integration, aggregation and timeliness. To date, no study has explored the antecedents of departmental interdependence and their relation to MAS. The framework developed here identified the strategic priority of customization as an antecedent of both interdependence and MAS. The results support the theoretical framework and indicate that managers facing customization differ in MAS use from managers involved in mass production. These differences particularly manifest themselves via interdependence, which in turn triggers MAS use.

This chapter provides a summary of the findings of the study and some concluding comments. It is organized as follows. The next section provides a brief discussion of the theory developed in Chapter 3 and summarizes the results of the study. Section 7.3 discusses the implications of the findings on each hypothesis developed in Chapter 3. Section 7.4 discusses the implications of the findings for each MAS dimension. The contributions of the study are identified in Section 7.5, followed by a discussion of avenues for future research in Section 7.6. Section 7.7 discusses the limitations of this study. Section 7.8 draws together the major conclusions of the study.

7.2 Theory and results

7.2.1 Theory

Customization is described in this study as the extent to which a business unit allows individual customers to affect the product/service attributes that it produces. Interdependence is defined as the extent to which departments depend upon each other to accomplish their tasks. MAS is defined as the set of descriptions that managers use to consider the financial aspects of decisions. It is conceptualized as including dimensions of scope, integration, aggregation and timeliness. The theory argues that MAS use will differ among managers

facing different levels of customization and interdependence. This occurs due to the uncertainty that customization and interdependence creates in the decision making process. Uncertainty is created with respect to cause and effect and objectives (Earl and Hopwood, 1981). The study identifies how all MAS dimension help managers deal with uncertainties of cause and effect and objectives.[1] The theory argues that there are two ways in which MAS reduce uncertainty. First, these systems enable the manager to better understand the problem at hand from both a technological point of view and from the perspective of the objectives to be met. Second, MAS assist in making timely decisions, thus enabling managers to consider more alternatives than would be possible without the information provided by MAS.

Differences in MAS use are described in terms of sophistication. MAS is more sophisticated to the extent that managers attach more importance in decision making to the dimensions of scope, integration, aggregation and timeliness. More sophisticated MAS is claimed to decrease the level of uncertainty. It is, therefore, expected that increased levels of customization and interdependence will be positively associated with the importance managers attach to MAS information. While it is argued that customization and interdependence will both have a direct influence on MAS use, the theoretical framework also explores the interrelationships among customization, interdependence and MAS use. It is argued that interdependence will not only have a direct effect but will also operate as an intervening variable between customization and MAS use. These relationships are formalized in the hypotheses that contend: (1) customization increases interdependence; (2) interdependence directly influences MAS use in all dimensions; (3a) customization directly affects MAS use in the dimensions (i) scope, (ii) aggregation and (iii) timeliness; (3b) customization has no direct effect on integrated MAS; (3c) customization is positively associated with the MAS dimensions of (i) scope, (ii) integration, (iii) aggregation and (iv) timeliness, acting through interdependence.

7.2.2 Results

The hypotheses for the study were tested using sales and production managers in functionally structured organizations. A preliminary analysis of the data revealed that both groups of managers use MAS quite similarly, except for timeliness. Therefore, the data were only analyzed separately for production and sales managers as far as the MAS dimension of timeliness is concerned. The results for each hypothesis are as follows.

[1] This is not to say that the information could not be made available from other sources. This study assumes that the provision of information via accounting systems assists managerial decision making, which does not rule out other means of information collection.

Hypothesis 1
There exists strong support in the data for the relationship between customization and interdependence. Data analysis revealed a correlation coefficient of 0.35 (significant at the one percent level of confidence).

Hypothesis 2
The results indicate that increased levels of interdependence triggers the use of MAS. The regression coefficients (significance levels) for the MAS dimensions are: aggregation 0.19 (0.02); integration 0.43 (0.01); timeliness for production managers 0.36 (0.01); timeliness for sales managers 0.36 (0.01). There was no relationship between interdependence and the scope dimension. No further analysis was performed for this dimension.

Hypothesis 3a
The data provide no support for the direct relation of customization and MAS use, except for the dimension of timeliness in production units (β = 0.26, p=0.01). The regression coefficients (significance levels) for the MAS dimensions are: aggregation 0.11 (0.17); scope 0.03 (0.71); timeliness for production managers 0.26 (0.01); timeliness for sales managers - 0.06 (0.58).

Hypothesis 3b
The result does not warrant a definitive conclusion. Evaluated against the critical five percent level of confidence there exists no relationship between customization and integrated MAS (i.e. β=0.13, p=0.08. However, a simulation with the data revealed that in more than 50 percent of the cases the value exceeds the critical t value (5%). This number increases to 67 percent evaluated against an Alpha level of 10 percent.

Hypothesis 3c
The data support the hypothesis that customization affects MAS *via* interdependence for the dimensions of aggregation, integration and timeliness (both production and sales). The indirect effects (calculated as partial correlations) are for: aggregation 0.07; integration 0.14; timeliness production 0.12; timeliness sales 0.13.

7.3 Implications of the study's findings – overview

The following sub-sections provide an overview of the implications and are discussed in direct relation to each of the hypotheses developed in Chapter 3. Subsection 7.4 provides a detailed discussion of the results relating to each MAS dimension.

7.3.1 Customization and interdependence

This study lends strong support for the theory that customization increases interdependence. Production and sales managers have similar views on this relationship, which is demonstrated in the size and the significance of the association between customization and interdependence. These findings imply that customization is an important antecedent of interdependence and thus has significant managerial implications, particularly in functionally structured organizations. The evidence suggests that uncertainty in decision making is augmented with the introduction of increased levels of interdependence due to the increased level of co-operation required among functional units. This requires systems to be put into place to enable managers to deal with increased levels of uncertainty. The absence of such systems will increase managerial uncertainty in the decision making process itself and in the ability of managers to predict the outcomes of that process. This type of decision context has the potential to create dysfunctional managerial behaviour and ultimately have an adverse effect on organizational outcomes (Holmström, 1979; Milgrom and Roberts, 1992). There are several ways in which organizations can effectively manage the uncertainty associated with customization and interdependence (see Chapter 3). The first is by reducing the amount of information required to make a decision. This study provides evidence to support Galbraith's (1973) proposition that uncertainty can be reduced by increasing the organization's information processing capacity with the provision of more sophisticated information in MAS.

7.3.2 Hypothesis 2: interdependence and MAS

This is the third study (Chenhall and Morris, 1986; Mia and Goyal, 1991) to confirm that increased levels of interdependence are associated with MAS use. However, this study argued that the type of interdependence that is most likely to influence MAS use is interdepartmental interdependence. The evidence provided here supports this hypothesis. The results of this study differ from other studies in that scope does not appear to be associated with interdependence.

7.3.3 Hypothesis 3a: customization and MAS

The weak direct relationship between customization and MAS suggests that problems associated with increased levels of uncertainty due to customization are managed with the use of other information or control strategies not examined here. The use of MAS does not appear to be of particular importance for supporting operational decision making at the department level. One explanation for this finding is that managers facing increased levels of customization acquire information from alternative sources. It is also possible that

customization does not engender problems at the departmental level that require managers to process information contemporaneously and/or more timely to any greater extent than if they were pursuing a strategy of mass standardization.

7.3.4 Hypothesis 3b: customization and integrated MAS

The direct link (albeit weak) between customization and integrated information was not expected. This result suggests that managers use integrated information in direct response to customization. It is entirely possible that integrated information about other department's activities helps managers cope with intra-departmental uncertainty or possibly to buffer themselves from the effects of other departments' activities. For example, information concerning the activities of other departments may enable managers to formulate solutions that allow a department to perform activities as independently as possible (Macintosh, 1995; Thompson, 1967).

7.3.5 Hypothesis 3c: customization, interdependence and MAS

The evidence strongly supports the hypothesis that customization will influence MAS *via* interdependence. An important finding of the study is that customization affects MAS use indirectly rather then directly. At the conventional level of significance there only exists support for a direct relationship between customization and the dimension of timeliness and only for production units. This finding has important implications in the design of organizational structural arrangements and MAS. Organizations pursuing customization appear to have two choices. They can attempt to reduce interdependencies by changing the structural arrangements and/or implement MAS that meet the information requirements of managers. A functionally structured organization pursuing a strategy of customization will require MAS that facilitate co-ordination among interdependent functional units. This role of MAS appears to be of greater importance than its use as mechanism for reducing the uncertainty that results directly from the pursuit of customization.

7.4 Implications of the study's findings on each MAS dimension

7.4.1 The dimension of scope

Broad scope information consists of three sub-dimensions: focus (external/internal), quantification (financial/non-financial), and time horizon (ex ante/ex post). There is no support for the hypothesized relationships between: interdependence and scope (H.2), customization and scope (H3a), and customization affecting scope *via* interdependence (H.3c).

Broad scope information is posited as an idea provider for decision makers in that it can be used to engender new issues and possibilities for decision making. As customization requires more ideas as to how and what to produce, it was expected that departmental managers would consider this information to be important as a means of reducing intra-departmental uncertainty (of cause and effect relationships) and inter-departmental uncertainty (of cause and effect relationships and objectives). No such relation is found in this study. This finding is contrary to earlier studies that found broad scope information to be positively associated with strategy (e.g. Abernethy and Guthrie, 1994) and interdependence (Chenhall and Morris, 1986; Mia and Goyal, 1991). The results suggests that if managers require this type of information for decision making, they do not acquire it from the information provided by the management accounting system.

This finding has implications for the design of MAS. It would appear that managers do not consider the broad scope information provided by the MAS important for operational decision making. When it comes to setting priorities about what information should be made available for operational decision making, the evidence indicates that little emphasis needs to be devoted to the broad scope dimension of the MAS. However, these results do not suggest that broad scope information will not be useful at the managerial or strategic level of decision making. It is entirely possible that broad scope information would be particularly important for the development of yearly budgets and for the assessing the viability of alternative strategic priorities. There is some evidence that MAS can play an important role in environmental scanning and for reducing the uncertainties associated with strategic uncertainties (Simons, 1991).

7.4.2 The dimension of integration

Three sub-dimensions characterize integrated information: precise targets for activities, reporting on inter-unit interactions, and sub-unit information. Integrative information helps departmental managers to assess the effect their decisions have on activities carried out in interdependent departments.

The data strongly supports the hypothesized relationship between customization and integrated MAS, acting *via* interdependence (H.3c) and the relationship between interdependence and integration (H.2). Integrated information facilitates those decisions that are influenced by the interdependencies between production and sales. It assists decision making by reducing the uncertainty that would arise if this information was not available. The direct relationship between interdependence and integrated information was expected and is supported by the data ($\beta=0.43$; $p=0.01$). The results also indicate that increased levels of customization augments use of integrated information via interdependence. This supports the theory

presented in Chapter 3 which contends that uncertainty in decision making with respect to interdependent situations can be mitigated with the provision of integrated information. This finding is consistent with earlier studies (Chenhall and Morris, 1986; Mia and Goyal, 1991).

7.4.3 The dimension of aggregation

Aggregated information is considered important as it provides decision makers with information that enables them to oversee larger parts of their decision space. It provides the managers with summary information on activities carried by other profit centres of the firm; it can be used for decision models like a cost-volume-profit analysis; and it provides information on results of past events (e.g. month, year). There is no support for the hypothesized relationship between customization and aggregated information (H.3a) at conventional levels of significance. This implies that production and sales managers do not attach much importance to aggregated information for intra-departmental decisions making. This has important implications for the design of accounting systems. One important function of accounting information is that it aggregates data. This aggregation enables managers to oversee larger parts of their decision space contemporaneously. The finding seems to suggest that increased levels of customization, for intra-departmental decision making, requires detailed rather than aggregated information. This detailed information provides managers with the necessary insight as to how to produce the required product/service. In other words, it would appear that higher levels of customization requires detailed production knowledge which is not provided with aggregated information. This result is contrary to expectations and differs from earlier studies which indicated a positive relationship between uncertainty and aggregated information (Chenhall and Morris, 1986; Gul and Chia, 1994; Mia and Goyal, 1991). However, there exists strong support for the relationships between: customization and aggregated information acting via interdependence (H. 3c), and between interdependence and aggregated information (H.2). This implies that, to address inter-departmental issues, managers use aggregated information. This is in line with the theory that is built on the premise that managers require knowledge of their common decision space in order to make co-ordinated decisions, and hence reduce uncertainty of objectives and cause and effect relationships with the help of aggregated information.

7.4.4 The dimension of timeliness

Timeliness of information pertains to how frequently information is provided and the speed by which new information is provided by the system. The data lend strong support for the hypothesized relationships between interdependence and timeliness (H.2), and between customization, and timeliness acting *via* interdependence (H.3c). The implication of this finding is that both product and sales managers require more information updates when

interdependence increases. Customization also has a direct relationship with timeliness (H.3a) but only for production managers. This suggests that information used for intra-departmental purposes may become obsolete faster for production managers than for sales managers. In other words, sales managers require information updates on a more frequent basis when it comes to inter-departmental decision making, but not for intra-departmental decision making. Production managers, on the other hand, require frequent information updates to both address inter and intra-departmental issues. This result is counter intuitive in that sales managers are exposed to more uncertainty than production managers (Mia and Chenhall, 1994). Under such conditions it is expected that more information updates are required (Fisher, 1996).

One reason for this finding is that sales departments may be more adaptive to change than production departments (Thompson, 1967; Mia and Chenhall, 1994) and have implemented ways of reducing their department's dependence on formal information systems for intra-departmental decision making. The ability to adapt quickly is no doubt a function of the nature of sales activities. The transformation processes that occur in sales departments are generally not dependent on physical assets (i.e. machinery), nor are activities co-ordinated and managed using formalized procedures (e.g. production schedules). Changes in a production department in response to increased levels of customization is likely to involve significant levels of expenditure both in terms of investment in capital and in the development of new operating procedures. In contrast, changes into the transformation process in a sales departments can be accomplished relatively easily.

If customization also involves production activities, sales has to make decisions that may have important resource implications for production department. To enable sales managers to quickly respond to customers they need to have this information fast, to assess profit margins and to set prices. Thus, it is quite possible that sales managers will be interested in more frequently updated information provided by MAS for those decisions that have consequences that exceed beyond the sales department, but such updates are not required for decisions that involve only their own department.

While choice in production method does not necessarily affects the production department's output (as far as sales and customers are concerned), the relative inflexible nature of physical assets requires production managers to efficiently deploy these assets. As a consequence, interdependence between production and sales does not increase by the production manager's choice of how capacity is used, but rather this decision affects production department activities exclusively. Therefore, customization affects production departments directly. Timely information assists production managers to better understand the (complex) situation, and to solve the problem in the given time. The probability of making an efficient production decision increases when managers have more time to consider alternatives.

7.5 Contributions

The discussion of the contribution of this thesis to the literature requires three issues to be addressed: the design of the study, the instruments and the results.

7.5.1 The design of the study

This study has been designed to enable the effects of strategy and interdependence on MAS to be examined empirically. It differs from prior research in four important ways. It focuses on a particular dimension of strategy, namely, customization. It controls for structure and the level of decision making, and it focuses on one type of interdependence. In addition it compares two different types of managers exposed to similar levels of uncertainty.

Focusing on customization as a strategic priority improves the interpretation of the findings in that they can be identified with that element of strategy only, and not with multiple elements that comprise the generic strategic typologies used in prior research (Chapman, 1997). The study controlled for structure by including functionally differentiated organizations only. This enhances the interpretation of the results in that it rules out the possibility that organizations may have responded to customization by changing their organizational structure, rather than changing their MAS. By focusing on interdependence between departments it becomes possible to discern the effect of inter-departmental from intra-departmental co-ordination problems. As a consequence the role of MAS can be attributed. The focus on operational decision making improves the interpretation of the findings in that it is known for what type of decision making the information is used. It has long been recognized that different types of decisions require different types of information (Clark, 1923; Anthony, 1965).

The study includes both production and sales department managers. This provides a possibility to identify if managers from different functional units within a business unit use MAS differently. The design of Mia and Chenhall (1994) allowed them to examine whether sales managers use MAS differently from production managers because sales managers are exposed to different levels of uncertainty. This study further examines this issue in that it is investigated whether production managers and sales managers differ in MAS use if they are exposed to equal levels of customization and/or interdependence. The finding that production and sales managers do not differ in MAS use under similar conditions suggests that despite differences in their orientation (Mia and Chenhall, 1994) both type of managers have quite similar views on the importance of MAS when they are exposed to equal levels of customization and interdependence, and hence uncertainty.

7.5.2 The instruments

Very few studies in the management accounting literature address issues of reliability and validity thoroughly (Brownell, 1995). This research has paid particular attention when assessing the psychometric properties of each of the instruments. The customization instrument was developed for use in this study. It was then subject to an assessment of its reliability and validity. Careful analysis indicated that the instrument more than satisfied the criteria associated with reliability and validity. The analysis of the psychometric properties of the interdependence instrument also confirmed the assessment provided by Van de Ven et al. (1976). Considerable attention was devoted to the assessment of the MAS instrument. This assessment required that some modifications were made to the original instrument. The major changes were due to differences in the way in which production and sales managers viewed the separate items of each MAS dimension. In other words, different people categorized some items of the MAS instrument into different MAS dimensions. Examining the factor structures that emerged when the data were analyzed separately for production and sales managers enabled these items to be identified. It is hoped that the modified instrument will be more robust when used with a sample that is not homogeneous.

7.5.3 Results

This was the first study to link accounting for decision making with the issue of customization. The results of the study are encouraging in that MAS use was found to be associated with increased levels of customization. More importantly, the study demonstrates the nature of the relationship between customization and MAS use. The decomposition of the relationship into a direct and indirect effect revealed that the direct effect is very limited, while the indirect effect of customization on MAS via interdependence is large and thus can be considered to be important.

The study also revealed that the scope dimension is not important for operational decision making. This is contrary to general expectations (Mia and Chenhall, 1994) and the findings of earlier research (e.g., Abernethy and Guthrie, 1994; Chong, 1996). Another important finding is that there exist only minor differences in MAS use between production and sales managers. It is only on the issue of timeliness where significant differences surfaced. This is also inconsistent with the findings of Mia and Chenhall (1994) who found that production and sales managers differ in MAS use along the dimension of scope.

7.6 Avenues for further research

7.6.1 The dimension of scope

The findings on the MAS dimension of scope are very compelling in that it refutes the theory developed in Chapter 3 and contradicts earlier findings. Future research could address two issues in that respect. The first relates to the MAS instrument itself. Research examining the broad scope of MAS does not allow for the possibility that managers use *both* narrow and broad scope information. Narrow scope information relates to the traditional role of MAS (i.e. financial, quantitative and historical). Future research could add the dimension of 'traditional information' to the MAS instrument so that the importance of this role as well as the non-traditional role of management accounting could be assessed. The item 'future oriented information' (see Chapters 4 and 5), for instance, may be considered to be equally important as an item on 'past events.' Past events in terms of actual expenditure, for instance, can be equally important as future oriented information (i.e. budget forecasts) in decisions relating to the introduction of new inputs.

The second avenue for further research is an investigation as to how scope relates to decisions other then operational decisions. While the evidence provided by this study suggests that 'broad scope' information is not important for operational decisions, this does not imply that it is not important for other types of decisions. The use of broad scope MAS may be of particular interest for planning and strategic decision making, and not for operational decisions. It has long been recognized that different types of information are required for different types of decisions or as argued by Clark (1922), managers use "different costs for different purposes." To date no study has specifically compared information required for shorter as opposed to longer term decisions, nor how information requirements differ for different levels of decision making (Abernethy and Guthrie, 1994).

7.6.2 The dimension of aggregation

More attention could be given to the issue of aggregation. The modest results provided by this study suggest that the issue is more complicated than suggested in Chapter 3. A more thorough study into this issue could involve two equally important parts. First, there is a need to further examine the way in which aggregation has been operationalized. The results may have been influenced by the way in which the construct was measured. Assessment of he original instrument required the deletion of a number of items that related to this dimension. It is possible that the instrument of aggregation has become too 'lean' since six items of the original instrument had to be removed to attain convergent validity. Indeed the low association between customization and aggregated MAS may be due to the fact that the

instrument no longer captures the aggregation construct.
The instrument might be extended to capture both detailed and aggregated information. On the evidence provided in this study it can be concluded that aggregated information is not always regarded as the panacea to reduce uncertainty. It is possible that detailed information as well as aggregated information is required. As argued earlier with respect to the broad/narrow scope dimension of MAS, these two requirements for information may also not be mutually exclusive. In summary, further development of this instrument is warranted not only to ensure that the aggregation dimension is captured by the measure but also to allow for the possibility that managers may require information that is both aggregated and detailed.

7.6.3 The dimension of integration

The findings on the dimension of integration contain the surprising result that integrated information seems to be directly associated with customization. This prompts a more thorough investigation into the question as to why this information is used under these circumstances. Two possible explanations have been given in this study, but further research could be devoted to exploring how integrated information supports intra-departmental decision making.

7.6.4 The dimension of timeliness

The issue of timeliness has been neglected in management accounting research. The results of this study reveal that managers consider timely information an important issue. This study found support for the inter-relationship between customization, interdependence and timeliness. This issue, however, can be investigated in a much broader context, including different types of strategies and decision situations. On the basis of the specific difference between sales and production managers, further research is warranted to investigate why sales managers consider timeliness important when interdependence increases, but not when customization increases independently from interdependence. In particular, future research could investigate whether sales managers use and receive information from sources, other than the MAS, to a great extent than production managers. If this is the case then this might explain the finding that sales departments do not depend to the same extent as production managers on MAS for making intra-departmental decisions.

7.6.5 The lack of difference between sales and production managers

The findings in regard to the general lack of difference in MAS use between production and sales managers is another issue which might be of interest for future research. The findings

of Hayes (1977) and Mia and Goyal (1994) suggest that production managers and sales managers differ in the use of MAS. This study found only minor differences in MAS use between sales and production managers for operational decision making. Future research could address this issue through the comparison of MAS use for operational, managerial and strategic decision making.

7.7 Limitations

This study is subject to a number of potential limitations. First, the results do not provide evidence of causality. All that can be said is that the results are consistent with the theoretical position taken in the study. The study also emphasized MAS use rather than the availability of MAS information. In theory, a manager could rate a MAS item to be very important in his decision, while the information provided is not elaborate at all. However, intuitively it is unlikely that this would be a problem, as it would suggest that managers make 'sophisticated use of non-sophisticated information'. The results may also be subject to omitted variable bias. While the study design attempted to control for variables which were considered likely to influence the results, it is impossible to control for all potential confounding variables. It is quite possible that organizations would have employed other mechanisms that may have influence the use of MAS. For example, establishing liaison groups (Galbraith, 1973) are another means by which an organization can increase its information processing capacity.

The study does not incorporate organizational effectiveness into the model. One would expect that differences in MAS use affect the performance of business units. Thus, it is difficult to conclude that support for the relationship between customization, interdependence and MAS is necessarily desirable in terms of the impact on organizational outcomes. Future research could be directed towards the development of a more complex model that incorporates organizational performance as a dependent variable.

As noted earlier, the MAS instrument has rarely been used in its entirely. This study required modification of the original instrument. Further assessment and development of the modified instrument is required. And finally, further analysis of the relationships among the variables is required. One important extension of the analysis would be to assess the point of infliction where customization and interdependence become important to MAS use. This can be accomplished in two ways. One is to analyze additional data of smaller organizations and to compare the result with the results of the current study. A second possibility would be to further analyze the existing data by calculating associations at different levels of customization and or interdependence. This analysis can give further insight into the question why and when MAS use is triggered by customization and interdependence.

7.8 Conclusions

This study investigated the relationship between customization and MAS. It has sought to improve our insight into the factors that influence the design of MAS. A theoretical frame work was developed to examine the relationship between strategy, interdependence and MAS. The theory contends that organizations pursuing a strategy of customization face increased levels of interdependence between departments. Both customization and interdependence are identified in the theory as sources of uncertainty in decision making. In addition it is argued that managers who face increased levels of customization and interdependence will seek information to decrease the associated uncertainty. This model contributes to the literature in that it is the first integrative model to examine the relationships between strategy, interdependence and MAS design.

The study attempts to address a number of the limitations that have been identified in prior research (e.g. Chapman, 1997; Langfield-Smith, 1997; Otley and Pollanen, 1997). The study controls for structure, managerial level and type of decision. It focuses on production and sales mangers making operational decisions in functionally differentiated business units. It chose to investigate the impact of customization in that setting rather than in a broader conceptualization of strategy so that associations were attributable to the particular variables of customization and interdependence between departments.

The findings support the theory in that a relationship exists between customization and interdependence. Prior work considered interdependence between departments a variable in its own right. This study identifies customization as an antecedent of interdependence between departments. Hence, future work investigating the impact of interdependence on organizations need also consider factors that affect interdependence. The practical implication of this finding is that organizations who want to adopt a customization strategy need also consider the increased co-ordination requirements that emerge between departments.

The data also supported the positive relationship between interdependence and MAS use, in that managers facing increased levels of interdependence attach more importance to the MAS dimensions of integration, aggregation and timeliness. As this is the third study to support this relationship, it can be concluded that this relationship is generalizable, these consistent results provide the foundation for future research. The practical consequence of this finding is that increased levels of interdependence are expected to prompt organizations to evaluate their MAS with respect to the information it provides to co-ordinate activities.

While the data failed to support a direct relationship between customization and MAS use, a strong association was identified between customization and MAS acting *via* interdepen-

dence. This suggests that managers use information other than MAS to meet problems confined to their own department. However, when customization augments interdependence, decision makers do attach more importance to MAS.
The practical and theoretical consequence of this finding is that customization in its own right does not justify a different MAS to be introduced. It is the interdependence that is associated with customization that triggers the demand for different information. In terms of MAS design this finding implies that increased levels of customization should prompt organizations to reconsider MAS in its function of co-ordination mechanism between departments rather then within departments.

The study found that production and sales managers do not use MAS differently, except with respect to timeliness. This suggests managers who face similar levels of uncertainty seek similar information to reduce their uncertainty, regardless of their functional status.
This finding would suggest that the design of management accounting systems need not be geared to a specific job but rather to specific levels of interdependence. However, this conclusion must be interpreted cautiously because it only pertains to operational decisions. Also this is only the first study that found managers to use MAS similarly. More studies are required to generalize the result (Otley and Pollanen, 1997).

The scope dimension was not found to be associated with either customization or interdependence. This is attributed to the fact that only operational decisions have been investigated. This suggests that the association that has been identified between scope and strategy (Abernethy and Guthrie, 1994) may be attributed to other elements that comprise business strategy, and/or a different decision context. The practical implication of this finding is that broad scope information need not be made available for operational decision making.

In conclusion, this study adds to the research literature both theoretically and empirically by providing a better understanding of how contextual factors influence the design and use of management accounting systems. The findings of the study have direct practical implications regarding the effective implementation of customer responsive strategies such as customization. It appears that production and sales managers require information systems which support the achievement of these strategies. Management accounting systems are an integral part of an organization's information system. The findings presented here indicate that the information provided by the management accounting system becomes particularly important when firms pursue a strategy of customization. It is hoped that this study will not only assist senior management but also those who are designing and implementing these systems.

Appendices

Appendix 4.1: Customization measurement instrument

1. Product/services

Below are descriptions which characterize products/services firms produce. Depending upon the context, each of these descriptions may represent the situation for all, only a fraction or none of the products/services a firm supplies. Please indicate below what percentage of current total sales regarding the business you are supervising is accounted for by products represented by each of the product/service descriptions. Your answers should total 100%.

Products/services:

a. are completely standardized	____ %
b. are basic models which are customized according to organizational specifications	____ %
c. are basic models which are customized according to client's specifications	____ %
d. are completely customized	____ %
e. None of the above descriptions fits our situation (please specify)	____ %
_____	
_____	
Total	100 %

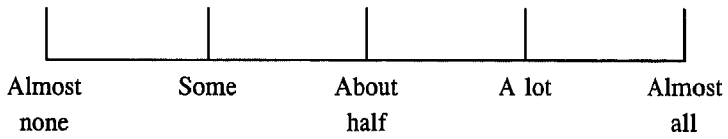
Appendix 4.2: Interdependence measurement instrument

A change of emphasis is required in this Section. Here, I would like you to think of the other department you work with.

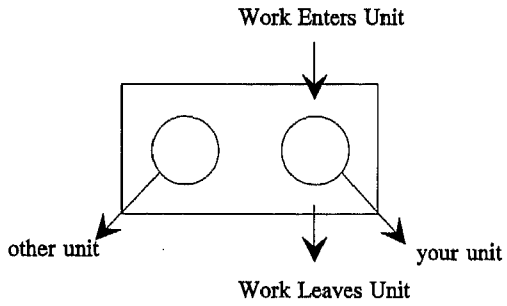
The following series of questions deal with your perceptions of cooperation of your department and the ..... department in joint activities you undertake with them. Please give your judgements on the typical relationship that exist.

3. Please indicate how much of the total work within your department flows in each of the ways, as shown by the figures and as described under a), b), c), and d).

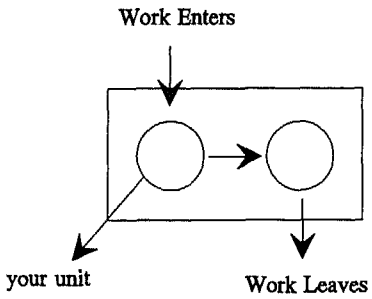
   Scale used for all the interdependence questions:



   a) *Independent Work Flow Case*. Where work and activities are performed by your department independently and do not flow between them.

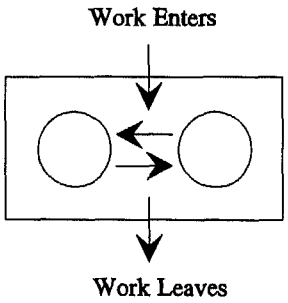


   b) *Sequential Work Flow Case 1*: from you to them. Where work and activities flow between your department and the other department, but only from your to the other department.



c) *Sequential Work Flow Case 2*: from them to you. Where work and activities flow between your department and the other department, but only from their to your department.

d) *Reciprocal Work Flow Case*. Where work and activities flow between your department and the other department in a reciprocal "back and forth" manner over a period of time until the work is done.

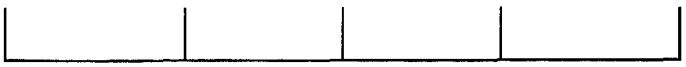


Appendix 4.3: MAS measurement instrument

If you make operational decisions for your business, some sources of information or information items are more important than others. Below information characteristics are described in regard to information systems. Information system should be regarded as: files, reports, documents, minutes, accounts, and notes, one can look into for decision making, provided within the organization.

I would like you to rate the importance of each characteristic of the current system in place, in making operational decisions within your department. If a characteristic is not part of your information system, please mark the lower end of the scale for that question.

The question numbers were randomized in the original instrument



Of little importance	Of some importance	Fairly important	Important	Extremely important

[character between brackets refers to the dimension the items covers: (S)cope, (T)imeliness, (I)ntegration and (A)ggregation].

1. (S) Information which relates to possible future events (for example new legislation).
2. (T) Requested information to arrive immediately upon request.
3. (I) Cost and price information of other departments of your business unit.
4. (A) Information in forms which enable you to conduct "what-if" analysis.
5. (A) Information which has been processed to show the influence of events on different functions, such as marketing or production associated with particular activities or tasks.
6. (S) Non-financial information that relates to the following areas:
   (a) Internally-oriented information such as efficiency, output rates, employee absenteeism, etc.
   (b) Market information such as market size, growth share,
7. (I) Presence of precise targets for the activities of all sections within your department.
8. (T) Information supplied to you automatically upon its receipt into information systems or as soon as processing is completed.
9. (A) Costs separated into fixed and variable components.
10. (T) There is no delay between an event occurring and relevant information being reported to you.

11. (A) Information provided on the different sections or functional areas in your organization, such as marketing and production, or sales, cost, or profit centers.
12. (A) Information on the effect of events on particular time periods (e.g. monthly/quarterly/annual summaries, trends, comparisons, etc.).
13. (I) Information that relates to the impact that your decision have on the performance of other departments.
14. (A) Information on the effect of different section's activities on summary reports such as profit, cost, revenue reports for:
    a) your particular department .....
    b) the overall organization .....
15. (A) Information in formats suitable for input into decision models such as: (discounted cash flow analysis or incremental/marginal analysis).
16. (T) Reports are provided frequently on a systematic, regular basis; e.g. daily reports, weekly reports (for less frequent reporting, mark lower end of a scale).
17. (I) Information on the impact that your decision will have throughout your business-unit, and the influence of other individual's decisions on your area of responsibility.
18. (S) Quantification of the likelihood of future events occurring (e.g. probability estimates).
19. (S) Information on broad factors external to your organization, such as economic conditions, population growth, technological development, labor market, etc.
20. (S) Non-economic information, such as customer preferences, employee attitudes, labor relations, attitudes of government and consumer bodies, competitive threats, etc.

Appendix 5.1: Production standardization to test for discriminate validity of the customization instrument

Processes

Below are descriptions which characterize processes firms carry out. Depending upon the context, each of these descriptions may represent the situation for all, only a fraction or none of the processes a firm carries out. Please indicate below what percentage of current total activities regarding the production and marketing departments you are supervising is accounted for by processes represented by each of the descriptions given below. Again your answers should total 100%.

To produce the right products/services:

a. we always use the same process	____ %
b. on each occasion the process is switched into a pre-specified mode	____ %
c. on each occasion the process is switched partly into a pre-specified mode and partly into a unique mode	____ %
d. a new process is designed for every product/service/client	____ %
e. None of the above descriptions fits our situation (please specify)	____ %
_____	
_____	
Total	100 %

Appendix 5.2: Tables for the multi method multi trait test of the customization instrument

(1)	(2) Bu 1a[a]	(3) Bu 1b	(4) Bu 1c	(5) Bu 1d
Co 2a[b]	0.01 (0.96)	0.28 (0.01)	0.15 (0.43)	-0.33 (0.06)
Co 2b	0.23 (0.20)	-0.25 (0.17)	-0.02 (0.91)	-0.07 (0.71)
Co 2c	-0.15 (0.41)	-0.08 (0.64)	0.01 (0.95)	0.25 (0.16)
Co 2d	-0.28 (0.11)	0.17 (0.35)	-0.07 (0.68)	0.26 (0.14)

[a] = business unit manager, question 1a: standard products, question 1b: mass customization, question 1c, semi-tailored product, question 1 d tailored products.
[b] = controller, question 2a: always using the same production process, question 2b: switching production to pre-specified mode, question 2c: semi-unique mode, question 2d: unique mode.

Table A5.1: Different traits/different raters test for validity, business unit managers and controllers, correlations (significance) between items

(1)	(2) Bu 2a[a]	(3) Bu 2b	(4) Bu 2c	(5) Bu 2d
Co 1a[b]	0.18 (0.31)	-0.05 (0.78)	0.16 (0.37)	-0.01 (0.95)
Co 1b	-0.08 (0.65)	0.17 (0.35)	-0.16 (0.37)	-0.04 (0.83)
Co 1c	-0.06 (0.75)	-0.10 (0.58)	0.38 (0.03)	0.16 (0.38)
Co 1d	-0.13 (0.48)	0.06 (0.76)	-0.15 (0.40)	0.29 (0.10)

[a] = business unit manager, question 2a: always using the same production process, question 2b: switching production to pre-specified mode, question 2c: semi-unique mode, question 2d: unique mode.
[b] = controller, question 1a: standard products, question 1b: mass customization, question 1c, semi-tailored product, question 1 d tailored products.

Table A5.2: Different traits/different raters test for validity, business unit managers and controllers, correlations (significance) between items

(1)	(2) Bu 1a[a]	(3) Bu 1b	(4) Bu 1c	(5) Bu 1d
Bu 2a[b]	0.43 (0.01)	-0.21 (0.23)	-0.30 (0.09)	-0.16 (0.37)
Bu 2b	-0.26 (0.20)	0.12 (0.51)	0.44 (0.00)	-0.05 (0.80)
Bu 2c	-0.19 (0.29)	-0.22 (0.22)	-0.08 (0.66)	0.10 (0.57)
Bu 2d	-0.19 (0.30)	0.01 (0.96)	-0.04 (0.81)	0.25 (0.16)

[a] = business unit manager one, question 1a: standard products, question 1b: mass customization, question 1c, semi-tailored product, question 1 d tailored products.
[b] = business unit manager two, question 2a: always using the same production process, question 2b: switching production to pre-specified mode, question 2c: semi-unique mode, question 2d: unique mode.

Table A5.3: Different traits/Single raters test for validity, business unit managers, correlations (significance) between items

(1)	(2) Co 1a[a]	(3) Co 1b	(4) Co 1c	(5) Co 1d
Co 2a[b]	-0.13 (0.48)	0.05 (0.78)	0.29 (0.10)	-0.26 (0.15)
Co 2b	-0.37 (0.04)	0.07 (0.72)	-0.46 (0.01)	-0.07 (0.70)
Co 2c	-0.16 (0.39)	-0.09 (0.61)	-0.10 (0.59)	0.13 (0.48)
Co 2d	-0.24 (0.18)	0.00 (0.99)	0.34 (0.05)	-0.08 (0.64)

[a] = controllers 1, question 1a: standard products, question 1b: mass customization, question 1c, semi-tailored product, question 1 d tailored products.
[b] = controllers 2, question 2a: always using the same production process, question 2b: switching production to pre-specified mode, question 2c: semi-unique mode, question 2d: unique mode

Table A5.4: Different traits/Single raters test for validity, controllers, correlations (significance) between items

(1)	(2) Bu 1a[a]	(3) Bu 1b	(4) Bu 1c	(5) Bu 1d
Co 1a[b]	0.74 (0.00)	-0.30 (0.09)	-0.33 (0.06)	-0.46 (0.01)
Co 1b	-0.24 (0.19)	0.52 (0.00)	0.04 (0.84)	-0.17 (0.35)
Co 1c	-0.29 (0.11)	0.05 (0.77)	0.28 (0.12)	0.14 (0.45)
Co 1d	-0.45 (0.00)	0.17 (0.35)	-0.06 (0.74)	0.66 (0.00)

[a] = business unit manager; question 1a: standard products, question 1b: mass customization, question 1c, semi-tailored product, question 1 d tailored products.
[b] = controller; question 1a: standard products, question 1b: mass customization, question 1c, semi-tailored product, question 1 d tailored products.

Table A5.5: Same traits/different raters test for validity customization, controllers and business unit managers, correlations (significance) between items

(1)	(2) Bu 2a[a]	(3) Bu 2b	(4) Bu 2c	(5) Bu 2d
Co 2a[b]	0.12 (0.49)	-0.07 (0.71)	-0.11 (0.53)	-0.02 (0.95)
Co 2b	-0.05 (0.76)	0.28 (0.11)	-0.21 (0.24)	-0.26 (0.14)
Co 2c	0.16 (0.36)	-0.10 (0.57)	-0.05 (0.78)	-0.09 (0.64)
Co 2d	-0.30 (0.09)	-0.15 (0.41)	0.76 (0.01)	0.08 (0.68)

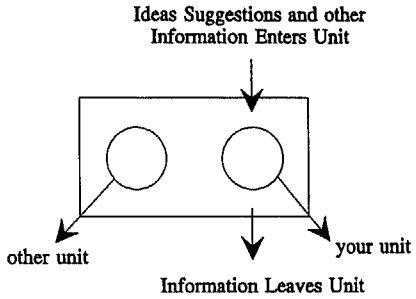
[a] = business unit manager; question 1a: standard products, question 1b: mass customization, question 1c, semi-tailored product, question 1 d tailored products.
[b] = controller; question 1a: standard products, question 1b: mass customization, question 1c, semi-tailored product, question 1 d tailored products.

Table A5.6: Same traits/different raters test for validity, production standardization, business unit managers and controllers, correlations (significance) between items

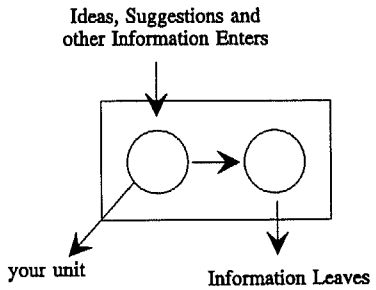
Appendix 5.3: Communication flow instrument to test for discriminate validity of the workflow interdependence instrument

Please indicate how much of the total ideas, suggestions, and other information in regard to the departments' work, flows in each of the ways, as shown by the figures and as described in a), b), c), and d).

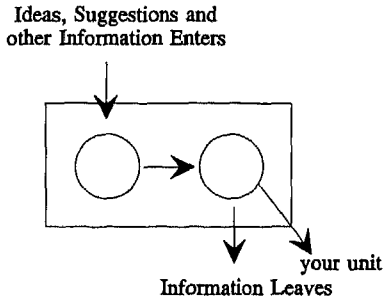
a) *Independent Information Flow Case*. Where ideas, suggestions, and other information are used by your department independently and do not flow between your and the other department.



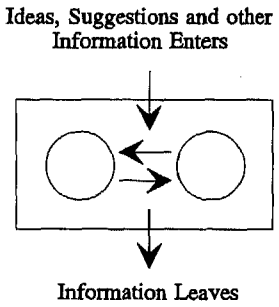
b) *Sequential Information Flow Case 1*: from you to them. Where ideas, suggestions, and other information flow between your department and the other department, but only from your to the other department.



c) *Sequential Information Flow Case 2*: from them to you. Where ideas, suggestions, and other information and activities flow between your department and the other department, but only from the other to your department.



d) *Reciprocal Information Flow Case.* Where ideas, suggestions, and other information flow between your department and the other department in a reciprocal "back and forth" manner over a period of time until the work it regards is done.



Appendix 5.4: Tables in regard to the multi trait multi rater test of the interdependence instrument

(1)	(2) Pooled work PM	(3) Sequential Work PM	(4) Reciprocal work PM
Pooled information SM	0.61 (0.01)	-0.82 (0.01)	-0.47 (0.01)
Sequential Information SM	-0.46 (0.01)	0.31 (0.01)	0.32 (0.01)
Reciprocal Information SM	-0.41 (0.01)	0.36 (0.01)	0.17 (0.12)

Table A5.7: Different traits/different raters test for validity, work/information flows Production and Sales managers, correlations (significance)

(1)	(2) Pooled Information PM	(3) Sequential Information PM	(4) Reciprocal Information PM
Pooled Work SM	0.66 (0.01)	-0.36 (0.01)	-0.51 (0.01)
Sequential work SM	-0.59 (0.01)	0.41 (0.03)	0.34 (0.01)
Reciprocal work SM	-0.27 (0.00)	0.01 (0.94)	0.38 (0.00)

Table A5.8: Different traits/different raters test for validity, work/information flows Sales and Production managers, correlations (significance of the correlation)

(1)	(2) Pooled work PM	(3) Sequential Work PM	(4) Reciprocal work PM
Pooled information PM	0.59 (0.01)	-0.82 (0.01)	-0.47 (0.01)
Sequential Information PM	-0.46 (0.01)	0.46 (0.01)	0.08 (0.46)
Reciprocal Information PM	-0.51 (0.01)	0.28 (0.09)	0.45 (0.01)

Table A5.9: Different traits/Single rater test for validity, work/information flows Production managers, correlations (significance)

(1)	(2) Pooled work SM	(3) Sequential Work SM	(4) Reciprocal work SM
Pooled information SM	0.76 (0.01)	-0.66 (0.01)	-0.34 (0.00)
Sequential Information SM	-0.59 (0.01)	0.63 (0.01)	0.08 (0.48)
Reciprocal Information SM	0.50 (0.01)	0.29 (0.01)	0.43 (0.01)

Table A5.10: Different traits/Single rater test for validity, work/information flows Sales managers, correlations (significance)

(1)	(2) Pooled work PM	(3) Sequential Work PM	(4) Reciprocal work PM
Pooled work SM	0.63 (0.01)	-0.41 (0.01)	-0.45 (0.01)
Sequential work SM	-0.54 (0.01)	0.41 (0.01)	0.29 (0.01)
Reciprocal work SM	-0.28 (0.01)	0.10 (0.38)	0.34 (0.01)

Table A5.11: Same traits/Different rater test for validity, work flows Production and Sales managers, correlations (significance)

(1)	(2) Pooled information PM	(3) Sequential information PM	(4) Reciprocal information PM
Pooled information SM	0.86 (0.01)	-0.45 (0.01)	-0.54 (0.01)
Sequential information SM	-0.67 (0.01)	0.40 (0.01)	0.33 (0.01)
Reciprocal information SM	-0.55 (0.01)	0.23 (0.04)	0.45 (0.01)

Table A5.12: Same traits/Different rater test for validity, information flows Production managers, correlations (significance)

Appendix 6.1: The error terms in the system of equations

Before hypotheses 2 to 3c can be tested it should first be ascertained that the data are suited to conduct the proposed path analysis. It is assumed in the path model that the error terms produced in the system of equations (1) and (2) are uncorrelated (Dillon and Goldstein, 1985). This assumes that independence exists for error terms with respect to the same items, and that violation of the assumption would preclude the proposed analyses. To ensure that this assumption was not violated with the data used in these analyses a test is conducted that estimates the correlation coefficient of the error terms [$p_{2u}S_u$ with $p_{3v(i)}S_{v(i)}$]. The model was run in 2-stage least squares (2 SLS) rather than in OLS, letting error terms free to move. A significant correlation between these error terms would preclude the use of OLS and would violate the fundamental theorem of path analysis which assumes error terms to be uncorrelated. The results of this test are presented in Table A6.1.

	Scope	Integration	Aggregation	Timeliness
Correlation				
Error terms equation(1)/equation (2)	-0.01	-0.05	-0.04	-0.04
Significance level	(0.99)	(0.99)	(0.99)	(0.99)

Table A6.1: Correlations (significance levels) between the error terms of equations (1) and (2) to assess the independence of errors on the same items in the equations

Correlations are insignificant. This supports the hypothesis that the error terms are uncorrelated. Hence, the fundamental theorem of path analysis is met and the results of the test warrant the use of OLS.

Appendix 6.2: Simulation

A Monte Carlo simulation is performed to ascertain whether the different distributions of the Wald test and the t test affect the conclusions about the levels of significance in the sample. The simulation is carried out using the calculated path coefficients and standard errors as predictors for the variables of interdependence and MAS. The simulation is carried out using the following equations:

$X(a)_2 = p(a)_{21}X_1 + S_1\,\epsilon_1$

$X(b)_{3(i)} = p(b)_{31(i)}X_1 + p(b)_{32(i)}X_2 + S_2\epsilon_2$

where,

X_1 = Customization

X_2 = Interdependence

$X_{3(i)}$ = MAS

$X(.)$ = simulated value of interdependence/MAS

$p(.)$ = sample beta

and i = 1..4;

1 = Scope

2 = Integration

3 = Aggregation

4 = Timeliness

S_i = Error variable

$\epsilon_i \sim$ N(0,1)

$N(.)$ = normal distribution

In the simulation $X(.)$ is calculated under the assumption of a normal distribution of error terms, using the sample betas. Then $X(.)$ is regressed on the sample variables of customization and interdependence. This procedure is repeated 1,000 times for each dependent variable. The claim of the test is that when the critical value of W or t is exceeded by a vast majority of the simulations, the probability of a type II error (falsely accept the null hypothesis) becomes small. The significance level of the betas is in both the simulation and the sample evaluated against the same critical point (5 percent level of significance). The simulation is also used to examine whether a beta insignificant in the sample appears also insignificant in the simulation, precluding the occurrence of a type I error (falsely reject the null hypothesis).

Production or sales manager (p/s)	*Independent variable*	*MAS dimension*	*Percentage sample W ≥ critical W*	*Percentage sample t ≥ critical t*	*Sample conclusion (P=5 percent)*
p and s	customization	aggregation	32.4	32.8	reject
	interdependence		69.0	69.3	accept
	customization	integration	50.8	51.1	reject
	interdependence		100.0	100.0	accept
	customization	scope	6.4	5.8	reject
	interdependence		5.5	4.0	reject
p	customization	timeliness	85.8	85.8	accept
	interdependence		97.0	97.0	accept
s	customization	timeliness	9.5	0.1	reject
	interdependence		92.9	92.9	accept

Table A6.4: Comparison of Wald tests versus t tests

Type I error

For most betas the simulation leaves little doubt with respect to whether a relationship extends beyond the level of significance. This makes it unlikely that a type I error occurred. There is one relationship for which the conclusion is not straightforward: customization and integrated MAS. Rejection of this relationship may result in a type I error because in 50 percent of the cases the level of significance exceeds the critical value.

Type II error

It appears from the simulation that the Wald and the t tests show similar power. Thus, it does not make much difference, in this model and data set, whether conclusions are based on either test. Comparison of the number of times that the critical Wald or t values are exceeded in the simulation suggests that the Wald test and the t show similar power. This means that conclusion based on either test runs a similar risk for the occurrence of type II errors. Given these results it is unlikely for a type II error to occur.

References

Abernethy, M.A. (1988), *The Impact of Task and individual Goal Orientations on the Effectiveness of Management Control Systems*, (Unpublished Ph.D thesis La Trobe University, Melbourne).

Abernethy, M.A. and Lillis, A.M. (1995), *The Impact of Manufacturing Flexibility on Management Control System Design*, Accounting, Organizations and Society, 20(4) pp. 241-258.

Abernethy, M.A. and Guthrie, C.H. (1994), *An Empirical Assessment of the "Fits" between Strategy and Management Information System Design* Accounting and Finance, pp. 49-66.

Ackoff, R.L. (1967), *Management Misinformation Systems*, Management Science, 11(4), pp. 147-156.

Anthony, R.N. (1965), *Planning and control systems: a framework for analysis*, (Division of Research, Harvard Graduate School of Business, Boston).

Argyris, C. (1977), *Organizational Learning and Management Information Systems*, Accounting, Organizations and Society, 2(2) pp. 113-123.

Atkinson A.A., Banker, R.D., Kaplan, R.S. and Young, M., (1997), *Management Accounting, second edition*, (Prentice-Hall International Editions).

Baldwin C.Y., Clark, K.M., (1997), *Managing in an Age of Modularity*, Harvard Business Review, September-October, pp. 85-93.

Barnard, C. (1938), *The Functions of the executive*, (Cambridge: Harvard University Press).

Baumler, J.V. (1971), *Defined Criterion of Performance and Organizational Control*, Administrative Science Quarterly, pp. 340-349.

Bohrnstedt, G.W. (1983), *Measurement*, in: Rossi, P.H., Wright, J.D., and Anderson, A.B. (Eds.), (The Handbook of Survey Research, Academic Press London Inc.).

Bohrnstedt, G.W. and Knoke, D. (1988), *Statistics for Social Data Analysis*, (F.E. Peacock Publishers, Inc. Itasca, Illinois).

Bolton, P. and Dewatripont, M. (1995), *The Time and Budget Constraints of the Firm*, European Economic Review, 39/3-4, pp. 691-699.

Bowen, D.E., C. Siehl and Schneider, B.A. (1989), *A Framework for Analyzing Customer Service Orientations in Manufacturing*, Academy of Management Review, pp. 75-95.

Breusch, T.S. (1979), *Conflict among Criteria for Testing Hypotheses: Extensions and Comments*, Econometrica, 47, pp. 203-207.

Brickley, J.A., Smith, C.W., and Zimmerman, J.L. (1997), *Managerial Economics and Organizational Architecture*, (IRWIN Inc.).

Brownell, P. (1982), *The Role of Accounting Data in Performance Evaluation, Budgetary Participation and Organizational Effectiveness*, Journal of Accounting Research, 23(2) pp. 12-27.

Brownell, P. (1985), *Budgetary Systems and the Control of Functionally differentiated Organizational Activities*, Journal of Accounting Research, 23(2) pp. 502-512.

Brownell, P. and McInnes, M. (1986), *Budgetary Participation, Motivation and Managerial Performance*, The Accounting Review, 61(4) pp. 502-512.

Brownell, P. and Merchant, K.A. (1990), *The Budgetary and Performance Influences of Product Standardization and Manufacturing Process Automation*, Journal of Accounting Research, 28(2) pp. 388-397.

Bruns, W.J. and McKinnon, S.M. (1992), *The Information Mosaic*, (Harvard Business press).

Bruns, W.J. and McKinnon, S.M. (1993), *Information and Managers: A Field Study*, Journal of Management Accounting Research, 5, pp. 84-108.

Burchell, S., Clubb, C., Hopwood, A., Hughes, J. and Nahapiet, J. (1980), *The Role of Accounting in Organizations and Society*, Accounting, Organizations and Society, 2, pp. 5-27.

Campbell, D.T. (1953), *a Study of Leadership among Submarine Officers*, (Columbus: Ohio State University Research Foundation).

Campbell, D.T. (1956), *Leadership and its Effects upon the Group*, (Columbus: Ohio State University Bureau of Business Research).

Carmines, E.G. and Zeller, R.A. (1991), *Reliability and Validity Assessment*, (Sage University Paper series on Quantitative Applications in the Social Sciences, series no. 01-017, Beverly Hills and London: Sage Pubns).

Chandler, A.D. (1962), *Strategy and Structure*, (Anchor Books).

Chapman, C.S. (1997), *Reflections on a Contingency View of Accounting*, Accounting, Organizations and Society, 22(2), pp. 189-205.

Chenhall, R.H. and Morris D. (1986), *The Impact of Structure, Environment, and Interdependence on the Perceived Usefulness of Management Accounting Systems*, Accounting Review, 61, pp. 15-36.

Chenhall, R.H. and Morris D. (1995), *Organic Decisions and Communication Processes and Management Accounting Systems in Entrepreneurial and Conservative Business Firms*, Omega, pp. 485-497.

Chenhall, R.H. and Brownell, P. (1988), *The Effect of Participative Budgeting on Job Satisfaction and Performance: Role Ambiguity an Intervening Variable*, Accounting, Organizations and Society, 13(3) pp. 225-233.

Chia, Y.M. (1995), *Decentralization, Management Accounting Systems MAS Information Characteristics and Their Interaction Effects on Managerial Performance: A Singapore Study*, Journal of Business Finance and Accounting , 22 (6) pp. 811-830.

Chong, V.K. (1996), *Management Accounting systems, Task Uncertainty and Managerial Performance: A Research Note*, Accounting, Organizations and Society, 21(5) pp. 415-421.

Chrisman, J.J., Hofer, C.W. and Boulton, W.R. (1988), *Toward a System for Classifying Business Strategies*, Academy of Management Review, pp. 16-35.

Clark, J.M. (1923), *Studies in Economics of Overhead Costs*, (University of Chicago Press).

Coase, R. (1937), *The Nature of the Firm*, Economica, p. 386-405.

Cooper, R. and Kaplan, R.S. (1991), *The Design of Cost Management Systems: Text, Cases and Readings,* (Prentice Hall).

Cronbach, L.J. (1951), *Coefficient Alpha and the Internal Structure of Tests*, Psychometrica, 16, pp. 297-334.

Daft R.L. and Lengel, R.H. (1984), *Information richness, a New Approach to Managerial Behavior and Organization Design*, Research in Accounting behavior, 6, pp. 191-233.

Daft R.L. and Lengel, R.H. (1986), *Organizational Information Requirements, Media Richness and Structural Design*, Management Science, 32(5), pp 554-571.

Demski, J.S. and Feltham, G.A. (1976), *Cost Determination, a Conceptual Approach*, (Ames: IOWA State University Press).

Demski, J.S. (1980), *Information Analysis*, second edition, (Addison-Wesley Publishing Company, Reading Massachusetts).

Dent, J.F. (1990), *Strategy, Organizations and Control: Some Possibilities for Accounting Research*, Administrative Science Quarterly, pp. 313-327.

Dillman, D.A. (1983), *Mail and Other Self-Administered Questionnaires*, in: Rossi, P.H., Wright, J.D., and Anderson, A.B. (Eds.), (The Handbook of Survey Research, Academic Press London Inc.).

Dillon, W. and Goldstein, M. (1984), *Multivariate Analysis, Methods and Applications*, (John Wiley & Sons).

Drazin, R. and Van de Ven, A.H. (1985), *Alternative Forms of Fit in Contingency Theory*, Administrative Science Quarterly, 30, pp. 514-539.

Drury, C. (1996), *Management Accounting and Cost Accounting*, (International Thompson Business Press).

Drury, C. and Tayles, M. (1998), *Cost System Design for Enhancing Profitability* , Management Accounting (CIMA), January, pp. 40-42.

Earl, M.J. (1983), *Management Information Systems and Management Accounting*, in: Cooper, D., Scapens, R.W., and Arnold, J. (Management Accounting Research and Practice, Cima, London).

Earl, M.J. and Hopwood, A.G. (1981), *From Management Information to Information Management*, in: Lucas, H.C., Jr et al. (Eds.), (The Information Systems Environment, North-Holland).

Emmanuel, C., Otley, D.T. and Merchant, K.A. (1990), *Accounting for Management Control*, (Chapman and Hall).

Evans, G.B.A. and Savin, N.A. (1982), *Conflict among the Criteria Revisited; the WLR and LM Tests,* Econometrica, 50, pp. 737-748.

Fama, E.F. and Jensen, M.C. (1983a), *Separation of Ownership and Control*, Journal of Law and Economics, 24, pp. 301-325.

Fama, E.F. and Jensen, M.C. (1983b), *Agency Problems and Residual Claims*, Journal of Law and Economics, 26, pp. 327-349

Feitzinger, E. and Lee, H.L. (1997), *Mass Customization at Hewlett-Packard*, Harvard Business Review, January-February, pp. 117-121

Fisher, J. (1994), *Technological Interdependence, Labor Production Functions and Control Systems*, Accounting, Organizations and Society, 19(6) pp. 493-505.

Fisher, J. (1995), *Contingency-Based Research on Management Control Systems: Categorization by Level of Complexity*, Journal of Accounting Literature, 14, pp. 24-53.

Fisher, R.A. (1946), *Statistical Methods for Research Workers* (10th edition), (Edinburgh: Oliver and Boyd).

Fisher, C. (1996) *The Impact of Perceived Environmental Uncertainty and Individual Differences on Management Information Requirements: A Research note*, Accounting, Organizations and Society, 21, pp 361-369.

Foster, B.P and Ward, T.J. (1994), *Management Accounting Innovation Lag*, Accounting, Organizations and Society, 19(4), pp. 401-411.

Frankel, M. (1983), *Sampling Theory*, in: Rossi, P.H., Wright, J.D., and Anderson, A.B. (Eds.), (The Handbook of Survey Research, Academic Press London Inc.)

Galbraith, J. (1973), *Designing Complex Organizations*, (Addison-Wesley).

Galbraith, J. (1977), *Organization Design*, (Addison-Wesley).

Gilmore, J.H. and Pine II, B.J. (1997), *The Four Faces of Mass Customization*, Harvard Business review, pp 91-101.

Godfroy, L.G. (1991), *Misspecification Tests in Econometrics: the Lagrange Multiplier Principle and other Approaches*, (Cambridge University Press: Econometric Society Monographs).

Gordon, L.A. and Miller, D. (1976), *A Contingency Framework for the Design of Accounting Information Systems*, Accounting, Organizations and Society, 1, pp 59-69.

Gordon, L.A. and Narayanan, V.K., (1984), *Management Accounting Systems, Perceived Environmental Uncertainty and Organizational Structure: An Empirical Investigation*, Accounting, Organizations and Society, 9(1), pp. 493-505, 33-47.

Gorry G. and Scott-Morton, M.A. (1971), *A Framework for Management Information Systems*, Sloan Management Review, pp. 55-70.

Govindarajan, V. and Gupta, A.K. (1985), *Linking control Systems to Business Unit Strategy: Impact on Performance*, Accounting, Organizations and Society, 10(1), pp. 51-66.

Govindarajan, V. (1988), *A Contingency Approach to Strategy Implementation at the Business-Unit Level: Integrating Administrative Mechanisms with Strategy*, Academy of Management Journal, 31(4), pp. 828-853.

Govindarajan, V. and Fisher, J. (1990), *Strategy, Control Systems, and Resource Sharing: Effects on Business-Unit Performance*, Academy of Management Journal, 33(2), pp. 259-285.

Gresov, C. (1989), *Exploring Fit and Misfit with multiple Contingencies*, Administrative Science Quarterly, 34, pp. 431-453.

Gul, F.A. (1991), *The Effects of Management Accounting Systems and Environmental Uncertainty on Small Business Managers' Performance* Accounting and Business Research, 5, pp. 57-61.

Gul, F.A. and Chia, Y.M. (1994), *The Effects of Management Accounting Systems, Perceived Environmental Uncertainty and Decentralization on Managerial Performance' A Test of Three-way Interaction*, Accounting, Organizations and Society, 19(4/5), pp. 413-426.

Hammond, Th. H. (1994), *Structure, Strategy, and the Agenda of the Firm*, in: Rumult, R.P., Schendel, D.E. and Teece, D.J. (Eds.), (Fundamental Issues in Strategy, Harvard Business School Press, Boston Massachusetts).

Harrison, G.L. (1990), *Reliance on Accounting Performance Measures in Superior Evaluative Style - The Influence of Culture*, (Unpublished Ph.D thesis Macquarie University, Melbourne).

Hayes, D.C. (1975), *The Contingency Theory of Managerial Accounting, An Empirical Test of an Assessment Model*, (Ph.D. thesis, The Ohio State University).

Hayes, D.C. (1977), *The Contingency Theory of Managerial Accounting*, Accounting Review, pp. 22-39.

Heise, D.R. and Bohrnstedt, G.W. (1971), *Validity, Invalidity and Reliability*, in Borgatta, E.F., Bohrnstedt (eds.), (Sociologic Methodology, Jossey-Bass, San Francisco).

Hodap, V. (1984), *Analyse linearer Kausalmodelle*, (Bern: Verlag Hans Huber).

Hofstede, G.H. (1981), *Management Control of Public and Not-For-Profit Activities*, Accounting, Organizations and Society, 3, pp. 196-197.

Holmström, B. (1979), *Moral Hazard and Observability*, Bell Journal of Economics, 10, pp. 74-91.

Hopwood, A.G. (1974), *Accounting and Human Behaviour*, (Prentice Hall contemporary Topics in Accounting Series).

Horngren, C.T., Foster, G. (1994), *Cost Accounting: a Managerial Emphasis*, seventh edition (Prentice Hall).

Horngren, C.T,, Foster, G., and Datar, S.M. (1997), *Cost Accounting: a Managerial Emphasis*, ninth edition (Prentice Hall).

Johnson, H.T. and Kaplan R.S. (1987), *Relevance Lost: The Rise and Fall of Management Accounting*, (Boston, MA: Harvard Business School Press).

Jöroskog, K.G. (1993), *Testing Structural Equations Models*, in: Bollen, K.A. and Scot Long, J. (eds), (Testing Structural Equations models, Sage Publications, pp. 294-316).

Kerlinger, F.N. (1986), *Foundations of Behavioral Research, third edition*, (New York, N.Y. 10017).

Kotler, P. (1989), *From Mass Marketing to Mass Customization*, Planning Review, 17, pp. 10-13.

Kotha, S. and Orne, D. (1989), *Generic Manufacturing Strategies: A Conceptual Synthesis*, Strategic Management Journal, 10, pp. 211-231.

Kotha, S. (1995), *Mass Customization: Implementing the Emerging Paradigm for Competitive Advantage*, Strategic Management Journal, 16, pp. 21-42.

Langfield-Smith. K. (1997), *Management Control Systems and Strategy: a Critical Review*, Accounting Organizations and Society, 22(2), pp. 207-232.

Larcker, D.F. (1981), *The Perceived Importance of Selected Information Characteristics for Strategic Capital Budgeting Decisions*, The Accounting Review, pp. 519-538.

Larsson, R. and Bowen, D.E. (1989), *Organizations and Customer: Managing Design and Coordination of Services*, Academy of Management Review, 14(2), pp. 213-233.

Lawler, E.E. III (1967), *The Multitrait-Multirater Approach to Measuring Managerial Job Performance*, Journal of Applied Psychology, 51(5), Part 1, pp. 369-383.

Lawrence, P.R. and Lorsch, J.W. (1967), *Organization and Environment: Managing Differentiation and Integration*, (Irwin, Homewood, Illinois).

Macintosh, N.B. and Daft, R.L. (1987), *Management Control Systems and Departmental Interdependencies: An Empirical Study*, Accounting, Organizations and Society, 10(1), pp. 49-61.

Macintosh, N.B. (1995), *Management Accounting and Control Systems: an Organizational and Behavioral Approach*, (John Wiley and Sons, New York (NY)).

Macintosh, N.B. (1985), *The Social Software of Accounting and Information Systems*, (John Wiley and Sons, New York (NY)).

Mahoney, T.A., Jerdee, T.H., and Carroll S.J. (1965), *The Jobs of Management*, Industrial relations, pp. 97-110.

Majchrzak, A. and Wang, Q. (1996), *Breaking the Functional Mind-Set in Process Organizations*, Harvard Business Review, September-October, pp. 93-99.

Mansfield, E. (1983), *Statistics for Business Economics*, (New York (NY) W.W. Norton and Company).

March, J. and Simon, H. (1958), *Organizations*, (John Wiley and Sons, New York (NY)).

Mia, L. and Chenhall, R.H. (1994), *The Usefulness of Management Accounting Systems, Functional Differentiation and Managerial Effectiveness*, Accounting, Organizations and Society, 19(1), pp. 1-13.

Mia, L. and Goyal, M. (1991), *Span of Control, Task Interdependence and Usefulness of MAS Information in Not-For-Profit Government Organizations*, Financial Accountability & Management, 7(4), pp. 249-266.

Miles, R.E. and Snow, C.C. (1978), *Organizational Strategy, Structure, and Process*, (New York (NY): Mc-Graw-Hill).

Milgrom, P. and Roberts, J. (1990), *The Economics of Modern Manufacturing: Technology, Strategy and Organization*, American Economic Review, 80(3), pp. 511-528.

Milgrom, P. and Roberts. J. (1992), *Economics, Organization and Management*, (Prentice-Hall International, Inc.).

Miller, D. and Friessen, P.H. (1982), *Innovation in Conservative and Entrepreneurial Firms, Two Models of Strategic Momentum*, Strategic Management Journal, 3, pp. 1-25.

Mohr, L.B. (1971), *Organizational Technology and Organizational Structure*, Administrative Science Quarterly, 16, pp. 444-459.

Murray, A.I. (1988), *A Contingency View of Porter's "Generic Strategies"*, Academy of Management Review, 13(3), pp. 390-400.

Nehmetz, P.L. and Fry, L.W. (1988), *Flexible Manufacturing Organizations: Implications for Strategy Formulation and Organizational Design*, Academy of Management Review, 13(4), pp. 627-638.

Nunnaly, J.C. (1967), *Psychometric Theory*, (New York (NY): Mc-Graw-Hill).

Osborne, D. and Ringrose, N. (1998), *Market-Focused Cost Reduction*, Management Accounting (CIMA), January, pp. 28-30.

Otley, D.T. (1980), *The Contingency Theory of Management Accounting: Achievements and Prognosis*, Accounting, Organizations and Society, 4, pp. 413-428.

Otley, D.T. (1987), *Accounting Control and Organizational Behaviour*, (Heinemann professional publishing, Oxford).

Otley, D.T. and Pollanen R. (1997), *Budgetary Criteria in Performance Evaluation*, working paper.

Parthasarthy, R. and Sethi, S.P. (1993), *Relating Strategy and Structure to Flexible Automation: a Test of Fit and Performance Implications*, Strategic Management Journal, pp. 529-549.

Pentland, B.T. and Rueter, H.H. (1994), *Organizational Routines as Grammars of Actions*, Administrative Science Quarterly, 39, pp. 484-510.

Pine II, B.J. (1993), *Mass Customization: The New Frontier in Business Competition* (Harvard Business School Press, Boston Ma).

Pitz, G.F., Downing, L. and Reinhold, H. (1967), *Sequential Effects in the Revision of Subjective Probabilities*, Canadian Journal of Psychology, 21, pp. 381-391.

Porter, M.E. (1980), *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, (New York: The Free Press).

Porter, M.E. (1985), *Competitive Advantage*, (New York: The Free Press).

Pugh, D.S., Hickson, D.J., Hinings, C.R. and Turner, C. (1968), *Dimensions of Organization Structure*, Administrative Science Quarterly, 13, pp. 65-105.

Pugh, D.S., Hickson, D.J., Hinings, C.R. and Turner, C. (1969), *An Empirical Taxonomy of Structures of Work Organizations*, Administrative Science Quarterly, pp. 115-126.

Ronen, J. and Livingstone, J.L. (1975), *An Expectancy Theory Approach to the Motivational Impact of Budgets*, The Accounting review, 50, pp. 671-685.

Rosner, M.M. (1968), *Administrative Controls and Innovation*, Behavioral Science, 13, pp. 36-43.

Runkel, P.J. and McGrath, J.E. (1972), *Research on Human Behaviour: A Systematic Guide to Method*, (New York, Holt, Rinehart and Winston).

Samuelson, W. and Zeckhauser, R. (1988), *Status Quo Bias in Decision Making*, Journal of Risk and Uncertainty, 1, pp. 7-59.

Scapens, R.W. (1985), *Management Accounting: A Review of Contemporary Developments*, (MacMillan Publishers ltd).

Simon, H.A. (1959), *Theories of Decision Making in Economics and Behavioral science*, The American Economic Review, pp. 233-283.

Simon, H.A. (1960), *The New Science of Management Decision*, (Harper & Row, New York (NY)).

Simons, R. (1987), *Accounting Control Systems and Business Strategy: An Empirical Analysis*, Accounting, Organizations and Society, 12(4), pp. 357-374.

Simons, R. (1990), *The Role of Management Control in Creating Competitive Advantage: New Perspectives*, Accounting, Organizations and Society, 15(1/2), pp. 127-143.

Sitter, L.U. de (1994), *Synergetisch Produceren, Human Resource Mobilisation in de Produktie: een Inleiding in de Structuurbouw*, (Van Gorcum, Assen, The Netherlands)

Specht, D.A. and Warren, R.D. (1975), *Comparing Causal Models*, (in, Sociological Methodology, Heise, R.H, (Ed.) San Francisco: Jossey Bass).

Specht, D.A. (1975), *On the Evaluation of Causal Models*, Social Science Research , 4, pp. 113-133.

Sudman, S. (1983), *Applied Sampling*, in: Rossi, P.H., Wright, J.D., and Anderson, A.B. (Eds.), (The Handbook of Survey Research, Academic Press London Inc.).

Swenson, W. (1997), *Best Practices in Activity-Based Management Design*, Journal of Cost Management, November-December, pp. 6-14.

Thompson, J.D. (1967), *Organizations in Action*, New York (NY): Mc-Graw-Hill).

Thompson, J.D. and Tuden, A. (1959), *Strategies, structures, Processes of Organisational Decision*, in: Thompson, J.D. et al. (Eds.), (Comparative Studies in Administration, University of Pittsburgh Press).

Tushman, M.L. and Nadler, D.A (1978), *Information Processing as an Integrating Concept in Organizational Design*, Academy of Management Review, pp. 613-624.

Upton, D.M. and Macadam, S.E. (1997), *Why (and How) to Take a Plant Tour*, Harvard Business Review, May-June, pp. 97-106.

Van de Ven, A.H., Delbecq, A.L. and Koenig, R. (1976), *Determinants of Coordination within Organizations*, American Sociological Review, 41, pp. 322-338.

Walton, R.E. and Dutton, J.M. (1969), *The Management of Interdepartmental Conflict: A Model and Review*, Administrative Science Quarterly, pp. 73-84.

Williamson, O. (1985), *The Economic Institution of Capitalism*, (Free Press, New York).

Williamson, O. (1992), *Comments on "Specific and general knowledge and organizational structure" by Jensen, M.C. and Meckling, W.H.*, in: Werin, L. and Wijkander, H. (Eds.) (Contract Economics, Blackwell Publishers, Cambridge).

Zimmerman, J.L. (1979), *The Costs and Benefits of Cost Allocations*, Accounting Review, 54, pp. 504-521.

Zimmerman, J.L. (1995), *Accounting for Decision Making and Control*, (Richard D. Irwin Inc., 1995).

Samenvatting (summary in Dutch)

Het gebruik van Management Accounting Systems in Functioneel Gedifferentieerde Ondernemingen

1.1 Het object van onderzoek

Deze studie onderzoekt binnen business units, of de gekozen strategie en de afhankelijkheid tussen afdelingen een relatie hebben met het gebruik van Management Accounting Systemen (MAS). De volgende relaties worden in het bijzonder onderzocht:

* strategie en het gebruik van MAS;
* de afhankelijkheid tussen afdelingen en het gebruik van MAS;
* strategie in relatie tot de afhankelijkheid tussen afdelingen en het gebruik van MAS.

Deze verbanden worden onderzocht om de omstandigheden waaronder verschillen in het ontwerp MAS optreden, te identificeren.

1.2 Motivatie

Strategie en MAS
Eerdere studies naar de relatie tussen strategie en MAS gebruiken een zodanig ruime definitie van strategie dat deze alle aspecten van een business unit strategie omvat (Govindarajan and Gupta, 1985; Simons, 1990), of definiëren strategie op het niveau van bedijfsfunctie (Abernethy and Guthrie, 1994). Langfield-Smith (1997) stelt dat onderzoeksresultaten met betrekking tot de relatie strategie en accounting-systemen vaak gefragmenteerd zijn, en conflicteren. Als hoofdoorzaak van deze verwarring noemt zij de wijze van strategieformulering en -operationalisering.
Deze studie houdt rekening met verschillen die kunnen bestaan binnen en tussen generieke strategieën door zich te concentreren op één element ervan, namelijk customization. Customization wordt gedefinieerd als de mate waarin een business unit klantspecifieke kenmerken aan het produkt of de dienst toevoegt.

De afhankelijkheid in - en tussen afdelingen (interdependentie) en MAS
Studies die de relatie tussen interdependentie en MAS-gebruik onderzochten, hebben als gemeenschappelijk nadeel dat ze geen onderscheid maken in de afhankelijkheid die bestaat tussen individuele taken en de afhankelijkheid tussen functionele afdelingen. Dit terwijl er in de organisatieliteratuur wordt betoogd dat de coördinatie tussen individuele taken

belangrijk verschilt van coördinatie tussen afdelingen. Om vast te kunnen stellen aan welk van de twee typen interdependentie MAS-gebruik is gerelateerd, is interdependentie in deze studie geoperationaliseerd als de afhankelijkheid tussen afdelingen (verder zal dit interdependentie worden genoemd).

De link tussen strategie, interdependentie en MAS
De relatie tussen strategie en interdependentie heeft weinig aandacht gekregen in empirisch werk. Theoretisch werk suggereert echter dat coördinatieproblemen tussen verkoop en produktie ontstaan wanneer organisaties besluiten cliënten een grote variëteit aan produkten te bieden (Milgrom and Roberts, 1990; 1992).
Deze studie is de eerste waarin de relaties tussen strategie, interdependentie en MAS-gebruik in één onderzoek worden verenigd. Dit gebeurt in een theoretisch model dat de relaties tussen customization, interdependentie en MAS in kaart brengt in Hoofdstuk 3.
Tevens wordt deze theorie empirisch getest in Hoofdstuk 6, terwijl de implicaties ervan worden besproken in Hoofdstuk 7.

2 Theoretisch raamwerk: customization, interdependentie en MAS-gebruik

Het proefschrift ontwikkelt een theoretisch raamwerk waarin de genoemde relaties als volgt worden uitgewerkt. Customization heeft twee effecten voor afzonderlijke afdelingen. In de eerste plaats wordt het werk van elke afdeling beïnvloed doordat het maken van produkten op maat niet toestaat dat processen volledig vooraf worden geprogrammeerd. Dit heeft invloed op de operationele produktie- en verkoopbeslissing die daarmee niet langer een routinebeslissing kan zijn. Om deze operationele beslissingen te kunnen nemen, zal de manager op zoek gaan naar informatie die hem helpt bij het vinden van werkbare oplossingen. Deels kan deze informatie, zo wordt beargumenteerd, worden verkregen via MAS. Er wordt derhalve verwacht dat een verhoogde intensiteit in customization (meer produktkenmerken op maat maken) leidt tot een verandering in het gebruik van MAS.
Er is nog een tweede effect, namelijk dat customization invloed heeft op interdependentie. Dit effect wordt verwacht omdat produktie- en verkoopbeslissingen die binnen een business unit worden genomen invloed hebben op elkaar. Bijvoorbeeld: de beslissing van een verkoopmanager om aan een klant te beloven dat een produktkenmerk wordt toegevoegd dat nog niet eerder werd gemaakt, raakt niet alleen Verkoop, maar juist ook Produktie. Naarmate customization toeneemt, zal daarom de interdependentie toenemen. Omdat dit effect optreedt, is het voor zowel produktie- als verkoop-managers belangrijk inzicht te hebben in de lokale en interlokale gevolgen van een beslissing. Hierbij kan worden gedacht aan technologie en de verschillende doelstellingen van afdelingen (bijvoorbeeld efficiëntie voor Produktie en omzet voor Verkoop). Om deze problemen op te lossen heeft de manager behoefte aan

informatie die hem het noodzakelijke inzicht verschaft. In de theorie wordt beargumenteerd dat MAS hierin een rol kan vervullen. In de theorie worden MAS in de dimensies reikwijdte, tijdigheid, aggregatie en integratie beschreven (Chenhall and Morris, 1986):

> MAS-informatie met een brede reikwijdte kan financieel of niet-financieel zijn, kwantitatief of kwalitatief, en kan waarschijnlijkheidsgevens bevatten omtrent het optreden van gebeurtenissen. Reikwijdte kan ook gerelateerd zijn aan de interne en externe omgeving van de organisatie. Tijdigheid van MAS-informatie betreft de frequentie en snelheid waarmee informatie wordt bijgesteld. Geaggregeerde MAS-informatie bevat gecomprimeerde data over bedrijfsfuncties en input-output relaties, en is daarom geschikt voor toepassing in formele beslissingsmodellen. Integrerende MAS-informatie geeft informatie specifiek over een afdeling waarmee de beslissende afdeling een afhankelijkheidsrelatie heeft, weergegeven in doelen, kostprijzen en wederzijdse effecten van beslissingen die individuele afdelingen nemen.

De behoefte aan informatie wordt volgens de ontwikkelde theorie gevoed doordat managers die niet-programmeerbare beslissingen dienen te nemen, onzekerder worden over de uitkomst ervan. Dit betreft zowel de specifieke afdelingsactiviteiten als de activiteiten van andere afdelingen waarmee een afhankelijkheidsrelatie bestaat. Meer specifiek zijn de effecten merkbaar in het werk in technische zin en ten opzichte van de specifieke doelstellingen die elke afzonderlijke afdeling nastreeft (Earl en Hopwood, 1981). De studie identificeert hoe elke MAS-dimensie managers helpt om deze onzekerheden te verkleinen.[1] Deze ondersteuning is tweeledig. In de eerste plaats kan de manager het niet routinedeel in technisch opzicht beter begrijpen wanneer hij over informatie ter zake beschikt. Daarbij kan de betrokken manager tevens inschatten of een voorgenomen beslissing niet een zodanig effect heeft dat deze buiten de doelstellingen van de andere afdelingen vallen (verkoop van een produkt dat Produktie niet kan voortbrengen). In de tweede plaats kan MAS-informatie helpen bij het versnellen van het beslissingsproces. Hierdoor wordt voorkomen dat snel te nemen beslissingen zijn gespeend van analyse.

[1] Hiermee wordt niet beweerd dat MAS als exclusieve informatiebron dienst doet.

3 Belangrijkste resultaten en implicaties

3.1 Resultaten

1. Er is een sterk verband gevonden tussen customization en interdependentie.
2. Toegenomen interdependentie leidt inderdaad tot een gewijzigd gebruik van MAS
3. Toegenomen customization heeft nauwelijks een direct effect op het gebruik van MAS, behalve op produktie-managers die aangeven tijdig aangeleverde informatie intensiever te gaan gebruiken.
4. Er bestaat een sterk verband tussen customization en het gebruik van MAS *via* interdependentie voor de MAS-dimensies integratie, aggregatie en tijdigheid.

3.2 Implicaties

3.2.1 Customization-interdependentie

Het resultaat met betrekking tot deze relatie impliceert dat customization voor een deel samenvalt met interdependentie tussen afdelingen. Van functioneel gedifferentieerde organisaties die het niveau van customization verhogen, wordt daarom verwacht dat zij tevens systemen installeren die managers in de gelegenheid stellen de toenemende interdependentie het hoofd te bieden.

3.2.2 Interdependentie en MAS-gebruik

Dit is de derde studie (na Chenhall and Morris, 1986; Mia and Goyal, 1991) die een positieve relatie bevestigt tussen toenemende niveaus van interdependentie en MAS. Echter, interdependentie is in deze studie gedefinieerd tussen afdelingen. Het empirische bewijs van deze studie duidt erop met name dat de afhankelijkheidsrelatie tussen afdelingen het gebruikt van MAS beïnvloedt. Dit duidt erop informatie die nodig is voor problemen binnen afdelingen niet aan het MAS worden ontleend, terwijl dat voor problemen die samenvallen met interdependentie juist wel geldt.
De resultaten van deze studie wijken af van voorafgaande studies doordat geen relatie tussen 'reikwijdte' en interdependentie kon worden bevestigd. Dit indiceert dat managers over andere informatiemiddelen beschikken dan MAS om informatie met een brede reikwijdte te verwerven.

3.2.3 Customization MAS-gebruik

De zwakke directe relatie die werd gevonden tussen customization en MAS kan twee betekenissen hebben. Of de managers van afdelingen hebben geen additionele problemen als gevolg van customization die zich beperken tot de afdelingsgrenzen, of managers gebruiken andere informatie dan verstrekt door MAS om hun lokale problemen op te lossen. Met de huidige gegevens kan geen uitsluitsel worden gegeven omtrent de meest waarschijnlijke verklaring.

3.2.4 Customization, interdependentie, MAS-gebruik

De resultaten tonen een sterk verband aan tussen customization en MAS *via* interdependentie. Er wordt daarom geconcludeerd dat in functioneel gedifferentieerde organisaties rekening moet worden gehouden met een verhoogde onzekerheid bij het nemen van beslissingen die het gevolg is van customization. Zowel de economische organisatie-theorie (Holmström, 1979) als psychologie (Ronen en Livingstone, 1975) leren dat wanneer verwachte uitkomsten te veel van realisaties afwijken, de motivatie van managers om zich voor gunstige beslissingen in te zetten, afneemt. Het gevolg daarvan is dat de inzet van managers in afnemende mate de uitkomsten van het bedrijf bepaalt. Voor een organisatie die een customization-strategie invoert en niet tevens maatregelen neemt die de toegenomen onzekerheid verkleinen, wordt verwacht dat deze slechter presteert dan anderszins mogelijk. Maatregelen kunnen liggen in de sfeer van de organisatiestructuur, of, zoals onderzocht in deze studie, in de sfeer van de informatie.

3.3 Algemene bijdragen van de studie

Een belangrijke bijdrage van de studie bestaat er uit dat het ontwerp van de studie een precieze identificatie toestaat van de effecten van strategie en interdependentie:
Customization beïnvloedt, als een strategische prioriteit, het gebruik van MAS bij het nemen van operationele beslissingen. Dit effect verloopt vooral indirect *via* interdependentie tussen afdelingen. Dit resultaat kon worden gevonden door gebruik te maken van een enge definitie van strategie en te concentreren op organisaties die worden gekenmerkt door een functioneel gedifferentieerde structuur. Tevens wordt één soort beslissing en één soort interdependentie geoperationaliseerd.

Tevens werd met de studie gevonden dat produktie- en verkoop-managers die met eenzelfde mate van customization worden geconfronteerd, een vergelijkbaar beeld vertonen in de verandering van het gebruik van MAS. Dit duidt erop dat verschillende managers in dezelfde onderneming behoefte hebben aan gelijke informatie.

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JAN BOUWENS graduated in Business Administration (Finance) in 1991. Since then, he has held a position as a lecturer at the Department of Accounting at Tilburg University. His research is conducted under the aegis of the CentER Accounting Research Group and IOSA (Tilburg University).

Management Accounting Systems (MAS) facilitate decision making and control in organizations. This study investigates both theoretically and empirically how MAS help managers to make their decisions. This issue is specifically addressed in a context where production and sales managers face high levels of customization. This is a strategy where product features are determined by the customer, rather than by the organization. It is argued that, under these circumstances, production and sales departments must solve more difficult problems. Firstly, because each department must, for its own activities, consider what the consequences are of producing non-standardized products. Secondly, production of non-standardized products in one department may affect activities of other departments. For instance, sales must consider whether customer requirements are consistent with organizational objectives and technological constraints of sales as well as production. One of the major sources of information for decision making are MAS. The study reveals that customization increases interdependence, and that production and sales managers use MAS to co-ordinate the interdependence between production and sales. However, only weak support is found for the assumed relationship of customization affecting MAS use in its own right. Managers may use different information systems to address issues that concern their specific department only.

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