

**ACCOUNTING INFORMATION  
AND  
VALUE CHAIN ANALYSIS:  
An exploratory field study**

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Research Memorandum **ARC A-RM-0 1 • 11**

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## Abstract

Interfirm relationships introduce new challenges for management accounting. One such challenge is to **provide** the information for the coordination and optimization of **activities** across firms in a value chain. In literature it is argued that a value *analysis* is a method to meet this challenge. **However**, little empirical **evidence** currently exists on the use of this analysis in **practice**. This paper presents an exploratory case study on the use of an activity-based **costing** model by the U.K. retail firm J. Sainsbury's and a group of 36 suppliers for supporting supply chain management **practices**. This cost model is based on the **principles** of value chain analysis, and integrates **cost** information of firms across the value chain. This allows them to perform benchmark analyses, **strategic what-if** analyses and monitoring of supply chain **costs** for supply chain optimization.

### Keywords:

interfirm relationships,

value chain analysis,

case study

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## 1. Introduction

Until recently interfirm relationships have gained little attention on the agenda of management accounting researchers, and only since a few years in accounting literature more attention is asked for this issue (Hopwood, 1996; Munday, 1992; Otley, 1994). The acknowledgement of the major implications of these relationships for the **organization** of activities and the related consequences for accounting and **control** within and between organizations has, **however**, led to an increase of interest (e.g., **Anderson** et al., 2000; **Frances** and **Garnsey**, 1996; **Gietzman**, 1996; **Ittner** et al., 1999; **Seal** et al., 1999; **Tomkins**, 2001). Some **specific** issues in interfirm relationships that are more **intensively discussed** in accounting literature are the make-or-buy decision and outsourcing of activities (**Anderson** et al., 2000; **Gietzman** 1996; **Widener** and **Selto**, 1999), **inter-organizational cost** management (**Carr** and **Ng**, 1995; **Cooper** and **Slagmulder**, 1999), and value chain analysis (**Shank**, 1989; **Shank** and **Govindarajan**, 1992, 1993).

This paper **focuses** on the use of value chain analysis (VCA) in interfirm relationships. In literature VCA is viewed as a **core** analytical tool of **strategic management accounting**. This method of analyzing the value chain for **strategic** improvement, was **introduced** by **Porter** (1985) and in management accounting literature further developed by **Shank** (1989) and **Shank** and **Govindarajan** (1992, 1993). The central idea of the **analysis** is to break up “the chain of activities that runs from **basic raw** materials to end-use customers into strategically relevant segments in order to understand the behavior of **costs** and the sources of differentiation” (**Shank** and **Govindarajan**, 1992, p.180). The development of VCA in literature, **however**, has primarily been conceptual. Little **empirical evidence** of its use in **practice** exists, which has been a reason for criticism on the **relevance** of the concept for **practice** (**Lord**, 1996). In this paper an **empirical analy-**

sis of the use of VCA by the U.K. retail firm J. Sainsbury's and a group of its suppliers is provided. This company has developed a activity-based costing model, for performing cost analyses of the supply chains with its suppliers. To the author's knowledge, no empirical evidence on the use of such practices by firms has been published in literature before.

The remainder of this paper is structured as follows. First, the role of management accounting in interfirm relationships will be discussed. After this general discussion, the concept of VCA will be discussed in more depth. In particular, the use and problems of accounting information for supporting this analysis will be focused on. Then a case study is presented of how Sainsbury uses the VCA concept in its supply chain management efforts with suppliers. This case study will be followed by a discussion, in which it is suggested why little empirical evidence has been found up to date. The paper ends with a conclusion, and some avenues for further research into this subject.

## 2. Management accounting in interfirm relationships

Especially when compared with other fields of organizational research, such as management, organizational behavior and strategic management research, it can be observed that the issue of interfirm relationships has had little impact on management accounting research. Looking at those other areas of organizational research, however, learns that despite the extensive attention towards interfirm relationships, little attention has gone out to the actual *management* of those relationships. Most research has focused on the explanation of the *choice* for and of the (governance) *form* of interfirm relationships (Gulati and Singh, 1998; Spekman et al., 1998). Particularly in the management of interfirm relationships the role of management accounting information can

be significant. For instance, in a **strategic** alliance between a buyer and supplier of rail-way safety equipment, management accounting practices were intensively used by the partners for the management and **control** of the alliance (Dekker, 2000). These **specific** practices were used to coordinate innovations and to safeguard the partners' interests, and consisted of a financial incentive system, planning and budgeting, and performance measurement based on open book accounting. Tomkins (2001) calls for an increased focus on the management of interfirm relationships, by arguing that 'the area warrants more empirical research with a greater emphasis **upon** business **processes** and the use of accounting in **action/negotiation**' (p. 164).

Seal et al. (1999) **discuss** three **areas** of common ground between management accounting and interfirm relationships: (1) the make-or-buy decision that **can** lead to the initiation of a partnership, (2) the use of management accounting in the actual management of a partnership and (3) the partners' responsibilities to **each** other, inducing the use of performance measurement. It **can** be argued that the relationship between management accounting and interfirm relationship is not unidirectional: management accounting **may** both influence, and be influenced by interfirm relationships. These influences **may** change over **time**, depending on the stage of the relationship in the **relationship** life cycle (Spekman et al., 1998).<sup>1</sup> This relationship life cycle **can** be described by a phase-model, consisting of four phases: initiation, design, execution and decline. In the initiation phase one **firm** recognizes the need for or **benefits** of initiating an interfirm relationship, and **selects** an appropriate partner (or more) for this purpose. **After** this potential partner agrees to the **proposal** to **collaborate**, the design phase is entered, in which the relationship is shaped by designing a governance **structure** that **arranges** the functioning of the **alliance**.<sup>2</sup> In the execution phase the actual execution of the activities for which the relationship was started, takes **place**. Finally, the relationship **may** be **terminated**, for example because performance (of the alliance or of one of the partners) is

below expectations, or simply because the relationship was started only for a **predetermined** period or project.

On the one hand management accounting **can** have an influence on interfirm **relationships** in these different phases. For instance, management accounting **can** be beneficial at the initiation phase, influencing the **startup** of a relationship between organizations. Make or buy calculations, for instance, **can** indicate the benefits of allying with a **supplier**, instead of **internal** production.’ In an existing interfirm relationship a value chain analysis could indicate the benefits of **closer** coordination in a supply chain, for **improving** the efficiency and effectiveness of the supply chain (Porter, 1985). And performance measurement information **may** lead the partners to the conclusion that a **termination** of the alliance **may** be the best way forward.

On the other hand, the initiation of interfirm relationships **may** influence the role of management accounting *within* and *between* the cooperating organizations. For **instance**, accounting systems **may** be needed to **calculate costs** and benefits of the **cooperation** and to **allocate** these among the partners. These systems **may** be developed at the design stage of the relationship, in which partners wish to safeguard their interests, **before making** investments specifically for the relationship. And management accounting **may** be needed in order to **control** the behaviors and performances of the cooperating parties during the execution phase. In addition, management accounting **may** not only be needed for creating incentives, but **may also** be used for the coordination and **control** of activities to be performed (Dekker, 2000). Budgeting and performance measurement systems for example **can** be useful in this respect. Finally, **when** partners **decide** to **terminate** the alliance an accounting problem arises **how** to **allocate** the resources invested in and **generate** by the relationship among **the** partners.” These different implications of interfirm relationships for management accounting, and *vice versa*, clearly illustrate the

significance of this issue for management accounting research. As little empirical knowledge about this issue has been published, (exploratory) field research, generating empirical descriptions and explanations of the use and consequences of management accounting in interfirm relationships, **may** prove to be a successful research strategy for developing this area.

One issue in interfirm relationships, in which management accounting information is argued to play an important role, is the *value chain analysis (VCA)*. This analysis, which **builds** on the concept of the *value chain*, was developed by Porter (1985), and in accounting literature further addressed by Shank (1989) and Shank and Govindarajan (1992, 1993). Performing a VCA **can** be **beneficial** in several phases of the relationship life cycle. First, a VCA **can** be the impetus for initiating a cooperation, by indicating the **benefits** that **closer** coordination in an interfirm relationship **can** result in. **Second**, VCA **can** be used in the actual management of an existing relationship, to identify **possibilities** for improvement in the value chain.

### 3. Value Chain Analysis in interfirm relationships

According to Porter one important purpose of **strategic cost** analysis is to better manage linkages between buyers and suppliers in the value chain. A value chain is defined as “the linked set of value-creating activities **all** the way from **basic raw material** sources for component suppliers through the **ultimate** end-use product delivered into the **final** customers’ hands” (Shank, 1989, p.50). A VCA then is a **structured** method to analyze the **effects** of strategically important activities on the *cost and/or differentiation* of the value chain. In a VCA different types of relationships or ‘linkages’ **can** be **distin-**guished: relationships between activities, relationships between Business Units of the

firm, and vertical relationships between the firm and its buyers and suppliers (Porter, 1985). This latter type of relationships, referred to as 'vertical linkages' in the supply chain, describes how a firm's internal value chain is related to those of buyers and/or suppliers. A linkage expresses the relationship between the performance of one activity and its effects on the performance of another activity. In other words, a linkage exists when there is a certain degree of interdependence between activities (Shank and Govindarajan, 1992). In a relationship between a buyer and a supplier, linkages express how the supplier's activities influence the buyer's activities in terms of cost and differentiation, and vice versa. Often in literature it is not made clear what a VCA refers to, whether it is an internal oriented analysis of the activities within the firm, or whether it is an externally oriented analysis of the activities across firms in a supply chain. This paper focuses on the latter type of analysis, i.e. the analysis of linkages between activities of firms at different positions in the value chain.

According to Porter (1985) managing linkages in the value chain, which is also the central idea of the concept of *supply chain management* (SCM), can lead to a competitive advantage by reducing costs and enhancing differentiation. A VCA can be used to determine where in the value chain costs can be lowered or differentiation can be enhanced (Shank and Govindarajan, 1992). For performing this analysis and for managing linkages in the value chain, cost information is an essential element.

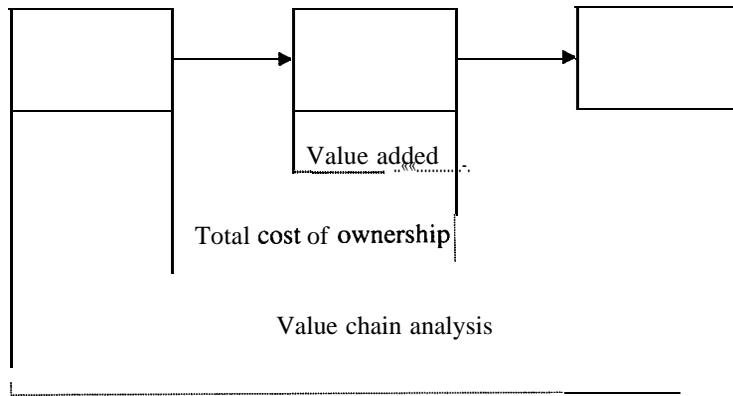
### 3.1 Accounting information for Value Chain Analysis

*While accounting systems do contain useful data for cost analysis, they often get in the way of strategic cost analysis (Porter, 1985, p.63)*

Porter's critique on what now are termed 'traditional' accounting systems, referred to the inability of those systems to adequately support a VCA. Traditional management

accounting practices are based on the internally oriented concept of *value added*. As Shank (1989) argues, a fundamental problem of this concept is that it “starts too late and it stops too soon” (p.5 1). He argues that by starting cost analysis not earlier than the costs of purchases, possibilities for exploiting linkages with suppliers are missed. And by stopping the cost analysis already at customers’ sales, possibilities to exploit linkages with those customers are missed. The value added perspective focuses only on (maximizing) the difference between purchasing costs and selling price, and ignores linkages in the wider value chain, such as the causes of this purchasing price, the costs of activities related to the product, and the consequences of the product for the activities of the buyer. Accounting systems that do account for costs that are caused by buying at a certain supplier, such as costs of ordering, delivery, quality and administration, are so-called *Total Cost of Ownership (TCO) systems* (Carr and Ittner, 1992). Compared to the scope of a VCA, TCO systems only analyze the effects of buying at a supplier on the costs of the internal organization. No external value chain perspective is taken, in which costs are analyzed for the overall chain. A VCA also includes the supplier’s activities and costs, and recognizes the interdependencies of activities and costs across the value chain. In order to perform this last type of analysis across different firms in the value chain, *in principle*, an integration of cost data of those different firms would be required.

The differences between the concepts of value added, TCO and VCA, in terms of (potential) scope of the analysis, can graphically be illustrated for a three firm value chain as in figure 1.



**Figure 1** A comparison of the Value Added, Total Cost of Ownership and Value Chain Analysis concepts

Hergert and **Morris** (1989) addressed the problems mentioned by Porter in more detail, and concluded that traditional accounting systems have several deficiencies for supporting **strategic** planning, and consequently for VCA. These can be summarized as follows:

**When** the firm is not organized around **Strategic Business Units (SBU's)**, the accounting system **will** not recognize the SBU as a dimension for data accumulation;

Traditional accounting systems do not focus on critical activities as a VCA does, but on responsibility centers;

Traditional accounting systems do not identify **factors** creating buyer value, which need to be treated as **cost objectives** for accumulating **costs, revenues** and **assets**;

Traditional accounting systems do not account for interdependence between **subunits** (**such** as activities), while **cost** and performance of one **subunit** **often** is dependent on the **costs** and performance of other subunits;

Cost center budgets are **often** a poor reflection of the economics of performing an activity, traditional accounting systems do not **accumulate** data about the drivers of **costs**.

Since the publications of Porter (1985) and Hergert and **Morris** (1989) several **man-**

agement accounting innovations have been introduced in the literature, of which in particular *Activity-Based Costing* (ABC) and the concept of *Strategic Cost Management* are important to the problems discussed above. ABC offered a solution for some of the problems of performing an internally oriented VCA, as it assigns costs to activities and identifies the specific drivers of those costs. Shank (1989) and Shank and Govindarajan (1992, 1993) subsequently developed the concept of Strategic Cost Management, in which accounting information is used for developing and supporting a firm's strategies. This concept in literature later was broadened to *Strategic Management Accounting* (SMA), which consists of analyses of different strategic dimensions of the firm, such as competitor analysis, strategic positioning analysis and analysis of the value chain which the firm is part of (Lord, 1996). SMA posits that management accounting information can be useful for supporting decisions related to these different strategic dimensions. The exploitation of linkages with suppliers and buyers is thus explicitly positioned as an important constituent of SMA. In the next paragraph it is discussed how a VCA is performed within the framework of SMA.

### 3.2 Performing a VCA

Shank and Govindarajan (1992, 1993) describe a methodology of how to perform a VCA. In their conception, a VCA explicitly takes account of the interdependence between activities of buyer and supplier. In the analysis the value chain is decomposed into strategically relevant activities, and costs, revenues and assets are assigned to these value activities. For each value activity that has been defined, the cost drivers are identified that cause the economic behavior of the activity. These steps enable to analyze the behavior of costs and the sources of differentiation. When performing a VCA, insight is gained into the relationships between the activities of buyers and suppliers, with respect to cost and differentiation. The last step they mention is to use the analysis to better control cost drivers (than competitors do) or to reconfigure the value chain, in order to

develop a sustainable competitive advantage. In **principle**, they argue, competitive advantage **can** be gained either by reducing costs, keeping value constant, or by increasing value, keeping costs constant.

Shank and Govindarajan's description of the VCA methodology assumes the analysis is performed by one organization, looking outside the organization to the related **firms** in the value chain (i.e., an external perspective). In interfirm cooperative relationships, **however**, a VCA **can also** be performed *jointly* by multiple **firms** in the supply chain. This is the case of the VCA **practices** of Sainsbury's and its suppliers, as **will be discussed** in the next **section**. This joint analysis of the value chain integrates **cost** data of those multiple **firms**, leading to a broader scope than an internally oriented VCA, and a **higher** accuracy of **cost** data than **when** the analysis is performed by one firm taking an **external perspective**.<sup>5</sup>

For the analysis of **cost** behavior it is important to have 'good' management accounting information. In literature ABC is mentioned as an important framework to use **when** performing a VCA (Guilding et al., 2000; Mecimore and Bell, 1996; Shank and Govindarajan, 1992, 1993). **When** based on ABC-principles, **much** of the problems of **accounting** systems for performing the VCA **discussed** by Hergert and Morris (1989) are **solved**.<sup>6</sup> The **cost** and **cost driver** information resulting from the analysis **can** be used, as suggested by Porter (1985), to optimize and better coordinate the performance of **activities** in the supply chain. For example, a VCA **may** lead partners to conclude that supply chain costs **will be reduced** **when** the supplier delivers **products** in another form, improving the efficiency of the buyer's receiving and stock keeping activities, or **when** activities (**such** as stock keeping) are aligned with **firms** in **the** supply chain **who can** perform them more **efficiently** (Dekker and Van Goor, 2000; LaLonde and Pohlen, 1996).

Empirical **evidence** on the use of VCA in practice is limited. It is not **clear** whether firms perform VCA's and if they do so, whether they do that according to the **methodology** proposed by Shank and Govindarajan. It has even been argued that, because of the **lack of evidence** on SMA, including VCA, this may be just 'a **figment of academic imagination**', with little **relevance** or interest in practice (Lord, 1996, p. 364). Tomkins (2001) **also** expresses his doubts about the extent to which **companies** go in **cross-organizational cost management** (p. 163). Chenhall and Langfield-Smith (1998) and Guilding et al. (2000) **provide** survey **evidence** on the adoption of SMA practices, including VCA practices, by large firms in respectively Australia, and New Zealand, the United **Kingdom** and the United States. **However**, these adoption **rates** are based on global descriptions of the VCA method, and no insight is gained into what these **practices** actually consist of. In addition, regarding their descriptions of the method, these results (probably) only account for the use of an internally oriented VCA of the firm, not an analysis of activities **across** the wider value chain. No empirical **evidence** has been published in literature on the use of VCA **across** firms in a value chain. The next **section** presents an empirical account of the use of **such** a VCA by the U.K. retail **company** J. Sainsbury's and a large group of its major suppliers.

## 4. The use of VCA at J. Sainsbury's

### 4.1 Research design

This section discusses the results of an exploratory case study into the use of a supply chain costing model by the U.K. retail firm J. Sainsbury's (from now on Sainsbury). Sainsbury has developed this model for supporting its supply chain management (SCM) practices with suppliers. Specifically, the model is used for analyzing the costs of activities of several firms in the supply chain to identify ways to reduce costs, and is based on similar principles as a VCA as discussed before. The selection of this case resulted from coincidence, as the existence and use of the model was identified as a result of a presentation of a company representative, about the use of ABC information for SCM practices. Because of the lack of evidence in literature about the use of VCA in practice, it was decided to further explore the use of this model at the company.

Exploratory case studies are especially useful for researching phenomena about which little empirical evidence is available, to find answers to how and why questions about these phenomena (Yin, 1994). However, the case study was not entered completely 'blank'. Based on existing literature about interfirm relationships, supply chain management, and ABC, and on the company data already available, an interview protocol was developed.<sup>7</sup> This protocol structured the data collection process of Sainsbury's SCM and VCA practices into three different topics: (1) company information, (2) the management of relationships with suppliers, and in particular SCM practices, and (3) the cost model. The data was collected in 1998. As, to the author's knowledge, this is the first empirical description of the use of VCA practices across a value chain, the presentation of the case study will primarily be descriptive. Questions discussed in this case study relate to the initiation, design, goals, and use of the cost model for supporting SCM practices.

## 4.2 Supply chain management at Sainsbury's

Since the company has been dethroned by Tesco in 1995, Sainsbury ranks as **second** largest retailer in the U.K., **when** measured in market share (Wheatley, 1998). In 1998 the company had over 23.000 different products on its shelves, supplied by **approx-**imately 4.000 suppliers. Based on the type of products these suppliers deliver, Sainsbury **classifies** them into **six** different networks: *produce, main ambient, slow moving ambient, bulky goods, chilled* and *frozen*. Around 1993, Sainsbury **changed** its way of working with suppliers by no **longer** using its power towards suppliers, which resulted in adversarial relationships, but to focus on cooperative relationships, to be able to **im-**prove supply chain performance. The idea behind this change of attitude was that the supply chain should not be perceived as a source of **costs**, but, to the contrary, should be regarded as a source of **competitive** advantage (Wheatley, 1998). These **changes** took **place** in a period in which U.K. retailers intensively reorganized their business **proc-**esses, in which new information systems were **introduced** into the supply chain to **re-**duce waste of resources and to improve the coordination of activities, referred to as *Efficient Consumer Response* (ECR), and *Quick Response Partnershipping* (Frances and Garnsey, 1996). In 1998, for example, Sainsbury launched a comprehensive man-agement information system on the internet, called *Sainsbury Information Direct (SID)*, which is used for coordinating activities with suppliers. SID consists of a diverse set of tools for information exchange for better coordination of activities, **such** as Web-EDI, joint promotion planning, performance measurement systems, and communication **sys-**tems.<sup>8</sup> Before this period of reorganizing activities in the supply chain, Sainsbury had **little** contact with suppliers about the functioning of the **supply** chain.

Sainsbury's SCM efforts are performed by the department of Logistics. For **managing** the supply chain, three types of suppliers are distinguished, primarily based on the

volume that they deliver, but **also** on the *strategic importance* of their products for Sainsbury. The 24 key suppliers together account for approximately 30% of **all** products sold by Sainsbury, and were referred to as '**core** suppliers'. In 1996 Sainsbury and these suppliers have formed the *Supply Chain Development Group (SCDG)*, which initiates activities for improving the supply chain. As these suppliers have a major impact on the supply chain and **also** have **sufficient** resources for carrying out large projects, the most important supply chain improvement projects are performed with them. Yearly, senior managers of **companies** in this group meet in a '**strategic** forum' to exchange **information**, to present the **changes** they are implementing in their supply chain, and to keep up personal **contacts**. In addition, meetings are held with individual members of the group to **discuss** developments in the supply chain and to initiate improvement projects, **such** as the development of **collaborative** planning systems, which are subsequently worked out in detail in joint project teams. The SCDG uses SID for exchanging information with members about projects that are being executed, **such** as reports, results, and opinions.

The **second** type of suppliers distinguished for SCM **practices** were referred to as 'middle-large suppliers', with **whom** individual actions for improvement have too little impact to justify the **costs** of those actions. **However, when** treated as a group, significant improvements **can** be realized with them (i.e., a critical mass **needs** to be realized). For instance, this is the case with cross-docking. **When** using cross-docking, suppliers do not deliver directly to **all** Sainsbury's regional distribution centers (**RDC's**) anymore, but instead deliver to a primary consolidation center (PCC or intermediate warehouse). In this PCC, deliveries of different suppliers for different **RDC's** are bundled, which are then transported by Sainsbury to the **RDC's**. This **practice can result** in large efficiency gains, as **each** supplier **can reduce** its number of deliveries from **many** to one, and Sainsbury transports only **once** to **every** RDC. **However**, for cross-docking to be **benefi-**

cial, a large group of suppliers that frequently deliver orders of a reasonable size is required. Deliveries from middle-large suppliers are of such a size that they do not deliver full loads at the RDC's, and are therefore suited for cross-docking. As orders at the core suppliers are of sufficient size that they, on a daily basis, deliver full vehicles to the RDC's, cross-docking results in no benefits for the supply chain. Because the number of middle-large suppliers at Sainsbury is growing, the impact of this group on cost and performance is also increasing.

The third type of suppliers distinguished in SCM practices were referred to as 'small suppliers', which often deliver a small number of products in low volumes. Specific actions for improving the supply chain with small suppliers have little impact on costs and performance. These suppliers primarily take part in general actions for supply chain improvements, such as the web-EDI, that Sainsbury has developed for all (especially for small and middle-large suppliers), as a cost reducing alternative for the costly normal EDI-systems. This web-EDI improves information exchange, by enabling suppliers to receive orders and production planning forecasts, and to send invoices to Sainsbury by the internet.

In addition to having intensified contact with its suppliers for SCM practices, Sainsbury has intensified contact with competitors, such as Tesco and Safeways, to discuss supply chain improvements, for example during *Efficient Consumer Response* conferences. It is possible that changes in the supply chain can only result in benefits, when more retailers cooperate in the initiative, for example, because a certain scale may be required for realizing the benefit. For example, the use of a new technology in RDC's, by which crates can be traced electronically (see also Wheatly, 1998), will only result in supply chain improvements when more retailers take part in the initiative, as otherwise the investment in the technology, and the supplier's different ways of working with retailers is

too costly and **ineffective**. Acknowledging this dependency on competitors, Sainsbury **will tell** them *what* they are doing or are planning to do (the electronically tracing of crates), in order to persuade them **also** to adopt the idea for improvement. **However**, Sainsbury **will not tell how** the company is doing it (the actual implementation and integration into existing systems), as this type of knowledge is perceived as a **competitive advantage**. SCM thus does not necessarily refer to a collaboration between buyer and supplier per se, but **can also** require a cooperation with or contribution of competitors. In the previous situation, in which Sainsbury had little contact with suppliers, there was little insight in the costs of activities and the performance of suppliers in the supply chain, as these were not measured. Therefore, supply chain **cost** and performance management was difficult to realize. Five years ago Sainsbury decided to improve **possibilities** for supply chain **control**, amongst others by developing a **cost** model for **SCM**.<sup>9</sup>

#### 4.3 A cost model for value chain analysis

Until 1996, the only insight Sainsbury had into the costs of the supply chain were the yearly distribution costs. This information provided little possibilities for coordination and **control** of activities in the supply chain. As argued by a Logistics project manager:

*"It wasn't really a supply chain measure of performance. You certainly couldn't say well, this level of performance in the supply chain is gonna cost us this amount of money. We didn't know what the costs were. You know, we didn't know where the cost felt within the supply chain."*

To support their SCM efforts, Sainsbury's senior management requested the Logistics department to develop an **ABC** model of the supply chain, as **ABC** was perceived as a 'key enabler' of **such practices** (see also Coopers & Lybrand, 1996). The **specific** request was:

*' To **provide** Senior Management with a greater understanding of the Total **Supply Chain Process** in order to improve decision **making** and deliver a **clear understanding** of the interrelationship of costs and the activities that drive them'*  
*[Sainsbury presentation].*

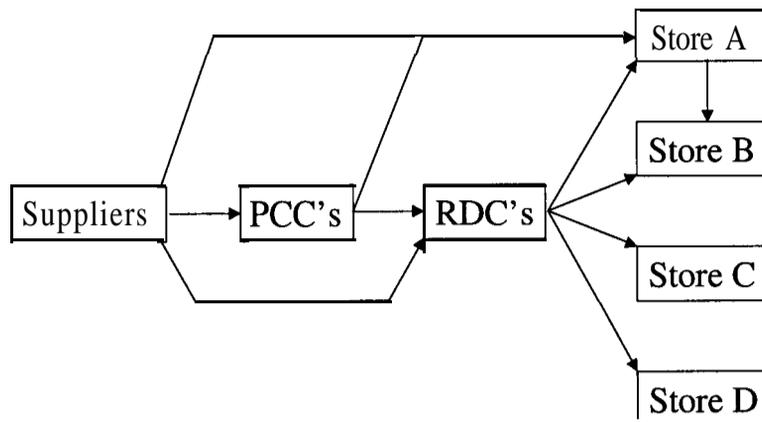
The purpose for **building** this model was to enable Sainsbury to analyze the costs of activities in the supply chain with suppliers in order to **reduce** costs and to better monitor and **control** costs. More specifically, the goal of the model is to perform activity and cost driver analyses to gain insight into the supply chain costs, to **generate** ideas for cost reduction and to **calculate** the cost effects of changes in supply chain activities.

#### **The design of the model**

For the development of the model the following definition of the boundaries of the supply chain was used:

*'All activities involved in moving the product from the end of the suppliers ' production line onto the supermarket **shelf** '[Sainsbury presentation].*

These boundaries of the supply chain thus include the supplier's activities, Sainsbury's distribution activities, and Sainsbury's retail activities. Sainsbury graphically visualizes the (complex) **structure** of its supply chain drawing by the flows of **products** that go through it, as in **figure 2**.



**Figure 2** The structure of Sainsbury's supply chain

Suppliers can thus deliver to PCC's, to RDC's or directly to the stores. When a supplier delivers to a PCC or RDC, then Sainsbury takes care of further distribution in the supply chain to the stores. The design of the cost model reflects this supply chain structure. It contains different sections reflecting the activities performed at different stages of the supply chain. The sections distinguished are "suppliers", reflecting the suppliers' activities, "distribution", reflecting Sainsbury's distribution activities, and "retail", reflecting Sainsbury's retail activities related to the supply chain. Each of these sections contains around 20 standard activities, which are possibly (but not necessarily) performed in the supply chain with a supplier. Thus, compared to figure 1, the scope of Sainsbury's cost model can be presented graphically as in figure 3.

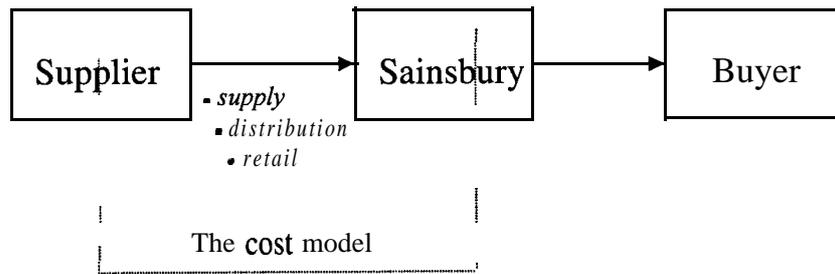


Figure 3 The scope of Sainsbury's cost model

The model thus does not reflect **all** value chain activities, but only activities related to moving the **products** through the supply chain to the stores' shelves. For **each** activity a **cost driver** is identified. A standard categorization of activities and **cost drivers** is used, as **when** compared to **each** other, most suppliers perform similar activities. The argument for using a standard categorization of activities was set forward by a project manager involved in the development and use of the model, **who** argued that:

*"We find that some suppliers would do some activities, not other activities, but **all** the activities that they want to do are in there. Like **unloading**, **all** the suppliers have to unload. Picking, **all** the suppliers have to pick, whether **they** pick by board automatically in a big automated warehouse, or whether they pick manually by **walking** around, they **all** pick. The **difference** is that the **cost** would be **different**, and the make up of the **cost** would be **different**. So, you know, one **supplier's cost** would be **almost** solely equipment maintenance and running, whereas another **one's** has got labor in there, and those associated **costs**. That's what we're looking for really, we're looking for the **difference**".*

Thus even though differences **may** exist between suppliers' operations, the model allows **all** activities they perform to be included. The model uses **cost** and activity

information of both Sainsbury and the suppliers, and thus integrates **cost** information of **firms across** the value chain. The costs (referred to as ‘resources’ in the model) consist of the supply chain related costs of suppliers, **PCC’s, RDC’s**, stores, and Sainsbury’s head office. The costs of both parties are allocated to the activities and **cost** drivers in the model. This exercise leads to an insight into **the** costs of activities in the supply chain. As the model does not **relate** costs to **cost objects** (e.g., **products**), but only to activities, it **can** be considered as a form of *Activity Cost Analysis* (Gosselin, 1997).<sup>10</sup> This is acknowledged by the project manager, **who** commented that:

*"Its not really true ABC as **such** you know, we **haven't** got the **profit sides** and everything **all** that in there, which is a different kind of **fish**. Purely **really** these are a list of activities, and these are the costs that are attached to those **activities**".*

The model is designed to be able to analyze activity costs from different perspectives: per *supplier network* (as **discussed** before), per *geographical region* (Sainsbury **distinguishes** **six** regions **where** activities are performed), and per *store category* (stores are classified as *super store, medium, **small** or product*). Sainsbury perceives the model as fairly simple and of high aggregation level. More detail, it was argued, is not necessary, because this level of detail is **sufficient** for realizing the model’s goal, as **discussed** before. The **structure** of the model **can** be summarized as in table 1.

Supplier	PCC	RDC	Retail
<i>Network</i>	<i>Location</i>	<i>Location</i>	<i>Location</i>
<i>Activities</i>	<i>Network</i>	<i>Activities</i>	<i>Store category</i>
<i>Cost elements</i>	<i>Activities</i>	<i>Cost elements</i>	<i>Activities</i>
	<i>Cost elements</i>		<i>Cost elements</i>

**Table 1** The structure of the cost model

### **The content of the model**

To be able to analyze the supply chain costs with the model, **cost** and **cost driver** data are required from both Sainsbury and suppliers. At the **time** of the study, the model **contained** two years of actual **cost** and **cost driver** data of Sainsbury and 36 suppliers. The suppliers participating in this initiative were mainly the larger suppliers (in terms of volume), with **whom much** work in improving the supply chain was **already** going on. These suppliers were involved **first**, because of the large volume of activities, leading to **higher benefits**, and because the joint SCM activities **already** taking **place** signified their willingness to participate in this type of efforts. The number of suppliers providing data was expected to increase, as several suppliers at that **time** were collecting the required data, or were investigating the possibilities for data collection.

Suppliers are free to choose whether or not they are willing to participate in this **initia-** tive. **When** they **decide** to participate, they are required to deliver **cost** data and **cost driver** quantities to Sainsbury for **feeding** the suppliers **side** of the model. Suppliers have to **collect** the data themselves. In order to **assist** them in this effort and to secure consistency of data **across** suppliers, a three page document is provided to new **partici-** pating suppliers, in which the data required for the model is described, and in which definitions of activities are provided. The reason for not providing a more detailed manual for data collection is that **this** would **scare** off suppliers **from** participation, as it would signal high complexity and a **time** consuming data collection **process**. In addition to the document, Sainsbury assists suppliers by informing them **how** they have **collected** the data. **However**, it was argued, Sainsbury does not have the **time**, nor the resources, to **assist all** new participating suppliers in their data collection efforts. Only in the **de-** velopment phase of the model Sainsbury participated in data collection at a few **suppli-** ers, to learn which information is required and **how** to **collect** it.

Suppliers thus have their own responsibility for **proving** reliable data. As it is not in their interests to **provide** unreliable information, Sainsbury does not perceive this as a risk for the reliability of the model.” Suppliers **can provide** their data in different formats. Some suppliers **provide** general ledger data, and related **cost** driver quantities, leaving Sainsbury to do the **cost** analysis. For other suppliers, **however**, the data collection process is a stimulus for also executing an ABC-analysis for **internal purposes**. Some suppliers, for instance, **already** had the wish to start an **internal ABC-study**, and the need to **collect** data for the **cost** model induced them to get started with that process. These suppliers generally **provide cost** data in **such** a format that it **can** be fed into the model directly. As has **often** been the case with the development of **internal ABC-models** (see for example Gosselin, 1997), Sainsbury experienced that **already** during the data collection process suppliers **often** realize benefits by identifying **possibilities** for (individually or jointly) improving processes, simply as a **result** of a better insight into their processes and costs. This has **also** been the company’s own experience during the development of the model.

The **cost** model is maintained by Sainsbury’s *Supply Chain Finance Group*. Quarterly, they update the model with Sainsbury’s **cost** and **cost** driver data. Suppliers need to **provide** new data **once** a year for updating the model. In addition, **when** a supplier implements important **changes** in its processes, the model is updated ad hoc.

#### **Analyzing the supply chain**

**Each time** the model has been updated, the supply chain **costs** are analyzed. This **analysis** results in an insight into the **costs** that have been generated by activities of Sainsbury and the suppliers. Participating suppliers **receive** the results of these analyses, which **include** their own activity **costs**, Sainsbury’s activity **costs** related to their activities, and the **average** activity costs of the network. More specifically, the Logistics project

manager commented that:

*"They see the proportion of our costs that plots to them. So they won't see our **entire structure**, what they'll see, they'll see their costs as it goes to ours that we spend moving their **stuff** through the supply chain, plus an **average cost** for that network, so they can see how they do against the **average** as it moves through our network. They **won't** see the resource element of it, but they'll see it **once** its split down into activities. So they 'll actually see the activities and **cost object side** of it. So they'll see the **cost** as it goes to the distribution network, **also** the costs as it goes into our **different stores**."*

Sainsbury's Logistics Operations department is the **main** user of the supply chain **cost** information. They use the outcomes of the **cost** analyses to initiate discussions with suppliers about the **cost** performance of the supply chain and its underlying **processes**. These discussions with suppliers are the most important goal of the **cost** information, in which it is used for generating ideas to **reduce** costs. Specifically, three types of analyses are made to support these discussions and to identify opportunities for **cost reduction**: *benchmark analyses*, *strategic what-if analyses* and *trend-analyses*.

*Benchmarking* is used to **compare** suppliers' activity costs with the **average** of their network. In addition, **cost** comparisons are made between networks, regions and store types. By clustering suppliers into different networks, the most important differences between their operations are eliminated for the benchmark analyses, as suppliers within a network perform fairly comparable activities. As argued by the project manager:

*"I think, the **fact** that we break down into network covers most of our **basic differences**, because essentially the operation is the same for **all** suppliers. We're not*

*looking at their production side, that's not included, there's a lot differences in their production side. But from once it has been made, they are going through pretty much the same processes. You know, they all forecast, they all produce picking lists, they all pick, they all load vehicles and they all transport. Below that level there are differences, but those are what we look at afterwards". [..] "We look at the high level figures first, and then we can start looking at well why is this different, because theirs is made up with these subactivities, and theirs is these subactivities".*

The most important measure for the benchmark analysis is the **cost per cost driver** (i.e., the **cost driver rate**), as this measure **can** be compared directly with other suppliers. For this purpose it is important that activities are **defined** accurately and that suppliers do not interpret the content of activities differently. The benchmark analysis reveals the activities the supplier performs better or worse than the network **average**. **When** a supplier deviates significantly from the **average**, the Logistics Operations department **initiates** a discussion with the supplier to find the **cause(s)** of the **difference**, by analyzing the underlying activities, and to assess whether and **how** performance **can** be improved. A similar procedure is followed for comparable activities between networks, **geographical** regions and store types. As suppliers in different networks face no competition, comparing the **costs** of their activities, and analyzing the differences in their operations **can** be **very** insightful to transfer **efficient practices** across networks. The model is not used to directly **compare** the performance of suppliers in the same network to **each** other. Comparisons are only made against the network **average**. **However, when** two suppliers in the same network agree on a direct comparison, **the** model **can** be used for that purpose.

*Strategic what-if analyses* are performed to analyze the **effects** of **changes** in the supply

chain on supply chain costs. **When**, for example, as a **result** of a benchmark analysis, Sainsbury and a supplier have developed ideas or scenario's for improving **processes**, the model is used to calculate an indication of the expected **cost** changes. In these scenario's **the** expected changes in **cost** drivers are used as input for the analysis, and the outcome consists of the expected change in supply chain costs. **All projects** that are initiated for improving the supply chain are evaluated by a **strategic** what-if analysis.

*Trend-analyses are* performed for monitoring the development of supply chain costs over **time**, and to intervene **when** necessary. These analyses are made on a quarterly basis, **after each** update of the model.

#### **An example of a supply chain analysis**

An example of a benchmark and a **strategic** what-if analysis that were performed for supply chain improvement relates to the use of plastic crates for chilled **products**. **Be-**fore the model was developed, Sainsbury' and a large supplier had a discussion about the use of these crates to improve the efficiency of product handling activities. As the **cost** consequences of adopting these crates were unclear to **the** supplier, Sainsbury was not able to persuade the **firm** to adopt these crates. **When** the model was developed, it was used to calculate the supply chain costs related to suppliers using the crates and the costs of the non-adopting supplier. The differences resulting from this benchmark analysis revealed a **cost** advantage for the adopting suppliers. The next step was to **ana-**lyze what changes would occur in the supplier's and Sainsbury's activities, **when** the supplier would adopt the plastic crates. By **feeding** these changes into the model, a **strategic** what-if analysis could be performed to calculate an indication of **how much** supply chain costs could be reduced. This analysis made possible to show the supplier the **cost** consequences of adopting the crates, which made subsequent negotiations **be-**tween the parties about the adoption decision **much** easier.

### **Decision making and negotiations**

**When** an idea for improvement is identified, and both parties agree to work it **out** in more detail, Sainsbury treats this idea as an investment proposal. The **proposal** is then **carried** over to the management accountants, **who** perform a profitability analysis to **calculate** an expected **rate** of return. **When** the expected return is **sufficient**, the **proposal** is **accepted** for further negotiations with the supplier. The results of a change in the supply chain do not necessarily **result** in (equal) **benefits** for both Sainsbury and the supplier. **Often** these changes **result** in an asymmetrical division of investments, costs and benefits. For instance, while the adoption of plastic crates **can result** in a **cost** reduction for the supply chain as a **whole**, it **can result** in a **cost** increase for the supplier, while the benefits of improved efficiency are mainly reaped by Sainsbury. This results in an **allocation** problem among the parties for the **cost** and **profit** consequences of the supply chain changes and for the investments that need to be made. This allocation problem **needs** to be resolved in negotiations, otherwise the party being left with a disadvantage would not be willing to adopt and implement the change. In these negotiations, **Sainsbury** uses the investment **proposal** for agreeing on an **acceptable** division of costs, **benefits**, and investments. For example, a possible solution in the negotiations with the supplier about adopting the plastic crates is that Sainsbury invests in the required handling equipment for the supplier. Another solution is that Sainsbury agrees on a **price** increase for the suppliers' product, which for Sainsbury is more than offset by the **cost** reduction.

## **5. Discussion**

Sainsbury's supply chain **cost** model is a **real-life** example of the use of the **principles** of VCA in an interfirm setting. Compared to the discussions of VCA in literature, **how-**

ever, this application is characterized by a limited range of activities in the value chain, as only supply chain activities are modeled. An analysis of the complete value chain would require to **also** include the activities preceding the supply chain logistics of the suppliers (e.g., production, and purchasing of **raw** materials) and those succeeding the logistics of the stores (e.g., sales to customers). Nevertheless, the model does **cope** with Hergert and **Morris'** (1989) critique on traditional accounting systems for supporting a VCA. First, it **focuses** on the activities in the value chain. **Second**, it reflects the **economics** of performing those activities by accumulating data on the drivers of costs. Third, it **accounts** for interdependence between activities **across** firms. In one way, the model actually **goes** beyond the VCA as currently described in literature, as it not only analyzes costs at the level of the individual supply chain, but **also** does this at **higher** levels of analysis, **such** as at the network level.

The use of this **cost** model for supporting SCM **practices** has several **effects** on the **relationships** between Sainsbury and the participating suppliers. One way to analyze **these effects** is to focus on the communications taking **place** between Sainsbury and the **suppliers** as a **result** of the model. Three types of discussions originate between the parties due to the model: (1) discussions about the provision of (sensitive) information by the suppliers, and its use by Sainsbury, (2) discussions about current supply chain performance, and **how** changing the supply chain **may** improve this performance, and (3) **negotiations** about the sharing of costs and benefits that **result** from supply chain **changes**.

The provision of **cost** and activity information by the suppliers to Sainsbury by reveals their relative efficiency compared to other suppliers. This **makes** them vulnerable to potentially opportunistic behavior of Sainsbury, **who can** exploit this knowledge to its own **benefit**. Although the model in **principle** is used to identify inefficiencies at **suppliers**, it is not used in an adversarial way, for example, by demanding efficiency **improvements** or selecting more **efficient** suppliers. For the early **participants** this kind of

(ab)use of the information they **provide** was an important issue. The project manager expressed this concern as follows:

*"Its not the agreement we have with the suppliers in them supplying the data with us. [...] we said **very specifically** that we would not be using it to sort of bash people with it. Its not for that, its to help US develop a supply chain, not to start comparing suppliers, and saying increase your **efficiency** up to the same level or Sainsbury is getting you **out**. Because that's obviously one of the concerns suppliers had. You know, the last thing they want is to give US data, **very sensitive data** and for US then to say **well** you are **actually really inefficient**, we have to get rid of you".*

Would Sainsbury use the information in an opportunistic way, then the suppliers' willingness to cooperate would vanish quickly, relationships would be damaged, and the cost saving potential in the supply chain would remain unrealized. The fact that suppliers do share this sensitive information acts as a signal of their trust in Sainsbury's goodwill, while the reciprocating actions of Sainsbury (i.e., not taking advantage of the information), reinforces this mutual bond of trust.

The **second** type of discussions **relate** to the use of the supply chain analyses for **initiating** and supporting SCM **practices**. These discussions have a positive effect on the **relationships** between Sainsbury and suppliers in at least two ways. First, the use of the analyses leads to an increased interaction between the parties about possible **improvements**. As argued before, no direct **action** is taken on basis of the results of the analyses. Instead, the data is taken to the supplier, and discussions are initiated about the **underlying** operations, and what actions could be taken to improve **these** operations. **Second**, compared to other retailers, suppliers **come** to Sainsbury first with new ideas for supply

chain improvement, as the **effects** of these ideas **can** be ‘tested’ with the model.

The identification of **beneficial** actions to from the previous discussions leads to a third issue for discussion, the profitability of proposed changes, and the allocation of benefits and costs between Sainsbury and the supplier. The calculations of and negotiations about benefits and costs that take **place** comply with Tomkins’ (2001) argument that **collaborative** decisions need to be taken based on two levels of analysis. First the **investment** must earn an adequate **rate** of return for the risks associated with the project, and **second** the partners need the prospect of receiving a fair share of the benefits, **before** they are willing to **participate** in the project.

From her case research, Lord (1996) believes the results attributed to SMA are nothing more than the logical consequences of **effective** operational management **processes**. She argues that **when firms** focus on cooperative relationships with suppliers **will**, as a **result**, automatically reap the benefits of exploiting their linkages. No formal VCA **needs** to be done for that purpose. She supports this critique with the **fact** that at the **time** of her publication no empirical prove or examples were present of **companies** actually **using such practices**.

This exploratory case study results in just the opposite conclusion: the use of the cost model to perform supply chain analyses gives insight into the economics and **interdependencies** of activities in the supply chain, which insight would have been difficult to obtain without the model. Thus in this situation, the VCA **adds** to an understanding of the performance of the supply chain and the **cost** consequences of changes. This **understanding** is the basis for actions to better exploit the linkages in the supply chain.

In addition, it **can** be questioned whether at the **time** Lord's paper was published, it was a reasonable expectation that **much** empirical data on the subject should have been present. Argued from a diffusion of innovations perspective, it **can** be expected that it **will** take some **time** for organizations to adopt the innovation, **after** it has been **introduced** to them. **First**, early adopters **will** try the innovation, and **when** successful, the number of adopters **will** increase based on these early adopters' **success**. In Finland, for example, the beginning of **such** a diffusion **process** was found to characterize the adoption **process** of ABC (Malmi, 1999). And chances are high that **after** adoption, firms **will first** use ABC for **internal** purposes, before thinking about using it in an **inter-firm** context (although Sainsbury did not have an ABC system, **when** the model was **developed**).<sup>12</sup>

In addition, professional organizations, **such** as ECR Europe, are promoting the use of ABC for supporting SCM heavily, by positioning it as an 'enabling technology' (Coopers & Lybrand, 1996). And the recent surveys of Chenhall and Langfield-Smith (1998) and Guilding et al. (2000) show that **companies** are adopting VCA, at least for **internal** purposes. A logical step following this adoption could be to use this internal cost and performance information for SCM efforts with buyers and suppliers, similar to what Sainsbury does. The previous trends at least **indicate** that **practice** does have a growing interest in these SMA **practices**, and that more empirical research in this area **may** be fruitful.

## 6. Conclusions and directions for further research

This paper **discusses** an exploratory case study Sainsbury's use of a **cost** model to support supply chain management **practices**, which **builds** the concept of VCA. This **activity-based costing** model integrates **cost** information about supply chain activities of both

Sainsbury and suppliers, and serves several functions. First, it is used to analyze the **cost** performance of supply chain activities, both at the individual supplier level, as **well** as at the supplier network level. This information is **then** used in communications with suppliers to analyze the **causes** of this performance, and to **generate** 'ideas for improvement'. **Second, when such** ideas are generated, the model is used to **calculate** the **cost** impact of **changes** in supply chain activities. Third, the model is used to **periodically** monitor the development of supply chain **costs**.

This VCA **practice** identified at Sainsbury goes beyond the idea of performing an **analysis** of activities in the value chain by just one organization taking an 'external **perspective**'. In this case the analysis is made cooperatively with suppliers by integrating their **cost** data. It **can** be expected that due to sensitivity of the data involved and the fear of **participants** for other **(ab)use** of the information than it was intended for, that this type of information sharing will only occur in interfirm relationships characterized by a **sufficient** level of trust in the other's cooperative intentions.

This study presents a **rather** technical description of the **cost** model's goals, design and use. This VCA model, **however**, is not the only accounting information used in the SCM **practices** of Sainsbury and its suppliers. For example, for coordinating supply chain activities Sainsbury measures, exchanges and **discusses** non-financial performance indicators with suppliers. A more comprehensive view on the use of VCA and other **accounting** information in interfirm relationships would be gained by **making** more **explicit** use of theory in the research design, and by studying it in relation with other **formal** and informal **mechanisms** used in supply chain relationships for coordination and **control** purposes (Dekker, 2000). This would require more in-depth knowledge of **specific** characteristics of relationships, **such** as transaction **cost** considerations, **coordination** problems, and the **social** context in which the relationship is embedded. **Such** an

analysis, **however, goes** beyond the scope of the present paper, and is therefore **re-**garded as a fruitful direction for future research.

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## 8. Notes

<sup>1</sup> Tomkins (2001) **provides** an in-depth analysis of the different information **needs** of types of alliances at different stages of development, for the warranting of trust and for the '**mastery** of events'.

<sup>2</sup> This governance **structure can** be implemented formally by contract, but **can also consist** of various informal and organizational agreements (Dekker, 2000).

<sup>3</sup> In the context of interfirm relationships, Gietzman (1996) identifies an important shortcoming of the traditional make-or-buy analysis. He argues that the conventional textbook method to perform this analysis (that bases the decision criterion only on **pur-**chasing versus **internal** production costs) is incomplete and **can** even obstruct the **initia-**tion of a principally valuable cooperation between buyer and supplier. This **static** make or buy analysis simply results in a short-term oriented decision whether to internally **produce** or to buy externally. Interfirm relationships, **however**, are **often** oriented to-wards a **longer** term and are characterized by dynamism. This requires alternative forms of accounting information that include this dynamism, and that motivate the partners to focus on innovative cooperation. In addition, this information **needs** to include the costs of governance **structures** of cooperation and internal production, not only production and purchasing costs.

<sup>4</sup> This is **only** the case **when insufficient** contractual agreements are made for that **deal-**ing with this allocation problem directly

<sup>5</sup> **However**, as cost data of different firms **across** the supply chain is required, additional problems of accounting information **can** be anticipated. **Difficulties** might be **experi-**enced with differences between accounting systems, leading to incompatibility of **the in-**formation they **provide**.

<sup>6</sup> Although Shank and Govindarajan (1992, 1993) argue that ABC is **only** one of several frameworks for **strategic cost analysis**. Other frameworks, **such** as the **cost of quality framework**, **can also** be **beneficial** for **strategic cost analysis**, although it is not **directly clear how** these **relate** to a VCA.

<sup>7</sup> This prior available data included the presentation slides, describing the design and use of the **cost model**, general company information from annual reports and the **internet**, and specific publications in which Sainsbury was subject of analysis (Frances and Garnsey, 1996; Wheatley, 1998).

<sup>8</sup> See also Eqos case studies (2001) for more specific information about SID.

<sup>9</sup> In addition to **cost analysis** of the supply chain, other management accounting **practices** have been employed for this purpose, for example the exchange of performance information with suppliers by SID on a range of performance indicators for coordination and the identification of possibilities for improvement with suppliers.

<sup>10</sup> Gosselin (1997) distinguishes three levels of activity management, (1) **Activity Analysis (AA)**, which does not account for **costs** (2) **Activity Cost Analysis (ACA, also called Cost Driver Analysis)**, which **allocates costs** to activities and **cost drivers** and (3) **Activity-Based Costing (ABC)**, which **allocates costs** of activities to **cost objects**, such as **products** and services.

<sup>11</sup> In addition, it was commented that it **will** easily be noticed **when** a supplier's data deviates significantly **from** the other suppliers' data. **When this happens**, it is normally the **result** of an error during data collection or input.

<sup>12</sup> Also, one **needs** to acknowledge that it takes **time** for firms to develop and implement these systems, just like that it takes **quite** a while before researchers **will** publish about **such** applications, **when** they identify them.