

## **Purchasing as Market-Shaping: the case of component-based software engineering**

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*Competitive paper*

### Abstract

Marketing scholars have recently started to address markets as constructed, socio-material orders rather than taking them as naturalised entities. This approach contrasts with traditional economic sociology which focuses on markets as purely social structures. However, within marketing, the study of market-shaping efforts has hitherto focused almost exclusively on the supply side and the role of marketing activities in shaping demand. And yet, there are many other markets where the distribution of influential market actors is more evenly balanced and the role of purchasing is just as important as marketing.

In this paper we focus on an example where purchasing plays a key market-shaping role. The market in question is standard software components. Component-based software engineering is based on the idea that software systems are developed by pre-producing and selecting appropriate existing modules and assembling them according to a well-defined architecture. Even though the use of software components is being trumpeted in many software development fora, the market for standard software components is still in its infancy. The purpose of the present study is to analyse the emerging software component market from a purchasing perspective and to identify how buyers are seeking to shape the emerging market. We describe the role of prospective customers in developing the supply structure for standard software components that corresponds closely to their preferred template of how this market should function. This involves the creation of a competitive supply base, robust standards to facilitate the specification and purchase of software components, and an appropriate system that would allow customers to assess the risk they take on by including standard components in their software systems.

## ***Introduction***

Marketing scholars have recently started addressing the nature of markets as socio-material constructions (e.g. Araujo, 2007; Kjellberg and Helgesson, 2007a; Araujo et al, 2008). The shift of focus from marketing to markets stresses that many and varied efforts are required for markets to operate. Marketing is seen to have an essential role but any other forms of expertise partake in the construction and operation of markets.

Most definitions of markets place the emphasis on their institutional, recurring character and the role of competition between autonomous and independent agents (cf. Slater and Tonkiss, 2001). Caliskan and Callon (2010: 3) define markets as sociotechnical arrangements with three characteristics:

“1. Markets organize the conception, production and circulation of goods, as well as the voluntary transfer of some sorts of property rights attached to them. These transfers involve a monetary compensation which seals the goods’ attachment to their new owners.

2. A market is an arrangement of heterogeneous constituents that deploys the following: rules and conventions; technical devices; metrological systems; logistical infrastructures; texts, discourses and narratives (e.g. on the pros and cons of competition); technical and scientific knowledge (including social scientific methods), as well as the competencies and skills embodied in living beings.

3. Markets delimit and construct a space of confrontation and power struggles. Multiple contradictory definitions and valuations of goods as well as agents oppose one another in markets until the terms of the transaction are peacefully determined by pricing mechanisms.”

According to this definition, market agents have differing interests leading them to oppositions solved through transactions with well-defined prices. This definition illustrates the role of generic market agents (e.g. buyers, sellers) as entering and leaving transactions as strangers, with prices sealing the attachment and reattachment of goods to owners as defined by property rights. More importantly, markets are organised spaces of confrontation and struggle where valuations of goods are contested but the power struggles are not exhausted by price negotiations. The very infrastructure on which markets rest (e.g. rules and conventions, metrological systems) are also objects of contestation and struggle. In short, market actors do not just take markets as they find them; instead they actively attempt to shape the socio-material arrangements that constitute markets.

Within marketing, the study of market-shaping efforts has so far focused almost exclusively on the supply side and the role of marketing activities. Mass retail, in particular, provides us with exemplars of powerful market actors on the supply side influencing the functioning of consumer markets (Callon and Muniesa, 2005). The same mass retailers are, more often than not, equally powerful actors on the supply side, seeking to shape the structure of supply markets to their advantage (Azimont and Araujo, 2007).

There are many other markets where the distribution of influential market actors is more evenly balanced than mass retail, and the role of purchasing is just as important as marketing. The IMP research tradition has, from its early days, emphasised this symmetrical concern with marketing and purchasing as two sides of the same coin, both equally active participants in shaping the structure of business markets (Håkansson, 1982). Another topical example concerns public sector agencies, often faced with a concentrated, oligopolistic supply

structure, who seek to promote a broader and more competitive set of supply alternatives (Caldwell et al, 2005). In summary, the role of purchasing in shaping the markets is often essential and on a par with, if not more influential than that traditionally associated with marketing.

In this paper we focus on an example where purchasing plays a market-shaping role in a high-technology sector. Component-based software engineering (henceforth CBSE) is based on the idea that software systems are developed by pre-producing and selecting appropriate existing modules and assembling them according to a well-defined architecture. Software architectures are planned so that the whole system is divided into several functional parts, which are interconnected through standard interfaces. The architecture is composed of modules that can be developed in-house, through subcontracting or bought from external component suppliers. This engineering approach has generated new types of software markets, where the idea is to be able to exchange software components as any other standard components. This differs extensively from the traditional form of buying and selling software in the business-to-business setting, which has been based on subcontracting and close partnerships with highly tailored software. Interestingly, the emerging markets of software components are not only based on technological innovations made by software component suppliers but also on the essential role of prospective buyers in adopting the new software engineering method.

The CBSE has been on the agenda of the software engineering already since the 1960s (McIlroy 1969) and it still continues to both enchant and bemuse the software industry. The proliferation of CBSE was strong especially at the beginning of this century. Companies were increasingly using commercial off-the shelf (henceforth COTS) components in their software development for several reasons. The most compelling reason for adopting CBSE approach was the premise of reuse of software modules (Carvalho and Meira, 2009). The advantages of using COTS components include the minimising of the overall development and maintenance costs of software. Another important factor is the scarcity of software developers leading software providers and clients without in-house capabilities, to look for external solutions. The use of COTS products is also associated with reducing risks of software development and the possibility of shortening time-to-market for software products.

Even though the use of COTS is being blazoned as the way forward in many software development fora, various problems persist. CBSE is very different from the more traditional software engineering approaches, according to which software systems are implemented entirely from scratch, in-house or by specialised subcontractors (Xia et al. 2000). In reality, component-based software development and especially the use of COTS presents significant risks related to e.g. the software development processes and the nature of software components, component technologies and vendors' support to customers (Kotonya & Awais 2001). It is widely recognised that software component markets are immature, lack appropriate standards and management processes (e.g. Hahn & Turowski 2003, Alvaro, de Almeida & Meira 2007).

Our purpose in this paper is to analyse the emerging software component market from the purchasing perspective and to identify *how the buyers attempt to shape the emerging market through their buying behaviour*. This study aims to fill in the following gaps in current literature. Firstly, very little research attention has been paid to buyers' attempts to influence the supply market at as a whole, instead of the relationship or supply network level. Secondly, the purchasing perspective is missing from research focusing on transformation of

markets. Yet there are many firms in different industries hoping to increase their outsourcing without engaging in in-depth cooperation and long term relationships, such as in case of standardised supply interface identified by Araujo et al. (1999). We acknowledge that a single buyer company can shape the market mainly through its actions and buying behaviour. Only in a case of monopoly could we assume that a single buyer would have enough power to create market-wide practises or influence the market. Therefore, we will examine the way buyers can shape the emerging market at the level of exchanges they engage in the market.

The present paper follows in the emerging tradition of Market Studies (see Araujo, 2007; Kjellberg and Helgesson, 2007a; Araujo et al, 2008). One important aspect of this approach is the notion that markets are constructed through multiple and distributed efforts involving a multitude of market agents (Azimont and Araujo, 2007; Kjellberg and Helgesson, 2007b; Cochoy, 2008). In the paper, we will first discuss shortly some theoretical standpoints, focusing especially on the notion of framing (e.g. Callon, 1998) before moving on to describe the COTS software component market and its actors based on industry and software engineering literature. In the empirical part, we present a case study of the emerging COTS software component market as seen through the eyes of a purchasing company. To conclude, we describe the role of prospective customers in developing a supply structure for COTS that corresponds closely to their preferred template of how this market should function. This template involves the existence of a competitive supply base, robust standards to facilitate the specification and purchase of COTS, and an appropriate system allowing customers to assess the risk they take on by including COTS in their software systems.

### **Construction and operation of markets**

With a few exceptions, the area of purchasing and supply management has paid scant attention to markets and their operation. The existing body of knowledge is heavily focused on managing relationships with suppliers and methods for managing the purchasing function. Issues such as the structure of the supply base, supplier relationships and networks are all essential from a focal buying company's perspective, but broader market issues have rarely featured in purchasing and supply management literature. However, the emergence of competitive supply markets is often portrayed as a favorable development from a purchasing and supply perspective. The increasing modularisation of products and services may also lead to the development more traditional, competitive supply markets where standard components are exchanged. In other words, standard components can be bought from competitive markets whereas more customised parts are acquired through subcontracting and co-operative supply networks. Thus the issue of how purchasing and supply can influence the shaping of markets deserves more attention from both a theoretical and managerial perspective.

Current research on markets and market practices (Araujo et al, 2008) emphasises the way markets are constructed through multiple and distributed efforts involving a multitude of market agents. In this study we will define what constitutes supply and what constitutes demand from the perspective of the particular actor; an individual buyer company whose perspective is adopted throughout this study. The actors taking part in markets are often - and unproblematically - divided into sellers and buyers. Intermediaries can be seen another type of market actor, but they can be analysed as specific types of sellers if we take the buyer's perspective. In other words, the intermediary is seen here as a seller from the buyer's perspective. Of course, in many other markets, various other influencing actors can be identified, such as governments, mediators, standardization bodies etc. This suggests that what is defined as a market, in terms of the relevant actors to be included in the definition,

may differ according to the vantage point taken. A buyer can thus include certain suppliers into its market definition, whilst another buyer's definition may exclude some suppliers whilst adding others that were not contemplated in the first buyer's definition.

The concept of framing has been used to describe the way market actors are able to take certain issues into account when entering into a market transaction while ignoring others (e.g. Callon 1998). The networks of relationships in which agents are embedded are still influential, but framing allows these relationships to be abstracted and dissociated from one another. It is precisely due to framing that market transactions can take place and distinct objects and actors can be brought into play.

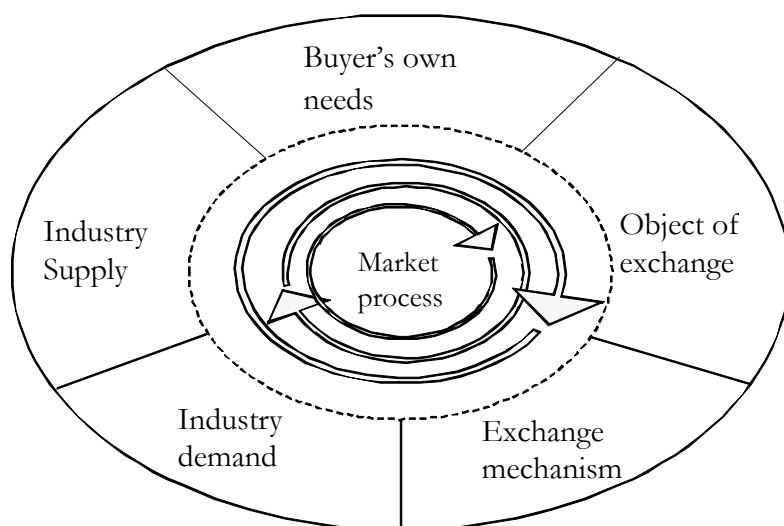
Market exchange is enabled by a process of framing that allows distinct agents to come together and agree a price for the exchange of goods and money. Callon and Muniesa (2005, p. 1230) define "...markets as collective devices that calculate compromises on the value of goods". But framing is always a fragile, partial and artificial achievement that requires substantive investments. Evidently, market actors cannot take all the relationships into account in their framing, as the states of the world are too complex. The counterpart to framing is overflowing. Overflowing is both the supplement as well as the foundation on which framings can be sustained. However, calculation may turn out to be a very complex task as illustrated by Finch and Acha (2008) in their study of the market of second-hand oil and gas fields. The definition of the object of exchange may be contested and the effort of framing may require significant investments and expertise.

When defining a market, the multiple forms of organisation that calculative agents bring into play are essential. Market actors have both differing ways of calculating, and the number and distribution of the calculative agents can vary according to the market in question (Araujo, 2007). Agents can integrate calculations already framed by another agent into their own calculations. The concepts of supply and demand refer to the existence of a larger group of actors who possess somehow equivalent needs or supply offers. Therefore, it can be argued that *demand and supply* also essential elements when making sense of what is a market. Furthermore, if we consider the behaviour of a single buyer company and its particular supply needs, its definition of market boundaries and its preferred supply structure are likely to be of interest. Thus, a particular buying company's *needs* should be taken into account.

At the heart of market exchanges lies the *object of exchange*, e.g. what is actually exchanged between the counterparts. This is closely related also to the buyer company's need definition as well as to the supply and demand. The object of exchange can be defined in the simplest possible sense as merely as a good transacted through a market exchange. In return for the exchange of property rights, the buyer provides the seller with a monetary compensation. According to Callon (1998), money provides agents with a tool to reduce the heterogeneity amongst different agents and objects. Money can be described as a common language, the keystone in a metrological infrastructure that underpins market exchanges. The existence of a clear definition of the object of exchange and the valuation processes that lead to the formation of prices are strong assumptions underpinning the perfectly competitive market envisaged by neoclassical economics. However, and especially within exchanges conducted in business markets, this is often not the case. Instead, buyers and sellers collaborate in close relationships to define what is actually exchanged and how it should be valued. Thus, objects of exchange and how they are defined and perceived by buyers and sellers deserves attention if we wish to understand how purchasing and supply can be also involved in shaping markets.

Closely related to the object of exchange, the *exchange mechanism* needs to be considered. Business markets encompass a variety of exchange mechanisms. For example, Webster (1992) presented a model of the relationship continuum, illustrating various types of relationships in which organisations may be involved. Accordingly, relationships vary from spot market transactions at one end and to vertically integrated firms at the other. In the IMP tradition, relationships are seen as a different type of exchange mechanism altogether rather than a midpoint in a market-hierarchy continuum (Håkansson & Snehota, 1995). Thus, in a business-to-business context, various different types of exchange mechanisms exist through which buyers and sellers conduct exchanges. In other words, how buyers and sellers conduct their exchanges should be examined as a way of shaping markets.

To conclude, we summarize the main suggestions concerning the identification of the market elements in relation to actors and exchanges in a market process. The identified elements of the markets from the buyer's perspective are *industry demand*, *industry supply*, *the buyer company's own needs*, *object of exchange* and the *exchange mechanism* as shown in Figure 1. The identified market elements from the buyer's perspective provide us with means to examine the market from a purchasing point of view, which further allows us to elaborate on the role of the purchasing in shaping the emerging markets.



**Figure 1. Elements of market process from the buyer's perspective.**

Next we will provide an overview of the software component markets as they were represented on the basis of industry literature in the early 2st century.

### **Overview of the COTS software component markets**

#### *The key characteristics of CBS software components*

Commercial software components are highly “productised” pieces of software that are used as parts of larger systems. The supplier of such a component sells the component to several business customers with minimal customisation. The most distinctive feature of COTS software is that the source code is not usually available to the customer organisation, and further development of the software cannot be pursued independently by the buyer.

Furthermore, COTS software is often used as a module. The rest of the system consists of other components or software developed by the buying organisation.

There are also many products – e.g. in automation, electronics and telecommunication industries – that incorporate tailored software which is embedded into products and invisible to end-users. Due to the increasing standardisation of technologies, computing platforms and application software interfaces, many of the developers of these products have become potential exploiters of COTS software. Since companies maintain capabilities in software development, the integration of external COTS components into tailored software packages becomes an option. This is the situation in the case study presented in this paper.

Keeping this perspective in mind, three key characteristics of COTS software components can be defined, from the viewpoint of a purchaser. First, the source code, i.e. the core of the package, is not available to the buyer. Secondly, further development of COTS software cannot be pursued independently by the buyer. Thirdly, the COTS software must be integrated into a larger software system as an individual module.

#### *Why are some firms interested in purchasing CBS?*

Companies are increasingly using COTS components in their software development for a number of reasons. One of the most important advantages is the ability to minimise the overall development and maintenance costs of software. Another factor responsible for the increasing the use of COTS software is a shortage of software developers. As organisations do not possess all the necessary resources for building software from scratch, they are often forced to resort to external providers. Buyers are also interested in software components to reduce the risks associated with the quality of software packages (Febowitz and Greenspan 1998). It is often thought that if a specific software component can be developed as a core product of a specialist supplier, it will generally be more reliable than the same software developed in-house. Furthermore, as the component sells to other customers, the quality of the component is regarded as being higher due to the more extensive testing that it is subjected to. Finally, a further factor behind the increasing use of software components is the possibility of attaining shorter time-to-market for products (Ochs *et al.* 2000).

#### *What stands in the way of developing the “ideal” market form?*

Even though the possible benefits of commercial software components are many and varied, there are significant problems related to e.g. the software development processes and the nature of software components, component technologies and vendors' support to customers (Kotonya & Awais 2001). The very nature of CBSE is different from the traditional software engineering approaches, according to which software systems are implemented entirely from scratch in-house or by specialised subcontractors (Xia *et al.* 2000). Moreover, the software component markets are immature, lacking appropriate standards and management guidelines (e.g. Xia *et al.* 2000).

First, buyers face product and supplier selection problems, as there is a lack of methods for how to determine the requirements for commercial software and how to select appropriate components. More specifically, organising problems, including issues such as who and what parties inside the buying organisation should be responsible for these decisions, represent a key problem especially in the use of fully commercial off-the-shelf software components (Ncube & Maiden 1999). Secondly, when companies acquire and use components for larger systems, many potentially confusing and complex liability problems may arise. Component

vendors are not usually willing, or even able to take the blame for the possible failure of the customer's whole system, as this could easily wipe out many small software development companies (Voas 1997).

Thirdly, the technical immaturity of the software and the vendor poses a risk. In all likelihood, software components may contain errors. Furthermore, there are risks associated with the inexperience of the integrators and users of COTS components. The COTS component may be incompatible with the buyer's application, platform or other COTS components. (Feblowitz & Greenspan 1998) The lack of the customer's control over the current and future functionality of the COTS software also presents some potential risks from the buyer's perspective. In other words, very often the customer is usually just one among several customers of the seller and therefore, its voice may be lost in a crowd when requesting changes to COTS product. Finally, it is very common that the customer views COTS software as a kind of component that creates zero development costs for the customer organisation. This naturally leads to risks, as most COTS components are not, in practice purely modular, 'plug-and-play' components. Brownsword, Carney and Oberndorf (1998) argue that although the COTS solution may seem a straightforward solution on the surface, many projects usually find it is quite the opposite, posing a variety of difficulties in how they should be integrated into larger systems.

When a COTS software component is used as a part of a product that is further sold to an end-user, the role of the component and the risks and problems related to it become critical. The buyer of the component is responsible of the functionality of the component as it is included in its final products. In addition to liability issues, there are also other issues concerning licensing, redistribution rights and royalties. These questions are often difficult to deal with and given less attention than technical issues.

#### *Actors in the emerging COTS markets*

The sellers of software components are very heterogeneous. As components are difficult to define and categorise, the notion of component vendors also becomes diverse. On the basis of industry literature, some of the vendors offer COTS components in the strictest sense of the term, while other vendors also provide services that could be regarded as customised software rather than COTS components. Many of the sellers, however, aim to increase their sales of COTS software component. COTS markets are thus not easily definable in terms of a relevant and bounded set of actors. However, we can conclude that there are at least two types of component sellers; companies selling components that they develop themselves and companies selling components developed by others, i.e. brokers (Harmon, 1999).

Brereton and Budgen (2000) note that software component vendors may typically develop markets along a horizontal and a vertical dimension. This means that a specific component may be used in a variety of different environments and thus it creates more business opportunities for the vendors. Issues related to marketability are also important factors to understand; the components need to be marketable in the sense that their strengths and key features can be effectively communicated and appeal to as many customers as possible (Brereton & Budgen 2000).

The so-called component brokers, who sell components developed by others, are typically Internet-based intermediary firms act as a kind of marketplace and intermediates for software components (e.g. [www.componentsource.com](http://www.componentsource.com)). They could also be considered as retailers in the component markets as they do not develop the components they are selling. These firms

work towards attracting software component developers to design and commercialise their components. The component brokers provide various support mechanisms for component developers to develop marketable and successful commercial components as well as providing an effective marketplace from a buyer's perspective.

Component buyers usually represent different types of manufacturers of products including software and possibly also hardware. Instead of being a software developer, many software companies are seeing themselves more and more as system integrators, companies who integrate their products and systems from several reusable components, commercial or those developed in-house (Ochs *et al.* 2000).

#### *Developing standards for COTS markets*

In the software industry, standards, specifications and software interfaces are important when defining COTS products. The nature of software as a product is complex and abstract, which creates the need for standardisation efforts in the industry. The purpose of software standards is to ensure that components provided by different sellers are inter-operable. Thus, it is easy to understand why the COTS business is described as a standards-based marketplace; markets are based on products using the same standards (Meyers & Oberndorf 2001). In the COTS software component community, there are particular standards bodies, i.e. groups including representatives of both component sellers and buyers. The idea behind the development of standards is that the software component seller develops products based on these standards, while customers adopt these standards as part of their own system specifications. This means that sellers can develop different products using the same standards. It is expected that the creation of industry standards will entice further suppliers to develop offerings, leading to the creation of a competitive market and a general reduction in prices.

The term standard can sometimes be used to refer to a product that has a dominant market share (Meyers and Oberndorf, 2001). As the product is widely used and accepted by a number of customers, it is regarded as a *de facto* standard. Thus other sellers are compelled to use same kind of specifications in their own products to be able to stay in the market. However, this does not imply that a consensus exists over this matter. There may be a chance for alternative solutions but sellers may find it risky to deviate from what the market leader does.

It is also essential to understand the role of specifications. Software products are based on specifications, a document that describes in detail the requirements, design, behaviour, or characteristics of a system or system component (Meyers & Oberndorf 2001). Standards, on the other hand, are specifications that are jointly agreed upon by standards committees. Interfaces between the software components are also an important part of defining software standards.

Allen (2001) discussed some of the most important standardisation efforts in the software component community. For buyers, there are many difficulties related to the development of standards. Standards often change over time, merge with each other and fall into disuse. This brings forth many problems for the buyers, as well as for the sellers. One reason for difficulties in the use of standards is the fact that there are several standardisation organisations in the software component markets and several different and partly overlapping standardisation efforts are made concurrently. Also, as the software technologies develop at such a high tempo, some areas receive scant attention as far as standardisation efforts are concerned. On the other hand, component sellers try to develop additional features exceeding

the standard in order to gain competitive advantage. Finally, some vendors attempt to gain control over market evolution by engaging strongly in standards development. (Allen 2001.)

Standardisation can also be seen as limiting development potential. If the innovations made by component vendors are based on existing standards, they are necessarily limited. As Messerschmitt and Szyperski (2000) have pointed out, there are other kinds of problems in standards from a software engineering perspective. Standards aimed at limiting the number of interfaces in order to decrease the development and maintenance costs present a problem since in principle, it is possible to develop a new interface every time two software components need to be joined. This delimits the possibilities of creating alternative interfaces. There are also some problems in relation to the timing for compiling the standard. If standardisation is to take place well in advance of actual software component development, the standardisation might fail, happen too slowly or be too difficult to use (Messerschmitt & Szyperski 2000).

### **Methodology**

In order to understand the emerging software component markets from the buyer's perspective, this study applies a qualitative case study of a buyer operating in the emerging COTS market. The emerging software component market is studied through the market that a chosen case company faced during 2000-2002 when the COTS market was emerging. The empirical data was gathered through interviews, case company's internal workshops, meetings organised for the purposes of this study as well as internal documents. The data was collected by the first author, in her native language (Finnish) and partly in English. The data analysis applied thematic coding, where the theoretical pre-understanding was used as guidance, but not forcing the data to fit a predefined framework. Thus, themes that emerged from the data were searched as well. The interpretation of the results was further discussed with the case company representatives.

The focal company, Bavla, was chosen as it represents a typical customer company in the emerging software component market, namely a large and well-established manufacturer of high-tech products. Software is an integral part of the case company's products, and therefore its role is regarded as very important. Bavla has traditionally developed software partly in-house and partly by using tailored solutions from subcontractors. The analytical focus of the study is on a specific part of Bavla's software engineering division. The purpose of this division is to develop the needed software for new products and thus it is an essential part of the product development effort of the whole company.

Bavla was interested in component-based software engineering and software components and had developed a component-based software engineering process to support the adoption of this new approach to software development. They wanted to increase the reuse of internally developed software, but also resort to external software components. However, in these efforts, the case company faced some of the typical problems described earlier. In the following section, the case company's behaviour in the software component market is elaborated with the special focus on how this behaviour was also an attempt to shape the markets for COTS.

### **Empirical analysis of purchasing as market-shaping**

In the following subsections, we will analyse each of the five identified market elements at a time and demonstrate the market shaping efforts that were identified in relation to these elements.

### *Buyer's own needs*

The first market process element of the case markets analysed here is the demand generated by the particular buyer organisation itself, the *buyer company's own needs*. One of the most difficult tasks for Bavla in COTS acquisition and use was related to the identification of the company's needs. Earlier, we highlighted that the two most important factors driving the need for components were scarce development resources and awareness of the existing solutions in the market. Software development resources were scarce in the sense that the time schedules of the development project were tightening, so that all software development could no longer be developed internally, or it was no longer sensible to do so. Knowledge of existing commercial solutions in the emerging market for COTS was an essential part of the argument to outsource part of software development.

However, Bavla did not know precisely what it needed. It faced great difficulties in defining all the specifications and criteria for the component. This resulted in conflicting views between the supplier and Bavla after the component was taken into use by the software development project. Due to difficulties in specifying the features of the component in the contract, Bavla and the component providers often ended up negotiating whether some specific issue was a bug, a deficiency in the component or merely the absence of a feature. Another issue related to company's needs were the difficulties in making a value analysis of alternative software component solutions. Make-or-buy decisions were made difficult because the costs associated with COTS acquisition and usage could not be unambiguously identified. More particularly, the costs related to acquisition beyond the actual price of the component were hard to estimate. Bavla realised that the price of the component represented only a fraction of the total costs of acquisition, which include costs of planning, bidding, evaluating, negotiating, using the component, personnel training, ensuring support and maintenance, as well as managing the supplier relationship.

Bavla communicated its needs to suppliers in an ad-hoc way by first inquiring about preliminary prices and asking potential suppliers to send their evaluation package of the component in question. At times, the scanning of the potential components and suppliers in the markets was given to an external consultant who identified potential suppliers and sent them a request for a proposal without identifying the buyer. This blind procedure was applied because Bavla assumed it would give them a more reliable picture of real offerings in the markets. A request from an anonymous buyer mediated by a consultant was deemed to be one way to assess competition between suppliers and the current state of the markets.

To conclude, two important ways to influence the emerging markets emerged from this analysis. The first aspect is the basis for the need; in other words, where and how the need for a software component originates. It can emerge from internal sources such as absence of own software development resources or from external sources, namely the availability of off-the-shelf commercial solutions. Bavla influenced the emerging markets not just through its own needs but also in terms of how the specification of components was defined. The company representatives seemed to cherish an ideal of buying COTS software components through defining and documenting the requirements and specifications meticulously. Even though careful definition of the requirements was pursued, in reality the acquisitions seemed to be

quite different. A strict definition of the requirements related to the component as well as to the supplier were lacking and rather they needed to explore the available solutions and be prepared to adapt their own software system to the existing components. Bavla did not quite know what it needed and it could only operate with more flexible requirements because the offerings of existing suppliers were limited. The emphasis put on internal and external factors in need recognition, and how need specifications were determined, reflected the way the buyer company adapted to the state of the markets for COTS.

### *Industry Demand*

The general demand existing in the markets created by a group of buyers, *or industry demand* was the second element of our analysis. In an emerging markets demand can be difficult to define as the needs of prospective customers can be so varied. Bavla was interested in how the other customers in the COTS markets behaved, especially its own direct competitors. It was prone to regard the component as reliable and high quality, if the other big players in the industry used the same components. In other words, the behaviour of competitors acted as a reference influencing buying decisions. However, this also created potential threats as Bavla emphasised the importance of taking into account the potential ownership relationships that would connect the supplier and a competitor when evaluating a component. The possibility of a corporate take-over conducted by a competitor could seriously inhibit the use of the component or result in a leak of strategic information to the competitor. This resulted in rather limited information flow towards the component supplier which further exacerbated the difficulties concerning support services for the component. For example, in case some problems emerged in the component and its functioning, the buyer wasn't happy for the software engineers of the supplier to gain access to the buyer's own software code.

The way Bavla acted in the markets was illustrated by its request that additional features be incorporated in the component. Suppliers were willing to provide extra features and some even had specific services divisions to provide these, but the prices for these services were high, unlike COTS components which were supposed to be standard and sold at low prices. The logic applied by the suppliers was to charge the development costs to the customer that ordered extra features whilst keeping the proprietary rights over the software and selling the new feature to other customers, but at a lower price. From the perspective of the buyer that paid for this development work, this procedure was regarded as untenable. As a result, Bavla started to avoid ordering special features whilst waiting for someone else to be the first customer to request a special feature and pay for the development costs. Thus, the aggregate demand generated by the group of buyers is clearly an interesting element of the market process from a buyer's perspective. It provides opportunities to shape markets especially when demand appears to be diverse, and buyer behaviour might bring about some consistency to diverse needs and thus influence the structure of supply.

Hence, two ways to influence the emerging markets related to demand emerged from the data. First, an essential issue from the perspective of the buyer is the meaning that is given to competitors' use of the same component and whether this is regarded as a sign of quality and/or a potential confidentiality risk. Secondly, the powerful position that Bavla occupied among other buyers of the same component had an impact on the markets. The notion of having a strong enough position towards other buyers was seen as an important means of influencing the future development of the component. A smaller buyer with limited bargaining power needs to follow the dominant demand pattern and adapt its needs accordingly.

### *Object of exchange*

The third market process element, the object of exchange, refers to the product or service or a combination of these that are exchanged in the market process. At a general level, the COTS markets are based on the idea of standard products and knowledgeable buyers. From the buyer's perspective, the products should be well defined and all the interfaces and features of the software should be documented and clearly stated in contracts. However, Bavla had difficulties in specifying the component it needed, even though the technical expertise within the company was high. This was also one of the reasons for the conflicting views that emerged between Bavla and one of its COTS suppliers.

Another important point that emerged from the analysis is the role of services in the exchange. The actual software component and the services provided by the supplier are clearly seen as separate entities. The software component is the product, and everything the representatives of the supplier company do beyond the supply of the product is seen as service. The main product, the software component, is considered to be the source of cost advantages, whereas the services are seen as the expensive part of the deal. Certain initialisation and support services could be included in the basic component price, but it was also typical that the support services could be divided into different alternative levels of support. For example, for a price the customer could get some basic support, including a telephone hotline and bug fixing during local business hours. The defects reported to the supplier by the customer are fixed in the reported order, taking also the criticality of the defect into consideration. In addition to basic support, suppliers also provided customers with extended maintenance for an additional fee negotiated between the customer and the supplier. The extended support services could include things like faster defect fixing and on-site support.

As a whole, the way the product is defined between the buyer and seller in the COTS software component markets appears to be an interesting issue. Two basic ways of defining the content of the component were either through the technical component characteristics and functions or through the more general solution that the component offered to the buyer. Another theme that emerged from the analysis of the object of exchange was the perception of the component, its nature and content. The buyer and the supplier perceived them differently. The definition of the component was a complex issue which influenced its perception as an object of exchange so that it varied between specific counterparts. The joint definition of the content of the component between the buyer and seller represents an attempt to create common rules in the markets.

### *Exchange mechanism*

As the fourth element of the market we examine the *exchange mechanism* that prevailed between suppliers and buyers. The empirical analysis emphasises a rather traditional view of competition in the COTS software component markets. A lot of attention is given to evaluating alternative components and co-ordinating exchange relationships through strictly formalised contracts. Another issue that emphasises a transaction orientation is the standard development efforts made by a number of market actors. The purpose of standards is to enhance the development of COTS software components to be sold and bought as a standardised product. This denotes a more transaction-based than a relationship-based view. The transactional orientation is also manifested by the behaviour of component brokers in the current COTS software component markets. Brokers behave as channel middlemen

encouraging developers to sell their components via the broker's services. Customers are enticed to buy components through easy accessibility, comprehensive product information and low prices. Therefore, the relationship between the actual component developer and the customer is essentially transaction-based.

In terms of Bavla, one decision-making criteria used in the supplier selection was the size of the supplier. In one example, the chosen component supplier was considered to be small enough, so that the customer would then be able to influence the supplier. This was important for Bavla, and the emphasis on dominance in the relationship could be associated with a hierarchical relationship. However, in relation to the general views of Bavla, the importance it placed on evaluating a number of suppliers at the beginning of the purchasing process denoted a preference for more transactional mechanisms.

However, the transactional approach could not be maintained despite the original intentions, and instead a more co-operative form of exchange was required in practice. As the component did not totally fulfil the needs of Bavla and new needs emerged, they had to contact the supplier and pursue a more collaborative form of relationship. The parties had conflicting views on the product's standard features and the resolution of bugs. Bavla required customer service and after-sales support, whereas suppliers were interested in offering more expensive development services. Also, counterparts had evolving and conflicting views on the kind of exchange mechanism they were engaged in. For example, in some instances the seller aimed at selling a standard product to several customers at as high a price as possible. Customers were interested in buying components from a marketplace where all suppliers sold components and where all the product and price information are available so that customers could make clear cut comparisons between suppliers.

Bavla ended up having to rely on a more collaborative exchange mechanism than were prepared to do at the outset. Suppliers did not seem to want to adopt this type of exchange mechanism, as they were only willing to make modifications to the components if the customer was willing to pay for the whole development work. Moreover, they wanted to have the right to sell customised modifications and functions as standard features to other customers. The problems faced by Bavla would suggest a more co-operative strategy as the customer-specific modifications and the future development of the company became critical. The creation of new versions of the component created a situation from the buyer's perspective in which it needed to have ways of influencing the supplier. The purchasing power of the customer was diminished due to the fact that the customer faced high switching costs as it was very difficult, or even impossible, to change the component once it had been initialised and taken to use.

The exchange mechanism that was planned was in sharp contrast with the mechanism that was actively pursued in practice raises an interesting issue in regard to market shaping. Similar to the definition of the object of exchange, the standardisation of exchange mechanism represents a market practice that emerges from the interaction between counterparts as the markets develop. The differing views of exchange counterparts regarding the ideal exchange mechanism was manifest in the way problems arose in the interaction between buyers and sellers.

### *Industry supply*

The fifth element analysed was the *industry supply* that refers to all the suppliers providing the COTS software component for the specific need. This element emerged in the case

analysis e.g. in the discussion on how potential suppliers are searched and contacted. Bavla felt that sending out requests for proposals (RFP) should be carried out in a well co-ordinated manner. The characteristics of the component and the criteria should be specified as clearly as possible. However, the content of the RFPs should be carefully planned so as not to reveal information that could diminish the power of the buyer in further negotiations. Bavla wanted to keep a distance from suppliers and enhance competition between alternatives from the very beginning of the purchasing process.

Bavla acknowledged the need to define the supply market on the basis of its own needs. This was illustrated by the interviewees arguing that, when identifying potential components and suppliers, it was important to take into account a broad range of alternatives. This meant that the markets were scanned fairly broadly, taking into account both off-the-shelf software and tailored solutions. However, Bavla made a rather clear distinction between COTS software component suppliers and suppliers of tailored software.

As far as industry supply is concerned, the standardisation efforts made by industry bodies encompassing both buyers and sellers of components, was an important phenomenon. Officially, Bavla did take part in many standards committees but the division studied was not closely connected to those efforts. The interviewees argued that to have some influence on the supply markets through the development of standards took a long time and did not offer an immediate relief to the problems they saw in the COTS software component markets.

Software development tools was a theme closely related to the buying and using COTS software components. Typically, these tools were provided by third parties working closely with the provider of the COTS component. Thus, the customer could only deal with the component supplier who also distributed the software tools made by other companies. This highlighted the need for Bavla to find ways of influencing these third parties.

As pointed out, Bavla had varying degrees of awareness of existing supply. On one hand, the existence of supply was recognised and it was even used as basis for identifying the company's own software component needs. On the other hand, the awareness of the existing supply was rather low since the company struggled to map them to any great extent. Moreover, after the component had been bought, the awareness of the existing supply was rapidly decreased since scant attention was subsequently paid to the state of the supply market. Furthermore, as the need for components was difficult to define, potential components and their supply market was also a complex issue for Bavla. The initial idea was that in the COTS markets there would be plenty of comparable alternatives to choose from. In reality, alternative solutions needed to be identified broadly if it was to be taken seriously. In other words, the degree of specificity concerning the definition of the solution was varied. Thus, the awareness and definition of the industry supply had an impact on buyer's behaviour in terms of market shaping. In case supply is defined from the perspective of all the alternative solutions, including different technologies, different software architectures, and standard components available as well as subcontracting and tailored solutions, the picture of the market from the buyer's perspective becomes highly complex and difficult to manage.

## **Conclusions**

Our purpose in the present study has been to analyse the emerging software component markets from a purchasing perspective and to identify *how the buyers shape the emerging markets through their behaviour*. To accomplish this task, we first identified five elements of the markets relevant from a purchasing perspective; industry demand, industry supply, the

buyer company's own needs, object of exchange and the exchange mechanism. These elements represent the relevant analytical elements that we chose to study how purchasing can help shape an emerging market. Our empirical analysis of the software component markets in the early days of this century revealed the ways that purchasing can influence each of these elements.

We argue that with respect to buyer's own needs, companies influence the emerging market through the way they identify and explicate their needs to potential suppliers. For example, the level of awareness of the nature of existing supply for components and how much this is integrated into the definition of one's own need has an impact on the market's structure and its development. In practice, this relates to the way a buyer company builds its own software architectures; are component needs created on the basis of knowing that such components are commercially available, or are the component needs defined from developed software architecture? By defining and adapting needs according to available offerings, helps to homogenise demand. On the other hand, relying more on one's own needs and defining the product specifications accordingly, may increase innovation but also lead to more heterogeneous demand.

The individual needs of buying companies constitute the demand for a specific market. Through one's own needs, of course, each buyer plays their part in influencing demand. However, buyers have also other ways to influence demand. Standardisation efforts or other types of joint purchasing agreements help homogenise demand. The standpoint taken towards other buyers in a market is essential in shaping the market's evolution. This study suggests that competitive and cooperative interests co-exist, creating different kinds of influences in market evolution. Cooperation between buyers has been recognised as a useful strategy in specific situations for quite some time now (see e.g. Essig, 2000; Schotanus et al., 2010). However, its influence on market evolution has not been addressed. The present study finds that that coordination and/ or cooperation between buyers can help homogenise the market but the emerging phase of a market can often create conflicting interests that may prove too strong to overcome. In particular, in high-technology settings, concerns about protecting core technologies can foster more rather than less heterogeneous demand.

The buyer's own needs are closely associated to the third identified element of the market from the purchasing perspective, the *object of exchange*. Defining specifications for items to be purchased is an essential part of industrial buying process. This varies heavily across different industries, e.g. in project business, services or small components in manufacturing industries. Interestingly, in the present study the importance of different perceptions on the object of exchange proved to be an important issue. In emerging markets, it is to be expected that clear and stable rules of exchange will need to be created incrementally (Fligstein, 1996; Baker, 1998). On the basis of conflicts that arise from contrasting views on the object of exchange, rules of exchange are yet to be stabilised. Thus, the specification of the object of exchange can serve as a means to shape markets.

The conflicting perceptions of what is the object of exchange manifest themselves in the *exchange mechanism*, which was identified as the fourth element of the markets from a purchasing perspective. In business-to-business settings, the type of relationship forged between buyers and sellers has attracted extensive research – indeed the whole of the IMP Group enterprise could be characterised as concerned with how relationships are formed and the impact these relationships have on business markets, seen as network-like structures. Relationships are typically described as close and cooperative and contrasted with the

faceless, serially independent exchanges portrayed in idealised versions of markets inspired by neoclassical economics (Easton and Araujo, 1994). However, it has also been widely accepted that there is considerable variety in relationships and interfaces between customers and suppliers in business markets (cf. Araujo et al, 1999). The software engineering literature appears to espouse an idealised version of COTS markets close to the neoclassical ideal where counterparts are kept at arm's-length and transactions occur smoothly, mirroring the modular nature of software systems. In reality such smooth interfaces can hardly be achieved due to, at least partly, the emerging and unsettled nature of the markets. This also resulted in conflicting views on how the counterparts relate to each other. Evidently, problems arise in situations where counterparts act use different relationship strategies. Similarly, conflicts related to exchange mechanisms are closely connected to the stage of evolution of the markets. Thus, the management of exchange mechanisms are also a means to influence the operation of the markets and the direction of its evolution.

As the fifth element of our framework, we identified industry supply comprising all the alternative providers of solutions to the need of the particular buyer. Interestingly, in our analysis, the existence of a supply base was taken as an important driver for need identification. A single buyer's possibilities to influence supply are dependent on several factors. The size and market power of the particular buyer is one obvious issue; larger players can have a huge influence and help homogenise supply. In case of smaller buyers, the influencing mechanisms may be more connected to actions taken in terms of standardization for example.

The preferred template for COTS markets on the part of buyers seems to be one where external definition of needs is paramount. Thus, for buyers, it is important to be aware of existing offerings in the markets and relate them to own needs. In these markets the use of the same component by several competitors is common, and software interfaces are open. The object of exchange in the ideal market template is defined meticulously based on component characteristics, not on a specific solution needed by the buyer. Consistency between the supplier and buyer's perception of the object of exchange is an essential ingredient of smooth market exchanges. The exchange mechanism in this idealised version of the market is simple in nature, and should be light on managerial resources. The role of standard procedures in handling sales negotiations as well as after-sales interactions is central. Concerning industry supply, awareness of supply is essential and should be considered in broad terms - in other words it is important to take advantage of a whole range of possible solutions rather than defining the solution space narrowly.

Two interesting and related issue raised by the discussion on COTS markets and how they should preferably function are modularity and standards. A competitive market template inspired by the neoclassical economics model relies on comparable and highly substitutable offers. The role of standards, especially in terms of basic technologies and interfaces, in the development of a market is particularly important. All in all, for markets to become more mature and go beyond the emerging stage, it typically means that both demand and supply need to be made homogeneous to some degree. The development of standards, either through organized industry standardization committees or through the emergence of *de facto* standards, is an important prerequisite for the COTS markets to develop further. However, from the single buyer company's perspective, it can be difficult to have any real influence on the development of these standards. Standards development can take a long time and due to the huge speed of technological development typical in the software industry, jointly defined standards can also constrain the development of new solutions and technologies.

Finally, the notion of modularity looms large in our analysis of market development. Software modularity, originating from the design and manufacturing of physical products (see e.g. Mayer & Dalal, 2001), is about decomposing complex systems into modules and re-assembling these modules into a system, which can be tailored according to different needs. Component-based software engineering is about design modularity – modules are structurally independent but are still able to work together in a system. The system provides a framework (a software architecture) that allows for a loosely connected structure (through appropriately defined interfaces) as well as the integration of module functions (Baldwin and Clark, 2000). However, what makes the definition of standard modules and their interfaces so difficult is that the definition is not a company-level issue but a market-wide effort (Langlois, 2001).

This study has described how the emerging markets is seen from the perspective of a single buying company, and how the company attempts to shapes the emerging markets though its actions in relation to the identified five market process elements. Our interpretations are in line with the existing understanding of market processes developed in the Market Studies literature (see Araujo, 2007; Kjellberg and Helgesson, 2007a; Araujo et al, 2008) but provide a novel contribution in terms of an empirical illustration of how purchasing can contribute to market shaping. The findings also provide a contribution in terms of purchasing and supply management. In the contexts of emerging markets, in particular, buying firms do not simply adjust their own purchasing processes according to existing offerings, but are involved in actively influencing the five market process elements we identified. Each of these elements, as we have shown, can drive market evolution in particular directions.

## References

- Allen, P. (2001) Component development strategies, The Monthly Newsletter from Cutter Information Corp., Vol. XI, No. 3, pp. 1-16.
- Alvaro, A., de Almeida, E.S. and Meira, S.L. (2007) A Software Component Maturity Model (SCMM). Proceedings of the 33rd EUROMICRO Conference on Software Engineering and Advanced Applications, August 28-31, 2007, Lübeck, German. IEEE Computer Society 2007, 83-92.
- Andersson, P., Aspenberg, K. and Kjellberg, H. ( 2008) ‘The Configuration of Actors in Market Practice’ , *Marketing Theory* 8(1): 67-80.
- Araujo, L. (2007) ‘Markets, Market-Making and Marketing’ , *Marketing Theory*, 7: 211–226.
- Araujo, L. M., Finch J. & Kjellberg H. (2010), Connecting to markets, in *Reconnecting Marketing to Markets*, Oxford University Press, Oxford, pp. 234-245.
- Araujo, L. M., Kjellberg, H. & Spencer, R. (2008). Market practices and forms: introduction to the special issue. *Marketing Theory* 8(1): 5-14.
- Azimont, F. and Araujo, L. (2007) ‘Category Reviews as Market-Shaping Events’ , *Industrial Marketing Management*, 36: 849–860.
- Baker, W.E., Faulkner, R.R., and Fisher, G.A. (1998) Hazards of the market: The continuity and dissolution of interorganizational market relationships. *American Sociological Review*, Vol. 63, No 2, pp. 147-177.

- Baldwin, K. B. & Clark, C. Y. (2000) *Design Rules: The power of modularity*. MIT Press, U.S.A.
- Brereton P & Budgen D (2000) Component-Based Systems: A Classification of Issues. *Computer* 33 (11) 54-62.
- Brownsword, L. & Clements, P. A Case Study in Successful Product Line Development (CMU/SEI-96-TR-016, ADA315802). Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 1996.
- Caldwell, N., Walker, H., Harland, C., Knight L., Zheng, J. and Wakeley, T. (2005) Promoting competitive markets: The role of public procurement. *Journal of Purchasing and Supply Management*, 11, 242-251
- Caliskan, K. and Callon, M. (2010). Economization, part 2: A research programme for the study of markets. *Economy and Society* 39(1): 1-32.
- Callon M (eds) (1998) *The Laws of the Markets*. Blackwell Publishers/The Sociological Review, London.
- Callon, M. and Muniesa, F. (2005) 'Economic Markets as Calculative Collective Devices', *Organization Studies*, 26: 1229–1250.
- Carvalho, F. and Meira, S.R.L (2009) Towards Embedded Software Component quality Verification Framework. Proceedings of the 14th IEEE International Conference on Engineering of Complex Computer Systems, ICECCS 2009, Potsdam, Germany, 2-4 June 2009. IEEE Computer Society 2009, 248-257.
- Cochoy, F. (2008) 'Calculation, qualculation, calculation: shopping cart arithmetic, equipped cognition and the clustered consumer', *Marketing Theory*, 8:15–44.
- Essig, M. (2000) 'Purchasing consortia as symbiotic relationships: developing the concept of 'consortium sourcing''. *European Journal of Purchasing & Supply Management*, Vol. 6, Iss. 1, pp.13-22.
- Febowitz MD & Greenspan SJ (1998) Scenario-Based Analysis of COTS Acquisition Impacts. *Requirements Engineering* (3) 182-201.
- Finch, J.H. and Acha, V.L. (2008) 'Making and exchanging a second-hand oil field, considered in an industrial marketing setting', *Marketing Theory*, 8, 45-66.
- Fligstein, N. (1996) Markets as politics: A political-cultural approach to market institutions. *American Sociological Review*, Vol. 61, Iss. 4, pp. 656-673.
- Guesnerie R (1996) *L'économie de marché*. Dominos, Paris: Flammarion.
- Hahn, H. and Turowski, K. (2003) Drivers and inhibitors to the development of a software component industry. Proceedings of the 29th EUROMICRO Conference 2003, New Waves in System Architecture, 3-5 September 2003, Belek-Antalya, Turkey. IEEE Computer Society 2003, 128-139.
- Håkansson, H. & Snehota, I. (1995) *Developing relationships in business networks*. International Thomson Press, Boston.

- Håkansson, H. (1982) An Interaction Approach in Håkansson, H. (ed.) *International Marketing and Purchasing of Industrial Goods: An Interaction Approach*, Chichester, UK, John Wiley & Sons, pp. 10-27.
- Harmon, P. (1999) Component development strategies. The Monthly Newsletter from Cutter Information Corp., Vol. IX, No. 12, pp. 1-16.
- Kjellberg, H. and Helgesson, C.-F. (2007a) 'On the Nature of Markets and their Practices', *Marketing Theory*, 7: 137-162.
- Kjellberg, H. and Helgesson, C.-F. (2007b) 'The Mode of Exchange and Shaping of Markets: Distributor Influence on the Swedish Post- War Food Industry', *Industrial Marketing Management*, 36: 861-878.
- Kotonya G & Awais R (2001) A Strategy for Managing Risk in Component-based Software Development. Proceedings of the 27<sup>th</sup> EUROMICRO Conference, pp.12-21.
- Langlois, A.J. (2001). The Politics of Justice and Human Rights: Southeast Asia and Universalist Theory. Press Syndicate of the University of Cambridge, U.K.
- McIlroy, M.D. (1969) Mass produced software components. In Software Engineering, Report on a conference sponsored by the NATO science committee, Garmisch, Germany, 7<sup>th</sup> to 11<sup>th</sup> October 1968. Scientific Affairs Division, NATO, Brussels. 138-155.
- Messerschmitt, DG & Szyperski, C (2000) Industrial and Economic Properties of Software: Technology, Processes, and Value. University of California at Berkeley Computer Science Division Technical Report UCB//CSD-01-1130, Jan. 18, 2001.
- Meyer, M. H. and Dalal, D. (2002) Managing platform architectures and manufacturing processes for nonassembled products. *The Journal of Product Innovation Management*, Vol. 19, pp. 277-293.
- Meyers, BC & Oberndorf, P (2001) Managing Software Acquisition. Open Systems and COTS Products. SEI Series in Software Engineering, Addison-Wesley.
- Ncube C & Maiden NAM (1999) Guiding Parallel Requirements Acquisition and COTS Software Selection. Proceedings of the IEEE International Symposium on Requirements Engineering, 1999 p. 133 -140.
- Ochs M., Pfahl D., Chrobok-Diening G and Nothhelfer-Kolb B. (2000) A COTS Acquisition Process: Definition and Application Experience. Fraunhofer Institute for Experimental Software Engineering (IESE). ISERN Report 00-02.
- Schotanus, F., Telgen, J. and de Boer, L. (2010) 'Critical success factors for managing purchasing groups'. *Journal of Purchasing & Supply Management*, Vol. 16, Iss. 1, pp.51-60.
- Slater, D. & Tonkiss, F. (2001) *Market society: markets and modern social theory*. Polity Press & Blackwell Publishers Ltd, Cambridge, U.K.
- Voas J (1997) A Defensive Approach to Certifying COTS Software. Reliable Software Technologies Corporation. Technical Report RSTR-002-97-002.01.

Webster FE (1992) The Changing Role of Marketing in the Corporation. *Journal of Marketing* 56 (October) 1.17.

Xia C, Lyu M.R., Wong K-F & Roy K (2000) Component-Based Software Engineering: Technologies, Development Frameworks, and Quality Assurance Schemes. Proceedings of the *Seventh Asia-Pacific Software Engineering Conference*, APSEC 2000, pp.372-379.