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Commercial Off-The-Shelf Software: Using Purchasing Portfolio Management to Gain Competitive Advantage

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Signed Statement

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Master of Science in Technology Management, is entirely my own work, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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Abstract

This study examines how purchasing portfolio management can be used to gain competitive advantage when using Commercial-off-the-Shelf (COTS) software products in software development. A case study research method was chosen, using a qualitative data gathering approach. The study is based in a large telecommunications company that uses an extensive number of COTS software products in the software development of a telecommunications software system.

Although there are many advantages to using COTS software products, there are also many disadvantages. There is a high degree of buyer lock-in, and the many challenges are attributed to vendor-controlled change and market conditions.

The case study findings indicate that purchasing portfolio management is a valuable technique to classify COTS products, analyse buyer-suppler relationships and to determine what strategic actions are needed to gain competitive advantage. The approach offers a structured and comprehensive classification approach that can be customised to each company's context and considers supply market complexities as well as the importance of the product to business strategy.

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Chapter 1: Introduction

1.1 Background to the Study

Commercial software products have become an increasingly popular choice in the development of software systems in many industries, especially since the development of standard interfaces and open technologies.

A Commercial-of-the-shelf (COTS) software product is defined as a commercially available or open source piece of software that other software projects can re-use and integrate into their own products (Torchiano and Morisio, 2004). This study is concerned with management aspects of the supplier relationship in the COTS software industry, from the perspective of the buyer. The context is COTS software products that are integrated as part of a larger system. Open source software products are not included, as the challenges raised are slightly different.

1.2 Motivation for this Research

The rapid growth of the COTS software market has created many challenges that do not fit with traditional software development or organisational models. While the main focus of the COTS literature has focused on the software engineering aspects, managing COTS-based development also requires an external focus as market conditions and technology forces can have large impacts. The COTS supply market is immature (Ulkuniemi and Seppanen, 2004) and according to Boehm and Abts (1999), COTS supplier behaviour varies widely with respect to support, co-operation and predictability. Reifer et al., (2003) conclude that traditional approaches to licensing software, where contracts govern instead of relationships, lead to distrust and poor results. There are many examples of supplier 'lock-in', lack of control over the product evolution and little influence on the buyer-supplier relationship. The models provided in the existing literature for managing the acquisition and the buyer-supplier relationship, do not address how buyers can understand and actively influence the emerging market to fulfil their strategic needs (Ulkuniemi and Seppanen, 2004).

Thus management of external context has been somewhat identified but not explored in COTS literature. For example, development organisations are advised to mitigate risks by having a 'market watch activity', and engage in 'close relationships' or 'strategic partnership' with COTS suppliers (Boehm 1999, Torchiano and Morisio (2004), Vigder and Dean (2000), Anderson and McAuley (2006), Vigder et al 1996). However, to date there has been no research in how to implement these recommendations in a structured way.

The purchasing literature is mainly concerned with management of the acquisition, including connection to business strategy, buyer-supplier relationships and more recently issues of power and dependence in the relationship between buyers and suppliers. Purchasing portfolio management is used as a technique to determine differentiated supplier management strategies by categorising the product based on internal and external factors, and relative strength of the buyer supplier relationship. While there are many conceptual studies on the portfolio approach in purchasing, there are only a limited number of case studies (Gelderman and Van Weele, 2005). The majority of these are based in the manufacturing industry, which has different characteristics to the software industry

This study seeks to address the gap in the COTS literature by exploring the usefulness of portfolio management as a technique to create differentiated strategies to manage supplier relationships, based on the strategic importance of the COTS product for competitive advantage, and the external context. This also extends the purchasing literature by applying the purchasing portfolio model approach in a software context. The research question at the centre of this study is **can purchasing portfolio management be used as a technique to gain competitive advantage in the management of COTS software suppliers.**

The study is performed in the context of a large telecommunications company that develops a software system consisting of proprietary software as well as approximately seventy commercial software products. The company has recently

put in place a supplier management function, to implement best practices and to address challenges encountered when developing a software system that includes COTS products. As this company has a ten year history in using commercial software products, it is an appropriate context to study the use of purchasing portfolio management for commercial software products.

1.3 Layout of the Chapters

Chapter 2 is a review of the literature on COTS-based software development, the COTS software market, and the purchasing portfolio models. The main bodies of literature that have been examined are in the software development, marketing, and purchasing domains. Chapter 3 presents the research methods used in this thesis. A case study approach is used and this is supplemented with structured workshops with key stakeholders involved in the selection, usage and management of COTS software products in the software development company. Chapter 4 presents the results and findings, based on the case study. Chapter 5 is a discussion of the main findings and conclusions. Chapter 6 presents conclusions, limitations and recommendations for future research.

Chapter 2: Literature Review

2.1 Introduction

The purpose of this chapter is to present the bodies of research that have been carried out to date regarding the usage of Commercial-off-the-Shelf (COTS) products in software development, and the usage of purchasing portfolio management models for strategic supplier management.

The first two sections look at the COTS based development and marketing literature, which includes the drivers, advantages and disadvantages of using COTS products, as well as the challenges and recommendations that have been identified relating to the external market. The third and fourth sections examine the use of portfolio management in purchasing, as well as a critique on the usage of purchasing portfolio models. Finally, the conclusion of the literature review proposes that the Kraljic purchasing portfolio model is applied in COTS based development to determine if the technique can be used to gain competitive advantage in the management of COTS software products.

A Commercial-off-the-Shelf software product can be defined as a commercially available piece of software that other software projects can re-use and integrate into their own products (Torchiano and Morisio, 2004). The source code is not available to the buyer, and this means the further development, i.e. the new versions of the COTS software, is not under the control of the buyer (Ulkuniemi, 2003).

The Software Engineering Institute (SEI) perspective (Brownsword, Oberndorf and Sledge, 2000) is that a COTS product is sold, leased, or licensed to the general public; offered by a vendor trying to profit from it, supported and evolved by the vendor, who retains intellectual property rights; available in multiple identical copies: and used without source code modification.

For the purposes of this study, the context of COTS usage refers to a software product, supplied by a vendor, that has a specific functionality as part of a system – a piece of pre-built software that is integrated into the system and must be delivered with the system, to provide operational functionality or to sustain maintenance efforts (Morisio et al., 2000).

2.2 Using COTS Software for Competitive Advantage

Porter (1980), in his seminal work on the forces that shape the competitive nature of industry, identified the power of buyers and suppliers as two of the five forces that influence the competitiveness of an industry. Purchasing power of buyers and power of suppliers can greatly differ between companies in different industries. Companies can gain competitive advantage by optimising purchasing power and minimising power of suppliers. According to Porter (2004), a firms' competitive advantage resides in the discrete activities performed by the firm within the business segment they operate. There is a strong link between usage of COTS products and competitive advantage. The company's resources for competitiveness, reside in the discrete activities associated with the usage of COTS products. Barney (1995) points to a competitive advantage being gained through the capabilities of the firm. He places particular emphasis on creating rareness barriers to imitability by developing a firm's capabilities. In the context of COTS products, the buyer-supplier relationship can provide the company with rareness and barriers to imitability.

Software is recognised as a growth area because of it potential in giving firms new competitive opportunities. The software development community recognises the great potential for using COTS products, especially in the current environment, where new technologies and domains have exploded in growth, along with the complexity and number of system (2006 International Conference on COTS-Based Software Systems (ICCBSS)). Recent estimates put the annual market for COTS software at almost $US200 billion worldwide (SIIA, 2003; Keil and Tiwana, 2005). The software industry has advanced from developing products using proprietary software, to extensive use of third party commercial software products.

This has been driven by the rapid advances in technology and the increasing standardization of technologies, computing platforms, middleware, and application software interfaces (Ulkuniemi and Seppanen, (2002), Albert and Brownsword (2002)).

2.2.1 COTS Advantages and Disadvantages

The advantage of COTS-based development has been described at the SEI/MCC Symposium in 1995 as reduced software development cost by use of existing components that have been previously developed or tested, reduced maintenance costs, improved re-use, and promotion of a competitive component marketplace in many technical domains, with the result that product developers will be able to chose from a range of components provided by third party suppliers.

According to Yang, Bhuta, Boehm and Port (2003), Boehm and Abts (1999), Albert and Brownsword (2002), there are several drivers for companies increasing usage of COTS in software development that can be summarised as follows:

- Reduce front-end development costs and complexity.
- Leverage industry and market supported skill-sets – especially in non-core competence areas
- Expand capabilities and performance by collaboration or partnering with suppliers to bring innovative solutions quickly to market

Software development organisations now focus on cost reduction and operational excellence for business survival. COTS can provide significant user capabilities within limited costs and development time (Yang et al., 2003) and can be used where a company does not view the technology/required competence or capability as core to the organisation. COTS products can be used to reduce development and maintenance complexity by buying in advanced, innovative or non-core technological capabilities. More COTS products are becoming available, offering increased product capabilities, leading to opportunities for business growth, with many software companies starting to collaborate and partner in order to increase business or to enter new markets.

"Use of COTS is gaining popularity. There is a vibrant market today that delivers a wide range of COTS software products that offer the promise of rapid delivery to the end users, shared development costs with other customers, and an opportunity, for expanding mission critical capabilities and performance as improvements are made in the marketplace. Few organisations today can afford the resources and time to replicate market-tested capabilities. Yet the promise of using pre-existing components is too often not realised in practice. Many organisations find that COTS-based systems are difficult and costly to build, field and support. Experience shows that effective use of COTS products demands a new way of doing business, and these changes are not happening.",

- Albert and Brownsword, 2002

McDermid (1997) also found the use of COTS is not the panacea sometimes implied – it can increase rather than decrease cost. The promises of COTS products are too often not realised in practice – while major benefits are still possible, there are many cases where use of COTS has resulted in increased lifecycle costs, mismatched solutions, and lock-in situations with suppliers as evident in the recent plethora of tales of woe, lessons learnt and recommended best practices (ICCBSS 2006). Most organisations have found that COTS gains are accompanied by frustrating COTS pains (Boehm and Abts, 1999). Table 1 summarises a number of the relative advantages and disadvantages of COTS solutions; these indicate that COTS integration differs significantly from traditional software development and requires significantly different approaches to its management (Boehm and Abts, 1999).

Advantages	Disadvantages
Immediately available; earlier payback	Licensing, intellectual property procurement delays
Avoids expensive development	Up-front license fees
Avoids expensive maintenance	Recurring maintenance fees
Predictable, confirmable license fees and performance	Reliability often unknown or inadequate; scale difficult to change
Rich functionality	Too-rich functionality compromises usability, performance.
Broadly used, mature technologies	Constraints on functionality, efficiency
Frequent upgrades often anticipate organization's needs	No control over upgrades and maintenance
Dedicated support organization	Dependence on vendor
Hardware/software independence	Integration not always trivial; incompatibilities among vendors
Tracks technology trends	Synchronizing multiple-vendor upgrades

Table 1 COTS Advantages and Disadvantages
(Source: Boehm and Abts, 1999)

2.2.2 Handling of Disadvantages

Traditionally, issues in software development have been primarily influenced by internal factors – requirements prioritisation, resource capacity, and cost reductions, delivery schedules versus scope or quality. The COTS-based software engineering literature has covered the technical aspects of developing and using COTS extensively - including selection processes, architectural and process issues in COTS-based software development (e.g. Brownword, Oberndorf and Sledge (2000); Reifer et al., (2003), Torchiano and Morisio, (2004)), quality assurance and cost analysis (e.g. Voas, 1998, Boehm and Abts (1999)) and requirements and specification handling (Ncube and Maiden, 1998).

Much has already been written about the challenges and risks generally associated with incorporating COTS components into systems (Yang et al., (2003), Boehm and Abts (1999), Basili and Boehm (2003), Vigder and Dean (2000), Merola (2006)). Most of the literature gives recommendations on internal processes and guidelines to handle these issues, i.e. selections processes, requirements and specification handling, experimentation, prototyping, trade-offs, allocating extra

budget to handle lifecycle costs and upgrades, technology and vendor surveillance (Torchiano and Morisio (2004), Morisio at al, (2000)).

Risk-based management is a common recommendation to handle known challenges associated with COTS products (Anderson and McAuley (2006), Basili and Boehm (2003), Shaffer and McPherson, (2002)). Risk based management can be seen as an internal processes used to develop workarounds to problems emanating from external sources that cannot be easily controlled, i.e. emanating from the vendor. Management-related aspects have focused on COTS selection and acquisition models and integration guidelines (Meyers and Oberndorf, 2001, Liu and Gorton, 2003). The IEEE and SEI supplier management processes (IEEE Standard 1062 (1998), SA-CMM (1999)) deal mainly with managing the COTS product acquisition as an engineering process rather than as a business process (Ulkuniemi and Seppanen, 2004). These processes assume an ideal market and do not differentiate between different types of COTS products or deal with relationship management of supplier, an activity that is recommended in the majority of lessons learned.

2.3 COTS Based Development - External Environment

Integration of COTS products also brings many external factors into play in the software development project, and this seems to be where most companies are finding problems. The complex nature of software integration creates many vendor dependencies and supplier lock-in situations. Buyers have no control over a COTS product's functionality or performance (Boehm and Abts, 1999). COTS vendors change and evolve products, but in response to the overall market place, not to the buyers need. Upgrades may not be compatible or interoperable with other products, releases can quickly become obsolete and unsupported by the vendor, product capabilities and quality can change over the product lifecycle. These are all factors that are controlled externally by the supplier, known as 'vendor-controlled change' and require closer attention to supplier relationships and the external market situation. Similar challenges are identified in many case studies

(e.g. Anderson and McAuley (2006), Merola (2006), Yang et al (2005), Torchiano and Morisio (2004), Boehm and Abts (1999)). Boehm and Abts (1999) refer to these as COTS gain and pain case studies where unpredictable evolution of COTS products increase maintenance cost and reduce the upfront gains in competitive advantages.

Morisio et al., (2000) found that the buyer must accept dependence on the vendor as a trade-off with expected gains in schedule, effort and cost. Managing these trade-offs is crucial to the success of COTS-based software development. The dependence on the vendor means that the vendor is the ultimate decision maker on the functionalities available, the release schedule, the architecture, reliability, and the service level. Consequently the buyer has little or no influence on the above issues. Torchiano and Morisio (2004) found that a distinguishing characteristic is that the marketplace, not the buyer, exerts a strong influence on the evolution of COTS products.

COTS software products may be an essential part of a system's software for a long time. Buyers need to ensure that they have continued support for existing product versions and can influence the longer term evolution of the COTS product (Boehm and Abts, 1999). The COTS literature has a 'widely accepted idea' that buyers must passively accept lack of control over the vendor, product features and evolution (Boehm and Abts (1999), Basili and Boehm (2001)). In 2004, Torchiano and Morisio contradicted this and claimed that buyers can influence the vendor on product evolution. However, this increased control occurred in two cases – by acquiring the firm that owns the COTS product, or by leveraging a monopsonistic condition (a market situation in which a sole buyer exerts a disproportionate influence on the market) for a niche market. A subsequent study in 2005, with a larger sample size, showed that COTS users could push vendors to change products (bug fixes or new features) but this did not imply that buyers actually influenced COTS product evolution. Torchiano and Morisio (2004), based on more empirical evidence, now believe that the COTS product evolution

is decided by the vendor's marketing strategy rather than the requirements of a specific user. While this can be true for COTS products that address a mass market, buyers may or may not be able to exert more influence on suppliers of niche products but this is dependent on how important the buyer is for that niche product.

2.3.1 Changing Market Conditions

A benefit quoted by SEI/MCC Symposium in June 1995 is that COTS software promotes a competitive marketplace in many technical domains, which will increase choice of products and suppliers; competition between vendors will drive prices down and improve quality of the systems and product developers will be able to choose from a wide range of products. However these arguments do not apply for many COTS products, where there is limited choice of products for purchase with minimal ongoing competition (Vigder, 1996).

Ulkuniemi, (2004) in her analysis of the COTS market place concludes that the COTS market place is in the early emerging phase and hence lacks industry standards and management guidelines, but the buyers (and the COTS literature) assume mature, competitive market conditions. In addition, marketplace consideration adds further variability: in the COTS products market there are no widely agreed upon standards, mainly due to marketing strategies aimed at obtaining vendor lock-in. Variability and marketing strategies suggest that there will never be a single unified marketplace of standardised COTS products (Morisio and Torchiano, 2002). Ulkuniemi and Seppanen (2004) advise that buyers need to manage the acquisition in different ways, dependent on the market conditions for the products:

"Software acquisition management requires looking beyond internal operational practices (for managing acquisitions and supplier relationships) – buyers need to understand and influence the entire market, particularly its development over time, to fulfil their strategic needs."

2.3.1.1 Technology Lifecycles and Standardisation

Technologies have lifecycles just like products (Foster, 1997). The COTS market is characterised by rapidly changing technologies, and technology lifecycles, that is, the time taken for a new technology to become mature, are reducing. As technologies mature, a dominant design emerges and becomes the de facto standard, until it is replaced by a new technology. The dominant design leads to more standardised supply and demand, thereby increasing competition. As technologies reach the end of their lifecycle and competition increases, suppliers can remain as is or can extend the lifecycle by differentiating the product with additional features to gain competitive advantage, which causes difficulty when trying to compare COTS products. Alternately, suppliers move to a new technology which will eventually replace the mature technology. New and emerging technologies are characterised by lack of standards and a complex supply market until the dominant design emerges.

According to Ulkuniemi and Seppanen (2004), suppliers don't follow any established standards but offer diverse solutions and service packages, thus making it difficult to compare suppliers. The Software Engineering Institute (SEI) describes a marketplace characterised by a vast array of products and product claims, extreme quality and capability difference between products, and many product incompatibilities, even when they purport to adhere to the same standards (Morisio et al., 2000). According to Ulkuniemi and Seppanen (2004), standardisation is unlikely, as the rapid development and complex nature of the software industry causes difficulties with standards. Firstly because there are several standards organisations, creating different and even overlapping standardisation efforts and secondly because technology development far outpaces standards creation (Ulkuniemi, 2003).

2.3.2 Influencing Vendor- Controlled Change

Rapid advancements in technology, changes in standards, mergers and acquisitions means that market conditions change and need to be monitored (Yang et al., 2005).

2.3.2.1 Market Watch

The COTS market is immature, highly competitive and reconfiguring rapidly, new competitor products may arrive, lesser products may improve, acquisitions and mergers may change the COTS product strategy. Reifer et al., (2003) recommend that firms establish a market watch function to keep track of product direction and to continuously assess their options. A market watch activity looks at the marketplace as a whole, monitoring the technology developments, product strategy, a specific vendor's health and viability as well as competitors' space. Yang, Bhuta, Boehm, and Port (2005) propose strategies to cope with vendor controlled change. These strategies include investing effort in a proactive COTS market-watch activity to manage evolution and continuously assess options, developing win-win rather than adversarial relations with COTS vendors, and always having a fallback/exit plan. Anderson and McAuley's (2006) lessons learned show that, when external business forces changed the supplier's strategy of a niche COTS product, the buyer was in the position of a 'captured client', without the benefit of vendor support. As there was no forewarning or fallback plan, the project was seriously compromised, and was forced to incentivise the vendor to fix problems.

According to Merola (2006) while performing market analysis is a recommended approach for managing COTS software products, past attempts to gather this data from well-known software vendors yielded few results. Merola (2006) found that software vendors are less forthcoming with product lifetime projections, than their counterparts in hardware, and software organisations are less likely to provide continued support of obsolete product versions.

2.3.2.2 Buyer-Supplier Relationships

Another common risk mitigation strategy is to have close relationships with suppliers (Anderson and McAuley (2006), Boehm and Abts (1999), Morisio et al., (2000)). Vendor behaviour varies widely and is a key issue that requires management. Boehm and Abts (1999) in their recommendation on avoiding common COTS pitfalls found that COTS vendor behaviour varies widely with

respect to support, co-operation and predictability. They advise buyers to be beware of uncritically accepting vendors' statements about their COTS products' capabilities and support and recommend that buyers:

- establish best relationship possible by checking track record of vendor
- Use a market watch activity to manage evolution and continuously assess options
- Always having a fallback/exit plan
- Establish strategic partnerships

According to Boehm and Abts (1999) shifting markets, mergers and buyouts, or unforeseen technological developments can convert a vendor's best intentions into broken promises. Boehm and Abts (1999) advise COTS buyers to establish strategic partnerships, or other incentives for COTS product vendors to provide continuing support.

Ulkuniemi and Seppanen (2004) analysis of the COTS market concludes COTS component acquisition cannot be managed as an isolated engineering activity – a software product is a complex object of exchange situated in a rapidly evolving market and different acquisition and relationship management strategies are required dependent on the purchasing scenario.

"Buyers must adapt to new kinds of relationships with COTS suppliers. Buyers can't manage these interfaces as in-depth project relationships with tailored software subcontractors; nor can they be managed using a purely transactional view."

Anderson and McAuley (2006) also found that different types of relationships are needed according to the maturity level and importance of the COTS product to the project. Risk increases as the market size decreases, COTS products should be classified and matched to a supplier management process. A highly customized, niche COTS application product with a smaller user base requires much more solid co-operations between user and supplier than a well-supported, mature COTS products, whose direction is not greatly influenced by any single customer (e.g. operating system or database). A key lesson learnt as a 'captured client' was to

understand the importance of the product to the vendor's bottom line, to develop the appropriate supplier relationship and to engage in a market watch activity.

Buyers of COTS software products are dependent on suppliers and supplier behaviour differs (for example, if the supplier product targets a niche or mass market, if the supplier is a technology leader, or in a monopoly situation). Market conditions more so than buyer's needs, influence product lifecycles and evolution. This causes many problems for buyers, who have very little control on COTS products that are integrated into their system solutions. The review of the literature suggests that buyers need to have differentiated relationships with COTS suppliers as in this way they can either influence the product evolution to some degree, or at least to ensure proactive communication of changes with suppliers. Anderson and McAuley (2006) suggest different buyer-supplier relationships are applicable based on the maturity level of the products and the size of the supply market. This suggests a classification is needed to determine buyer-supplier relationship approaches. Morisio and Torchiano (2002) have proposed a classification system for COTS product but this has been aimed toward improvement of product assessment and technical handling. A differentiated supplier management approach is required based on the importance of the product and the external market conditions, using only internal processes and risk-based management to manage this situation is not effective based on the increasing number of tales of woe (ICCBSS 2006).

2.4 Purchasing Portfolio Management

Ellram and Carr's (1994) review of strategic purchasing literature concludes that purchasing, amongst other things, must be concerned with the type of supplier relationship desired, external market factors and how purchasing can support the firm's competitive strategy. Suppliers have become increasingly important as they account for a large proportion of both the value creation and the total cost of goods sold (Van Weele, 2000). Chen, Paulraj and Lado (2004) found empirical evidence that purchasing can engender sustainable competitive advantage by enabling firms to foster close working relationships with suppliers, to promote open

communication among suppliers, and to develop long-tern strategic relationships to achieve mutual gains. Chakraborty and Philip (1996) found that many organizations today follow the practice of ad hoc development of vendor structures thereby affecting their competitive prospects. This can restrict the strategic flexibility of the organization. This aligns with the findings in the COTS literature where ad hoc relationships with COTS suppliers are leading to many challenges that reduce competitive advantage.

Thus managing the supplier base is becoming an essential strategic purchasing issue and consequently the need for differentiated approaches to purchasing behaviour increases (Dubois and Pedersen, 2002).

Portfolio models have received a great deal of attention in strategic planning (Olsen and Ellram, 1998) and emanated from Markowitz‘s (1952) pioneering portfolio theory for management of equity investments. Portfolio theory in general addresses the view of trade-offs in expected returns relative to risk characteristics of investments (Markowitz, 1952). Kraljic’s seminal paper (1983) proposed the use of portfolio models in purchasing as a basis for classifying purchases and setting purchasing strategy. Portfolio models provide an approach that enable a company assess its supply position and develop a tailor-made strategy to minimise the company’s supply vulnerability and optimise its buying power (Kraljic, 1983). Purchasing portfolio models can be used as a tool to look at both the internal and external dimensions of a purchased product, the supplier relationships, and to determine a management strategy based on trade-offs In the contemporary business environment, taking a portfolio perspective is important because of the increasingly critical role in a firm’s success that is played by suppliers (Wager and Johnson, 2004).

A strategic supplier portfolio consists of the set of supplier relationships assembled by the company with the intent of managing risk and optimising returns (Wagner and Johnson, 2004). Strategic supplier portfolios allow a firm to take into account the various buyer-supplier dependencies, and the trade-offs in terms of risks,

capabilities and competitive advantage. The portfolio is structured according to factors identified by the firm as important to sustainable competitive advantage.

Wagner and Johnson (2004) propose that portfolio management should be approached as a strategic management process that should comprise planning, implementation and control activities. Purchasing management has to shift its focus from striving for the lowest possible purchasing price to the sustained optimisation of the strategic supplier portfolios.

2.4.1 Kraljic's Purchasing Portfolio Model

Kraljic's (1983) purchasing portfolio model suggests the way suppliers are managed must be optimised according to the internal requirements of the purchased items and according to external factors. Instead of monitoring current developments (and reacting), management must learn to make things happen to its own advantage. The greater the uncertainty of supplier relationships and technological developments, the more important supplier management becomes. The general idea of Kraljic's model is to minimise supply risk and to make the most of buying power (Gelderman and Van Weele, 2003).

Kraljic's approach includes the construction of two portfolio matrices. The first model classifies purchased items into four categories based on a product's profit impact and supply risk and provides differentiated strategic actions for each category. The second model focuses on strategic items and shows the relative power of the company in corresponding supply markets. Three general purchasing strategies are distinguished based on the balance of power in the buyer-seller relationship: exploit (in case of buyer dominance), balance (in case of a balanced relationship), and diversify (in case of supplier dominance).

Kraljic does not pay much attention to strategic aspects of product categories other than the strategic items (Caniels and Gelderman, 2005). Other scholars have refined the original matrix and have formulated strategic recommendations for

each category. Table 2 gives an overview of the refined portfolio models and the resulting purchasing strategies proposed by various authors.

	Elliott-Shircore and Steel (1985)	Hadeler and Evans (1994)	Lilliecreutz and Ydreskog (1997)	Olsen and Ellram (1997)	Bensaou (1999)	Van Weele (2000)
name of the model	Procurement positioning overview	Supply strategy square	Classification model	Portfolio model	Portfolio of relationships	Purchasing portfolio
matrix dimensions	Profit/value potential Supply vulnerability	Product's value potential Product's complexity	Economic profile Complexity and risk profile	Strategic importance Difficulty of managing the purchase situation	Supplier's specific investments Buyer's specific investments	Profit impact Supply risk
category labels	strategic critical tactical profit strategic security tactical acquisition	(not specified)	strategic leverage bottleneck non-critical	strategic leverage bottleneck non-critical	strategic partnership captive supplier captive buyer market exchange	strategic leverage bottleneck non-critical
recommended purchasing strategy for:						
strategic items	manage suppliers	strategic partnerships		close relationships		partnership
leverage items	drive profit	global trading	(not specified)	leverage volume	management profiles in terms of	exploitation of power
bottleneck items	ensure supply	close relationships	desired co-operation with the supplier of the product	standardize and find substitutes	information sharing, tasks and climate for each category	assurance of supply
non-critical items	minimise attention	simple contracts		standardize and consolidate		systems contracting

Table 2 Overview and comparison of purchasing portfolio models and purchasing strategies
*(*Source: Caniels and Gelderman, 2005)

A comparison of the different portfolio models suggests there are more similarities than differences. The models all use Kraljic as a point of departure; employ practically the same dimensions, categories and the same recommendations (Caniels and Gelderman, 2005). Kraljic's model has subsequently become the dominant approach (Cox (1997), Gelderman and Van Weele (2003)).

The Kraljic model follows a four stage approach to assess the company's situation and to devise strategies to exploit purchasing power and reduce supply risks.

- Classification: classify purchased components in terms of profit impact and supply risk
- Market Analysis: analyse the supply market for these components
- Strategic Positioning: determine the overall strategic supply position

- Action plans: develop product strategies and action plans

2.4.1.1 Classification and Purchasing Approaches

The two dimensions used in the portfolio model are used to classify purchases based on both external factors and internal factors.

- The profit impact, also described as the strategic importance of the purchase, in terms of the value added by the purchase, the cost as a percentage of total product cost, and the impact on profitability.
- The complexity of the supply market gauged by supply scarcity, pace of technology substitution, entry barriers, logistics costs or complexity and monopoly or oligopoly conditions.

Although Kraljic gives guidelines on the measurement factors for these dimensions, further work is needed to define these based on what is important to the company and the industry in which it operates (Olsen and Ellram, 1997).

Kraljic's model then gives four strategic recommendations or approaches to manage the purchase situations, on the basis of these classifications (Figure 1). The complexity of each approach is in proportion to the strategic implications. Olsen and Ellram (1997) refer to the recommended purchasing strategies at this stage as 'idealised' and have extended the approaches by giving extra attention to the supplier-buyer relationship aspects, rather than just the purchasing approach.

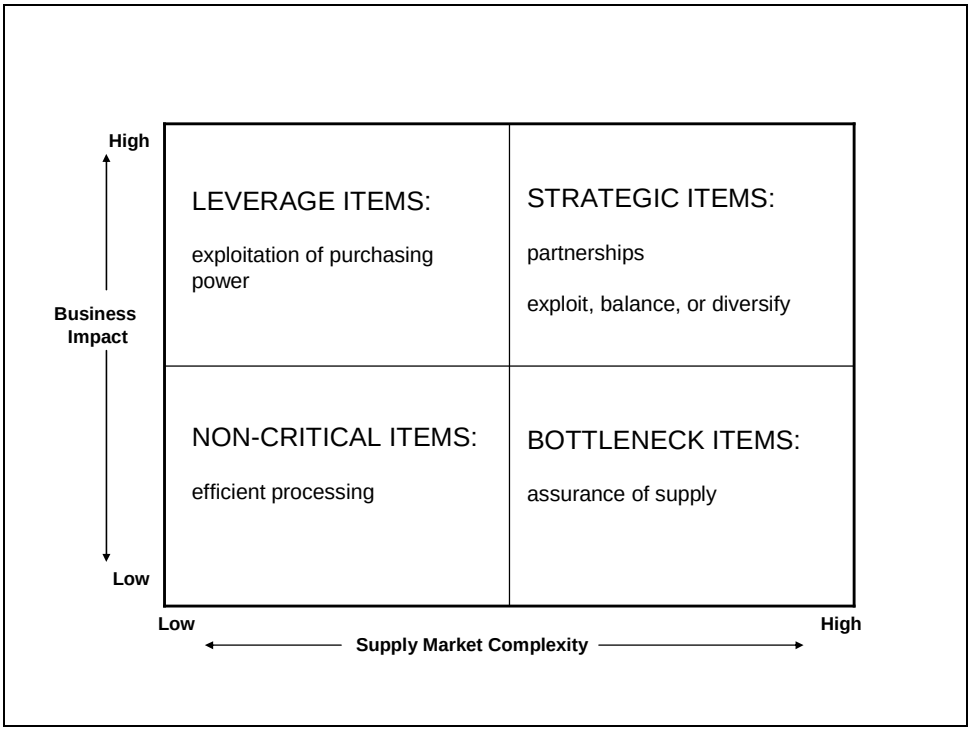

Figure 1 Kraljic matrix: categories and recommendations
Source: modified from Kraljic (1983)

Non-Critical Items

This category includes purchases that are easy to manage and with a low strategic importance. The strategic management approach is to standardise and consolidate. The focus should be on enhancing standardisation, and efficient processing through consolidation and reduction of administration costs, for example, by reducing the number of suppliers and the number of similar products. The supplier-buyer relationship should be managed by establishing a relationship that basically manages itself.

Leverage Items

This category contains purchases that are strategically important to the company and can be obtained from multiple suppliers, thus having a low supply risk. The recommended management approach is to leverage the market situation to get better terms and condition, e.g. to lower costs, or influence the product evolution. A product architecture that could support interchangeable products increases the leverage position.

Bottleneck Items

This category contains purchases that have a low strategic importance but are difficult to manage. The recommended purchasing strategy is assurance of supply based on acceptance of the bottleneck situation and reduction of the negative effects of the unfavourable position. A risk reduction approach/alternative strategy (Caniels and Gelderman, 2005) is to standardise the product requirements, seek alternative suppliers and move towards the non-critical quadrant. The company should try to establish a relationship that involves the supplier in value analysis in order to reduce risk.

Strategic Items

This category contains purchases that are difficult to manage and are strategically important to the company. The recommended management approach is to have strategic alliances, close relationships, early supplier involvement. The supplier should be viewed as a natural extension of the firm.

2.4.1.2 Market Positioning (Analysis of the Buyer-Supplier Relationship)

As these strategies are idealized purchasing strategies, the next steps according to Kraljic are to weigh the bargaining power of suppliers against the company's own strength as a buyer to gauge the buyer's ability to get the kind of supply terms it wants. Kraljic then suggests strategic thrusts based on the current power balance (see Figure 2) – the power of the suppliers and the power of the buyer.

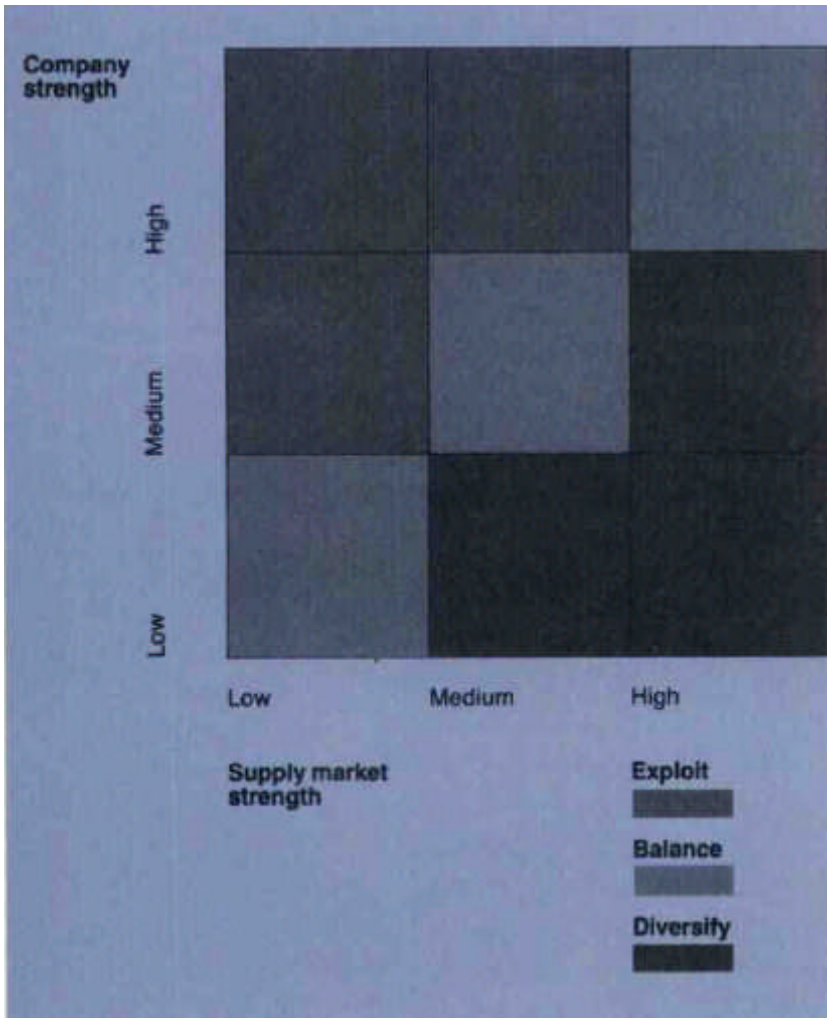

Figure 2 Strategic Supplier Portfolio Model
(Source: Kraljic (1983)

Kraljic (1983) suggests buyers should adopt the following strategic thrusts:

- exploit (in the case of buyer dominance)
- balance (in the case of a balanced relationship)
- diversify (in the case of supplier dominance)

Here Olsen and Ellram's (1997) research disagrees with Kraljic - their opinion is that basing relationships on power levels and exploiting power or avoiding risk when the supplier has greater power is a very dangerous strategy in today's world because of rapidly changing markets.

Kraljic does this analysis only for products in the strategic quadrant – he assumes that the power balance for non-critical and leverage categories is in favour of the buyer, and in favour of the supplier for products in the bottleneck quadrant. More recent research by Caniels and Gelderman (2005) has extended Kraljic's model and compared the literature's theoretical expectations on power and dependence for each quadrant based with observed power and dependence (see Table 3).

	relative power		total interdependence	
	expected	observed	expected	observed
strategic	balanced	supplier dominance	highest	highest
bottleneck	supplier dominance	supplier dominance	moderate	moderate
leverage	buyer dominance	buyer dominance	moderate	moderate
non-critical	balanced	balanced	lowest	lowest

Table 3 Comparison of power and interdependence in the Kraljic Matrix: theory and practice
(Source: Caniels and Gelderman (2005))

A remarkable finding was that in most observed cases suppliers had more dominance in strategic relationships, where the ideal according to the theoretical literature was a balanced relationship. Caniels and Gelderman conclude that this indicates the supplier dominates even satisfactory partnerships. This is presumed to be because once the buyer has entered a partnership this ensures a disproportionate raise in the dependence of the buyer on the supplying partner. Their results also suggest that unbalanced relationships may not always be troublesome as long as it is a known and effective relationship.

2.4.1.3 Develop Strategies and Action Plans

Each of the strategic approaches has distinctive implications for element of the purchasing strategy. This final step of the portfolio approaches explores various short and long term actions to realise the strategic approaches. The end product will be a set of systematically documented strategies and action plans for purchased products.

2.5 Critique of Purchasing Portfolio Models

The Kraljic approach has been described as a breakthrough, representing the single most important diagnostic and prescriptive tool available for purchasing and supply management (Syson, 1992). Studies have found it is a powerful tool for differentiating the overall purchasing strategy, with different strategies for different supplier groups (Lilliecreutz and Ydreskog, 1999); and for discussing visualising and illustrating the possibilities of differentiated purchasing strategies (Gelderman and Van Weele, 2002). Prior to this, ABC-analysis has been the main tool used in purchasing for differentiating between important and less-important purchases. However, the ABC-analysis concentrates on the financial value of items, ignoring the cost of poor quality, performance risk, and other components, Gelderman and Van Weele (2005). Moreover ABC analysis does not provide strategic recommendations for categories, it merely provides information on the concentration of purchasing spend (Gelderman and Van Weele, 2005).

Kraljic's seminal paper (1983) has been the basis for further research into portfolio models in relation to supply and purchasing situations; and more recently buyer-supplier relationships (Olsen and Ellram, 1997, Benasou, 1999, Gelderman and van Weele, 2000). Research on purchasing portfolio models has been mainly conceptual, with a small number of case studies. Arguments in favour of portfolio models have been reported in a limited number of case studies while the counter-arguments can be found in conceptual studies. The critique of portfolio models does not include the experience of practitioners (Gelderman and Van Weele, 2005).

The case study research (Olsen and Ellram (1997), Gelderman and Van Weele (2003) have all found that the approach both allows for and requires customisation based on the company and industry context.

Gelderman and Van Weele (2003) found that the positioning of items in the matrix was followed by a process of reviewing the positions and reflection on the consequences, if necessary adjustments were made. In-depth discussions at this point are considered as the most important phase of the analysis. Van Weele (2005) states that purchasing participation in cross-functional teams, is a sign of purchasing sophistication. Olsen and Ellram (1997) have a similar opinion – the analysis is the most important part and as it can be very subjective, the decision-makers in the company must come to agreement on the relative importance of each factor.

Wagner and Johnson, 2004 argue that Kraljic considered a limited number of factors when measuring dimensions. Important factors such as alternative governance forms, pressure to reduce portfolio size, and increased concern for sustainable competitive advantage were not included. However, many other authors (Olsen and Ellram (1997), Van Weele (2005)) contend that factors can vary across companies and industries. Changes in the external environment and competitive forces can alter the strategic direction, both of the company and of the suppliers, and this will have an impact on what criteria are strategically important. Olsen and Ellram (1997) suggest that if dimensions are very complex, there may be too much focus on developing measures and categorizing the elements, and not enough focus on realizing the full potential in terms of resource allocation and communication. If dimension are too simple, important variables can be overlooked. The classification is not an end in itself but a means to aid in the development of appropriate action plans.

Portfolio models provide very limited explanations of how to actually manage each category once a classification has been made. Recommendations on how to handle the purchasing situation are 'idealised' according to Olsen and Ellram (1997). Cox (1997) sees the major weakness is that the methodology 'does not provide us with any pro-active thinking about what can be done to change the existing reality of power'. A common recommendation from these case studies

(Olsen and Ellram (1997), Wagner and Johnson (2005), Gelderman and Van Weele (2003)) is that purchasing portfolio models are not completely prescriptive, but benefit from customization to the company and industry context. This includes the use of measurement criteria, strategic recommendations, and the resultant action plans.

In spite of these criticisms, Nellore and Soderquist (2000), Olsen and Ellram (1997) agree that portfolio models are an excellent way of organising information and classifying information in procurement management. Portfolio models are useful inputs for supply management decision-makers, as indicators of how to deal with different suppliers, and as eye-openers for a number of possible action plans.

2.6 Conclusion

The literature review was divided into three sections. The first section dealt with characteristics of COTS-based software development, including the advantages, disadvantages, and recommendations when using COTS products. The second section focused on challenges with the COTS market and the buyer-supplier relationship as well as recommended approaches to deal with these challenges. The third section dealt with the use of purchasing portfolio models in developing supplier management strategies to gain competitive advantage.

COTS software products can be used by software development organizations to gain competitive advantage through cost reductions, advanced technologies, and use of new innovative products. The COTS based development literature suggests that potential returns from COTS usage are large – as are the inherent risks (Reifer et al, 2003). Recommended practices to manage these inherent risks require both an internal and external focus. The COTS literature has largely addressed the internal processes, but there is still a gap in the literature on how to address the unique challenges arising from the immature supply market. Recommendations such as investing ‘market watch activities’ and ‘more co-operative buyer-supplier relationship’ are common, but there has of yet been no detailed research in these

areas. Software companies using COTS need to understand a complex and evolving marketplace, and manage a variety of buyer-supplier relationships, to gain sustainable competitive advantage whether it is cost reduction, technology leadership, or product differentiation.

Purchasing management is be concerned with the type of supplier relationship desired, external market factors and how purchasing can support the firm's competitive strategy, (Ellram and Carr, 1994). Purchasing portfolio management is a technique that can be used to identify what groups of products, suppliers, or relationships warrant greater attention than others. This study proposes that purchasing portfolio management can be used as a technique to gain competitive advantage by developing COTS supplier management strategies based on analysis of internal and external factors related to the COTS product.

The research question at the centre of this study is **can supplier portfolio management be used to gain competitive advantage in the management of COTS software suppliers.** In answering this question, the study attempts to capture insights and evidence on how purchasing portfolio management can be used in the software industry, specifically in handling purchases related to COTS-based software development. Although portfolio management models are extensively researched, there is a lack of empirical research providing insights and evidence on their actual use (Gelderman and Van Weele, 2001). While there are a number of recent case studies, the majority are based in the manufacturing industry.

The purchasing portfolio model was chosen as a technique for developing supplier management strategies for a number of reasons. The purchasing portfolio model takes a broad perspective of relationship management, based on the premise that the supplier base consists of a portfolio of different supplier relationships, each having various characteristics and serving the company in different ways (Wagner and Johnson, 2004). This perspective can be used to address the gaps identified in

the COTS based development literature, where it was found that different types of buyer-supplier relationships where needed dependent on if the COTS product was a mature and standardised, or a innovative niche product (Anderson and McAuley, 2006). While there are many recommendations on the need for differentiated buyer-supplier relationships, there has been no known detailed research in the COTS development domain on how this can be done.

Chapter 3: Research Methodology

3.1 Introduction

This chapter introduces the research question and related objectives. It discusses research methods in general and then describes the chosen empirical research design, the case study method, how it is evaluated as a research approach, and the approach taken for gathering the research data. Finally, the case study context and the limitations of the research are put forward.

3.2 Research Question

The research question at the centre of this study is **can purchasing portfolio management be used as a technique to gain competitive advantage in the management of COTS software suppliers?**

This study will attempt to answer this question by applying the purchasing portfolio approach in a COTS-based development context. There are three distinct objectives that are aligned with the purchasing portfolio management approach. The objectives of the research are to:

- Determine if Kraljic's classifications and generic purchasing approaches are appropriate for COTS software products
- Determine what insights can be gained by analysing the strengths of the buyer-supplier relationship for COTS software products
- Determine if action plans resulting from the purchasing portfolio approach can lead to competitive advantage in the management of COTS software suppliers.

3.3 Research Methods

In general, empirical research follows a generic pattern, choice of research area, formulation of research question, choice of method, formulation of design and

techniques, implementation of data collection, analysis of data, interpretation of data and conclusions. The research may take the form of inductive approach where observations and findings lead to a new theory, or a deductive approach where a theory drives the research to observe findings related to it (Bryman and Bell, 2003).

Deductive reasoning works from the more general to the more specific. Inductive reasoning works the other way, moving from specific observations to broader generalisations and theories (Trochim, 2006). Inductive reasoning is more open-ended and exploratory; deductive reasoning is narrower and is concerned with testing or confirming a hypothesis.

When using a deductive approach, the researcher, on the basis of a theory, deduces a hypothesis that must then be subjected empirical scrutiny (Bryman and Bell, 2003)

Theory -> Observations/Findings

When using an inductive approach, the researcher infers the implications of their findings for the theory that prompted the study. The theory is the outcome of the research. The process of induction involves drawing generalisability inferences out of observations.

Observations/Findings -> Theory

Theoretical reflection on a set of data is followed by the researcher collecting further data in order to establish the conditions in which a theory (or model) will or will not hold.

There are two main strategies that can be employed for data gathering in empirical research, a qualitative or a quantitative approach.

- Qualitative data collection can be construed as a research strategy that *"predominately emphasises words rather that the quantification of data and employs an inductive approach to the relationship between theory and*

research, in which the emphasis is based on the generation of the theory" (Bryman and Bell, 2003).

- Quantitative research emphasises *"quantification in the collection and analysis of data and entails a deductive approach to the relationship between theory and research in which the accent is placed on the testing of theories"* (Bryman and Bell, 2003), It is typically carried out through methods that elicit numerical data.

Qualitative research is best used to become more experienced with a particular phenomenon. It does not assign frequency variable to data so it can be difficult o make generalisations. In quantitative research, the data itself tends to both shape and limit the analysis, which lends itself to more generalisations.

Qualitative research provides a number of different methods to gather the data, interviews, focus groups, panel studies or surveys. The approach required is one that enables the researcher to explore methods deployed in other parts of the world, to develop hypothesis and describe how they may be relevant to the context of the study.

The main criteria used to evaluate a research method are reliability, replication, and validity. Reliability refers to the consistency of a measure (Bryman and Bell, 2003), that is the researcher should be able to repeat the same procedures and achieve the same outcomes. Replication is a measure of how any researcher at some future date must be able to carry out the same study. Validity is a measure of the integrity of the results. There are two forms of validity, internal validity and external validity. Internal validity is verification of the study itself. External validity is concerned with whether the measures put forward actually measures what they are supposed to.

3.4 Research Method Employed

The choice of research method is to a large extent determined by the research question. A case study approach is used for the purposes of this study. Case studies are the preferred strategy, when 'how' or 'why' questions are being posed, where the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real life context (Yin, 1984). The distinctive need for case studies arises out of desire to understand complex social phenomena. The method allows investigators to retain the holistic and meaningful characteristics of real-life events such as organisation and management processes and the maturation of industries.

"Case study research is of particular value where the theory base is comparatively weak and the environment under study is messy" (Partington, 2003).

Case-based research gives the researcher the opportunity to continually ask questions of the case study interviewees with the knowledge gained from the literature review. It allows the researcher to probe deeply into specific areas that may offer some answers in contrast to a questionnaire that is completed independently by the individual.

3.4.1 Case Study Approach

The basic case study approach entails the detailed and intensive analysis of a single case. As Stake (1995) observes, case study research is concerned with the complexity and particular nature of the case in question. Some of the best-known studies in business and management research are based on case studies. Case study design often favours qualitative methods such as participant observation and unstructured interviews, because these methods are viewed as particularly helpful in the generation of intensive, detailed examination of a case. Case study research can be developed to enhance its ability to meet reliability, replicability and validity criteria (Yin, 1984). This can help ensure the case study is findings may be applied more generally to other cases.

The research approach is inductive, in that the researcher reflects on the theory in the literature review, and uses the case study approach (research method) to collect further data to establish the conditions (context) in which the theory will or will not hold. The research approach taken is qualitative rather than quantitative. The collection and analysis of data is based on the experiences in applying a theoretical purchasing portfolio model in a single case study, which tests if the theory is appropriate for this case, and if it generates any additional theories or generalisations.

This particular case study is examined to determine if the application of the purchasing portfolio technique, to date only implemented in the manufacturing industry, is also appropriate in the software industry, specifically when a company purchases COTS software products that are integrated as part of a larger system. The case study approach contributes to theory on the experiences and findings in the implementation of the model. Most research on purchasing portfolio models to date has been conceptual; more cases studies, both single and multiple, are needed to improve and refine the purchasing portfolio theory so that it can be applied across different industries.

3.4.2 Evaluation of the Research Process

It is important for any research to evaluate the accuracy of the study with regard to the applied methods of data gathering, and the analysis of the material.

Reliability: refers to the notion of repeating the case study with the same results (Yin 1989). The term is commonly used in relation to consistency of measures devised for concepts in business and management (Bryman and Bell, 2003).

The reliability of measurement factors for the dimensions in the portfolio model were reviewed with experts and detailed explanations were included in each

analysis so that the participants all had a consistent interpretation. The range of values that each measurement factor could assume was pre-determined to ensure consistent measurement across all products and suppliers. In addition a 'dry run' was held with a small expert group so that any inconsistencies could be found prior to the workshops.

Replication: is a measure of how any researcher at some future date must be able to carry out the same study. This requires the researcher to describe the procedures in executing the case study in detail, so that replication is possible (Bryman and Bell, 2003). The steps and procedures undertaken as part of the empirical research process were documented (as in this report); interviews and workshop material were transcribed to increase the reliability and the replication of the research. It should be noted that the results of future case studies based on this case study will differ based on technology changes and changing market conditions that can occur in the meantime.

Validity: is a measure of the integrity of the results. There are two forms of validity, internal validity and external validity. Internal validity is a verification of the study itself; external validity is a question of whether the measures proposed actually measure what they are supposed to (Bryman and Bell, 2003)
Validity can be increased through having key informants review the case study reports. In this research, gathering different forms of data, interviews, workshop discussions, company documents and observation protected validity. Furthermore, the workshop participants reviewed and approved the resultant models as part of the portfolio approach. In addition, senior management reviewed the output (the resultant models and action plans), during management status meetings. In fact the agreed action plans have been incorporated into the company's operational excellence program and are followed up at monthly senior management meetings.

The three main criteria for successful research are reliability, replicability, and validity. The research method designed for the purposes of this case study meets

all of these criteria. It complies by setting a research strategy that is inductive in approach and qualitative in nature, based on a single case study that is researched by means of expert interviews, cross-functional workshops and management reviews. The workshops gave the researcher the opportunity to collect the experiences of a cross-functional team and to probe as necessary to ensure all research questions were answered, while at the same time ensuring that the same method, the purchasing portfolio approach, could be applied at any future date in any company or industry to carry out equivalent work.

3.5 Research Execution

3.5.1 Research Data

A qualitative data gathering approach is used in this study. Yin (1988) has identified six sources of evidence that work well in qualitative research settings: documentation, archival records, interviews, direct observation, participant-observations and physical artefacts. In this case study the most important method of collecting the empirical data was expert interviews, cross-functional workshops, and reviews of the outcome with senior management. Each of these interviews, workshops and reviews, was documented as minutes of meeting or formal reports. Multiple sources of evidence were used in the empirical analysis of this study. Company documents such as product strategy documents, product architecture descriptions, project final reports, supplier evaluation reports, supplier business and technical reviews, supplier websites, strategic product plans and roadmaps and the company's strategic goals were also included in the empirical analysis of this study.

Thus multiple sources of evidence were used in the empirical analysis of this study. According to Yin (1998) the use of multiple sources of evidence can help a researcher overcome potential problems regarding validity and reliability of the study. The purpose of multiple sources and forms of empirical data was also to get a broad and thorough understanding of experiences when using COTS products in software development. The 'research object', the COTS purchase, needed to be

examined from various perspectives within the company. The group of people included in the workshops needed to represent the perspectives of all persons participating in the selection, sourcing, development and management of the COTS software product. The interviews, workshops and review meetings that were held are documented in Appendix A.

3.5.2 Case Study Context

There is a lack of existing empirical analysis on the application of purchasing portfolio model approach in the software industry, specifically COTS-based software development. The COTS based software development literature has focused on the adaptation of internal processes and risk-based management. The purchasing literature has significant research in purchasing portfolio models, however the majority of these are conceptual, and the few case studies that exist have been limited mainly to the manufacturing industry. This study seeks to address that gap in the literature, using a case study approach to examine the application of the purchasing portfolio management technique in a COTS-base software development context. Purchasing practice is more advanced in the manufacturing industry, and although the industries have different characteristics, best practices can still be common.

The case study approach was chosen for a number of reasons. Firstly, because of the limited research available on the actual use and possibilities of the purchasing portfolio approaches. Little is known about the actual use of portfolio models in purchasing. Most publications have been conceptual or anecdotal by nature (Gelderman, Van Weele 2003). Secondly, case study research is preferable when the research questions focus on ‘how’ and ‘why’ questions. The author wanted to gain insights into the use and possibilities of the portfolio approach, exploring how it could be practiced in a COTS-based software development company and if the results could be useful in creating competitive advantage.

The single case study is based in a large telecommunications company that develops a large software system that includes both COTS software products and

proprietary code. The identity of the company is anonymous due to the need for confidentiality. Company X was chosen for the research because of their experience in the COTS-based development, and because of their desire to use the purchasing portfolio approach. Company X is a telecoms solutions provider of network infrastructure and software for all kinds of telecom networks and applications. X's strategic direction is based on being technology leader, which means being first to market with innovative solutions. In order to fund leading edge technology development, X operates from an operational excellence perspective, always looking for cost reductions, efficiency and best practices.

The company is divided in to business units that have a product focus and contain sourcing, strategic product management, and product development functions. This business unit has a high expenditure on COTS software products that are integrated into a large software system, which includes both COTS software products and proprietary code.

A decade ago, X's solutions used completely proprietary hardware and software, and as such, the development organization had little experience dealing with COTS suppliers. The advent of standardization and open technologies led to X using COTS suppliers for technologies that were non-core competences, for example operating systems, middleware applications such as databases, and some end user applications. As the size and complexity of networks increases, the software system is becoming more complex, and the number of COTS software product used is also increasing. Company X now has at least seventy COTS products integrated as part of the system solution. These include approximately thirty commercial-off-the shelf (COTS) software products, and forty open source products. This is a significant sample size of COTS products, and it will allow for the analysis of thirty different buyer-supplier relationships, and also means that it is easier for this case study to make generalisations as many of the products are common across software industry sectors outside of telecommunications.

The company have identified a need for a more structured approach to supplier management in an effort to reduce the many challenges encountered. Up to now, the strategic goals and objectives for supplier management was based on ABC or Pareto classification of the highest spend in cost of sales. There was an absence of strategic goals related to using capabilities of COTS products for strategic growth opportunities. There were also a number of buyer-supplier relationship problems similar to those identified in the COTS literature: there had recently been a large number of project interruptions due to quality, interoperability and lifecycle issues with existing COTS products. The company discovered a high level of dependency on suppliers that weren't necessarily co-operative. It became apparent that the existing relationships with suppliers needed to change to reflect the different company needs. The existing strategic goals and objectives for supplier management had no bearing on whether the supplier was strategic or a basic commodity. Thus the case company is an ideal candidate to 'test' the appropriateness of purchasing portfolio management as a technique to increase competitive advantage.

The data was gathered over a ten- month period and as such the results capture a snapshot in time. The fast pace of change in the software industry means that the study would need to be repeated an at least an annual basis, as both product strategy and supply market conditions are constantly changing due to technology lifecycles and competitive forces. Data sources used in the case study included expert interviews, cross-functional workshops, and management reviews. Expert interviews included sourcing, strategic product management, product release management, product development, and supply. The interviews were exploratory, and focused on getting feedback on the usage of COTS products, the challenges and feedback on the supplier relationship. The cross-functional workshops included representation from all company functions engaged in management of the COTS product. The expertise level of participants in the cross-functional workshops added to the value and quality of the output. The sourcing manager and many of the Strategic Product Managers (SPM) had up to twenty years

experience in the strategic product management and acquisitions in this area and had been involved when many of the COTS product were first purchased.

The secondary source of data involved documentary evidence, such as project final reports, product architecture documents, product strategy documents, supplier evaluations, strategic product plans, and financial reports. Project reports indicated the savings or overruns related to usage of COTS products. Supplier evaluations were carried out by the company on a regular basis and these identified what was working or not working well regarding various aspects of the supplier relationship. Strategic product plans gave indication of growth and opportunities, as well as areas were no further additional value-add was expected from using COTS products. Company financial reports giving and indication of the volume spend on each COTS supplier; suppliers, annual reports gave an indication of total revenue and indications of the financial strengths of the supplier.

3.6 Limitations

Although the case study is based on just one company, because it is such a large user of COTS products (a sample size of thirty COTS products and buyer supplier relationships was in used in the case study), and the same COTS products are widely used across the software industry, this may lead to more generalisability of the findings. However there are a number of limitations, due to the nature of a case study in a specific industry.

The first limitation is related to the measurement criteria used to develop the models. While findings related to the appropriateness of the model for COTS-based software development can be generalised, details such as the measurement factors may be specific to the company and industry context. The telecommunications sector of the software industry has some characteristics (e.g. robustness, quality, long lifecycle), that may not be as important in other software sectors. Some specifics are particular to the telecoms industry – the fact that the quality attribute can be system critical may not apply when the same product is

used in other software systems. Thus the measurement aspects of case study depth have limited generalisability.

The second limitation is that this study deals with only one company, which is representative of the telecommunications software industry. The same COTS software products are used across many sectors in the software industry and the same findings may or may not apply to other sectors. This could be the subject for further research. While the study is limited to one case company, the fact that the case company uses a large number of COTS products, adds more credibility to the findings because this constitute a very large sample of COTS products and of buyer-supplier relationships. Case studies in the COTS literature at least in the author's knowledge do not seem to have the same sample size and often focus on challenges with a small number of 'troublesome' COTS products where there is a high degree of dependence on the supplier.

The third limitation of the study is that it is completed at a particular time period and is therefore a snapshot in time. The fast pace of software technology lifecycles and market conditions mean that the findings may be different in one, five or ten year's time. However this can also be seen as an opportunity for further research – it may not necessarily be viewed as a limitation because both the buyer's competitive strategy and the supply market are both changing, so it will actually be beneficial to take a number of snapshots over time to see trends in the supply market. The case study finding was valuable as due to the experience level and year of service of the participants, the case study was able to capture what had changed both with the company's product strategy and the supply market over a five to ten year time period.

3.7 Conclusion

This chapter presented the research question at the centre of the study is **can supplier portfolio management can be used to gain competitive advantage in the management of COTS software suppliers.**

This study, a single case study, has been used to test existing theory from the purchasing literature, and to generalise the findings to the software industry, specifically to usage of COTS products in the telecommunications software industry. The approach taken to the study was a qualitative approach in the form of a number of interviews, workshops, presentations and reviews. There are a number of limitations of the study in that it is a snapshot in time, the measurement criteria are customized to the company and industry context. Nevertheless it provides valuable empirical evidence on the experiences in applying the purchasing portfolio model in emerging and rapidly changing market, and many of these experiences can be generalized across the software industry.

Chapter 4: Results and Findings

4.1 Case Study Background

The following chapter presents the findings of this study in the form of a case study, which explains how the portfolio management technique was applied at a software development unit in a large telecommunications company. The case study uses the Kraljic (1983) approach to classify purchased COTS products, analyse buyer-supplier relationships, and finally, to identify what actions are needed to gain competitive advantage.

4.2 Case Study Background

The context of this case study is software products that are integrated, and distributed with the system solution 'Neptune'. The software buyer can be viewed as an original equipment manufacturer (OEM), that is, taking COTS products developed elsewhere, integrating with the system architecture, and shipping the complete system to an end user. The end user does not necessarily have any knowledge of the underlying COTS products. The buyer has to maintain and support the COTS product for the end user as if it were proprietary code.

The Neptune product is a multi-technology software product that manages mobile networks. As a network manager, it has very stringent quality requirements, for example, telecom networks require telecom grade robustness - 99.99% reliability which equate to less than 53 minutes downtime per year. As the networks get more complex, the end customer, the telecom operator, desires one cohesive system that reduces complexity for operators. Thus the Neptune product is a 'weave of technologies and applications' that consists of proprietary code (architecture and applications) as well as thirty COTS products and forty open source software products that have been integrated into the software system. The open source software products have been excluded from the scope of the case study. Analysis of the Product Architecture Description document (Appendix A, Table A.4) indicates that the COTS products can be architectural (operating

systems, middleware, databases, ORBS, communication protocols, security products), design 'supporting' (code classes or components, utilities) or applications (innovative products, applications or services). The level of standardisation, integration level and effort can vary dependent on the COTS product and its purpose. Some products are telecom-specific (communication protocols), but the majority (operating systems, databases, ORBS, are widely used across the software industry.

4.2.1 COTS Based Software Development

The approach to COTS based development at Company X has been broadly in line with that of the COTS based development literature. The existing software development practices have been adapted to handle external products. Analysis of Company X's project final reports (Appendix A, Table A.4) that describe lessons learned and opportunities for improvement in future projects, capture the challenges and consequences related to usage of COTS products. These are similar to what has been identified in the COTS based software development literature.

- Increased misalignment of product roadmaps which has resulted in costly efforts in moving to new COTS versions. The driver for this has purely been to secure maintenance; there has been no value-added gain that can be passed onto Neptune end-customers.
- Interoperability issues between COTS versions. Company X has a policy to keep current with latest hardware and related operating systems. This has a knock-on impact on all COTS products which have to be certified against the latest changes. As COTS suppliers release management is not co-ordinated with industry dominant operating systems, this complicates Company X's development projects as all interoperating products cannot be changed simultaneously.
- Quality and support levels. Quality problems with updated COTS versions from suppliers have forced projects to roll back to earlier versions until the supplier has fixed the quality problems. There have been different levels of co-operation from suppliers when this has happened.

4.2.2 Buyer-Supplier Relationships

This section describes the existing practices of company X and the driver for implementing strategic supplier management. Analysis of interviews with Sourcing Manager and the development unit's COTS Supplier Manager (Appendix A, Table A.1) indicates that there has been a progression in the handling of COTS products over recent years. Initially there was ad hoc supplier management, unclear responsibility and interfaces to suppliers, poor communication, inconsistent feedback to suppliers, multiple products for same use. A cost reduction program was implemented as part of operational excellence. Then two events occurred that started the transformation of the COTS product handling within Company X. Firstly, the corporate sourcing function allocated a strategic sourcing manager to the product development unit, whose brief was to increase sourcing knowledge of the usage of COTS software products. Secondly, the product development unit appointed a COTS supplier manager, who was responsible for improving both the internal handling of the COTS products and the relationship to the supplier.

This was followed by the implementation of operative supplier management that consisted of supplier evaluation based on non-technical OEM requirements (for example, support handling, interoperability, roadmap alignment, quality). After a number of supplier review meetings, the Sourcing Manager and the COTS Manager found that there were great relationships with the less important suppliers and terrible relationships with the key suppliers (where the company was effectively locked-in). Another finding was that with a number of suppliers there was a 'divide' – there was a basic lack of understanding of the buyer's requirements on the relationship as a software OEM. Company X as a buyer had no idea that such a gap existed. This had resulted in a number of communication breakdowns with serious project implications that were captured final project reports and supplier reviews (Appendix A, Table A.4).

A management review (Appendix A, Table A.3) of the supplier challenges and consequences identified a need for a more structured and strategic approach to

COTS products and supplier-controlled change. An analysis of multiple final project reports (Appendix A, Table A.5) concluded that these challenges adversely affected the competitive advantage gained when using COTS products. The hidden supplier costs, that is, the costs to keep current with supplier versions, maintenance fees, cost of bad quality, and delays caused by interoperability, were significantly more that the COTS license cost, and adversely affected competitive advantage as these costs were not considered in any business cases. These hidden costs were attributed to 'supplier controlled change". The strategic goals and objectives for supplier management were based on ABC or Pareto classification of the highest spends. This had no bearing on whether the supplier was strategic or a basic commodity, or if the product was troublesome or not. In order to have more productive exchanges with suppliers, and to be able to influence the supplier regarding product evolution, quality and lifecycle aspects, that is 'supplier-controlled change,' the company needed agreed strategies and clear goals for management of COTS products. Feedback from the Sourcing Manager (Appendix A, Table A.1) indicated that in his experiences, the exchange could not always focus on cost reduction, as it was difficult to obtain cost reductions when many other aspects of the agreements were not working at a satisfactory level.

4.3 The Portfolio Management Approach

The approach taken in the case study is based on Kraljic's model, but is adapted based on other research (Olsen & Ellram (1997), Gelderman and Van Weele) and based on the company's own environment – COTS based software development in the telecommunications industry. Kraljic's approach includes the construction of two portfolio matrices. The first model classifies purchased items into four categories based on a product's profit impact and supply risk and provides differentiated strategic actions for each category. The second model focuses on strategic items and shows the relative power of the company in corresponding supply markets.

4.4 Classification and Strategic Approaches

The first step in the portfolio management technique involved classifying the COTS products according to two dimensions: business impact and supply market complexity. A number of factors are used to measure each COTS product's business impact and supply market complexity to determine the categorisation of the product and the recommended purchasing approach.

4.4.1 Measurement Factors

As this was the first time the model was being applied, the case study took a relatively simple approach to the measurement factors. The author found this was a good approach to generate buy-in from all stakeholders. Anything too complex would have made it more difficult to sell the concept. The purpose of the initial case study was to evaluate if this is really a worthwhile methodology for determining strategies for COTS software suppliers. Experience gained in the first iteration can be used to refine the factors in later iterations.

The dimensions used followed those of Kraljic, the factors used to measure these dimensions were reviewed and customized by a small expert group consisting of product development and sourcing (Appendix A, Table A.2). The factors had to be relevant to the software industry. This was followed by a dry run to understand and refine the measurement factors. The factors suggested by Kraljic (1983), and Olsen and Ellram (1997) were useful input. After the initial dry run, the feedback suggested the factors measuring the business importance dimension had to be weighted according to what was most important to the company's software system and product strategy.

Business impact was measured using the factors described in Table 4. The weighting (in order of strategic importance) was: future growth opportunities, quality of products, volume spend and design in capabilities.

MEASUREMENT FACTORS	EXPLANATION
Volume Spend	A range was used for high, medium , low spend
Importance of Quality	Was the product system critical or were quality issues just inconvenient or non-critical?
Impact on Business Growth	Is the COTS product contributing to Neptune's growth?
Product Opportunities	Are there future product opportunities, e.g., possibilities to design in more-capabilities? What is the potential to add more value by extended or customizing the COTS product?

Table 4 Business Impact Measurement factors

Supply complexity was measured using the factors described in Table 5, which describe factors external to the company that contribute to supply complexity.

MEASUREMENT FACTOR	EXPLANATION
Availability and number of suppliers	The overall capability of the market to provide the product. The number of competing suppliers and their presence define the complexity.
Make/Buy Opportunity	How difficult is it to make internally? How complex is it to integrate the product.
Substitution possibilities/ barriers to change	Measured by cost to substitute with an alternative product. Is the supplier protected? Standard-driven products have a low level of protection; niche/technology leading products are highly protected.
Technology Status	What is the maturity level of the technology? Basic, mature/medium or novel/ unique or innovative

Table 5 Supply Complexity Measurement Factors

A number of criteria mentioned in Kraljic's model (competitive demand, storage risks/buffer handling) were not used as they were deemed to apply more to the manufacturing industry than the software industry, where there is rarely a need to keep buffers or inventory. Additional factors were added to measure changes in COTS market conditions related to technology lifecycles and standardisation.

4.4.2 Classification and Strategic Approaches

The measurement factors were applied to thirty COTS products in a series of workshops with the relevant stakeholders, consolidated into the portfolio models and further reviewed with the stakeholders (Appendix A, Table A.2). The result is shown in Figure 3 Classification of COTS Products. A large number of suggested actions and strategies were discussed when conducting the measurements and reviewing the outcome.

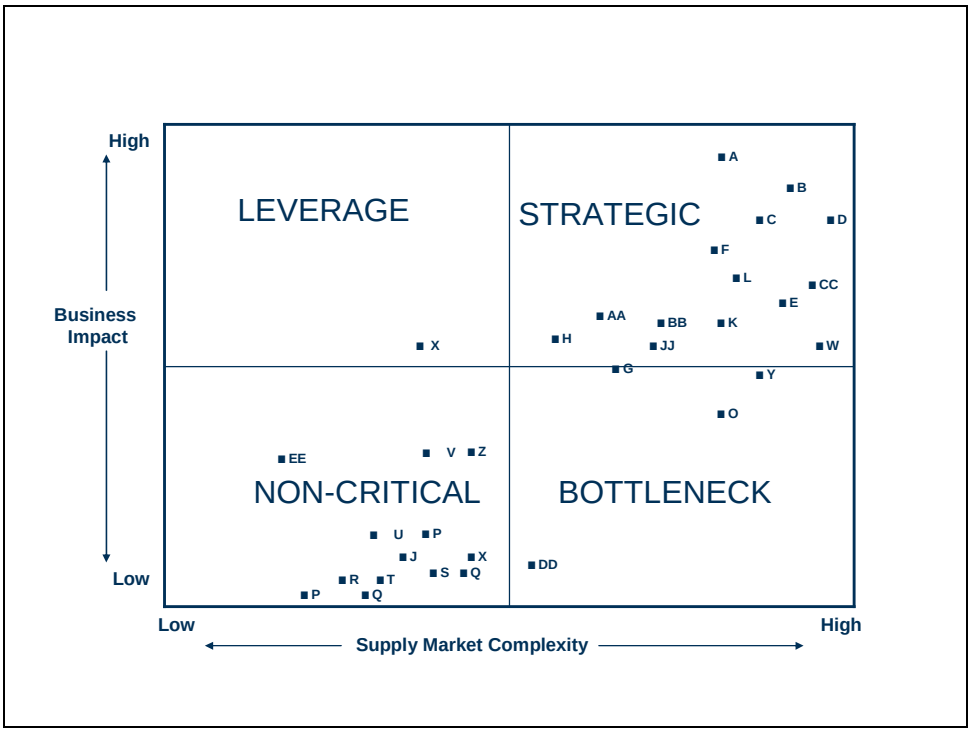

Figure 3 Classifications of COTS Products

The specific findings in each of the categories are as follows:

4.4.2.1 Non-Critical Products

This category contained typically low level components following well-defined standards (for example java components, parsers, communication protocols), and products that were highly transferable across software domains (user interface components). The recommended management approach is 'efficient processing', activities can include requirements and architecture standardisation, and efficient processing. This is applicable to Neptune, in that the management overhead in administering these types of products should be as low as possible.

4.4.2.2 Leverage Products

This category also contained mature standard-driven products, but with the difference that they are more important to the business. In the case of Neptune, this was due to the mission critical quality factor, scalability required network growth, and the volume-spend. These products are typically middleware products that have been specialised towards industries that require robust performance and scalability. The recommended management approach is exploitation of purchasing power, which includes product substitution, targeted pricing strategies/negotiations, and order volume optimisation. While volume related optimisation is not relevant, many of the activities are valid for the COTS products. In the short term, the market situation could be leveraged to reduce price. In addition, buyer's strength can be leveraged to get greater influence over vendor-controlled change, which can include better robustness, quality, support, lifecycle management or product enhancements, important criteria for Neptune's competitive advantage.

Only one product out of thirty ended up in the leverage quadrant. This was also met with disbelief as there was a common view that because Company X was a technology leader and a 'big player', this would be sufficient bargaining power to leverage many suppliers to reduce costs, or to influence vendor-controlled change. Discussion revealed that the reason for the high spend on this product was that the price was negotiated when the technology was novel and innovative, with few suppliers approximately ten years ago. Now the technology had become a mature and base technology, fully standardised with many very similar products available, both commercial and open source. As mission critical quality was important it was agreed that the open source alternative was not appropriate. However now there was potential to leverage the buying situation based on the availability of substitute products.

4.4.2.3 Bottleneck Products

The strongest example of a bottleneck product was the operating system, suggesting that suppliers of bottleneck products often have a dominant technology and market monopoly. The reason this product is not strategic, is that the cost is low and it does not generate revenue or growth; it is a cost of being in the software business. The recommended management approach is 'supply assurance', which can include securing needed volume and inventories, control of vendors, and having a back-up plan. While volume assurance and inventory doesn't quite apply to the software industry, control of vendors and back-up plan are most important. As these are typically monopoly-type products, with practically no competition, there is a high degree of lock-in. The workshop participants agreed that it is critical to have a good long-term supplier relationship so that there can be some influence over vendor-controlled change.

4.4.2.4 Strategic Products

This category contains many different types of products. The consensus was that strategic products are desired to be innovative, unique, technology leading applications that form a large part of value-add. There was surprise at the fact that so many 'commodity' type middleware products ended up in the strategic quadrant. The products were classified as strategic due to being mission critical (for example, middleware) and high cost, and a very high degree of buyer-lock-in due to either lack of viable alternatives and/or high substitution cost with little value add.

This immediately initiated discussions on what products should be moved out of this quadrant and how that could be done. Although it is not mentioned by Kraljic, and there are no guidelines on how it could be done, it is valid and should be included in future literature on purchasing or supplier relationship portfolio models.

The recommended management approach is to have a strong relationship with the suppliers of strategic products. Kraljic's recommends further analysis of the power balance between buyer and suppliers of strategic products to determine the required strategic thrust: exploit, balance or diversify. This is covered by creating a second portfolio model of the buyer and supplier strength.

4.5 Analysis of Buyer-Supplier Relationships

The next steps in the purchasing portfolio approach are concerned the creation of a second portfolio model that determines the relative buyer-supplier relationship strength. Kraljic does this only for products that are in the strategic quadrant. This case study has followed more recent research (Gelderman and Van Weele) and analyses the buyer supplier strength for all quadrants.

4.5.1 Measurement Factors

The measurement factors used to calculate supplier strength are shown in Table 6.

SUPPLIER STRENGTH	EXPLANATION
Market Share and suppliers growth potential	Strength of supplier increases with its market share.
Market growth and supplier potential to meet same	Supplier's strength is increasing if it can grow its market share.
Capacity to supply market	Can the supplier maintain the volume of buyers
Competitive structure	Perfect competition/ oligopoly/monopoly
Financial strength	Profitability, turnover
Cost/price structure	Cost base/price
Technology stability, uniqueness of product	Mature or new technology?
Uniqueness of product/entry barriers	How protected is the supplier's product from competitors?

Table 6 Supplier Strength Measurement Factors

Capacity utilization/bottleneck risk was not used. The workshop participants (Appendix A, Table A.2) concluded it was not applicable in a software context. However a type of bottleneck risk could be the supplier's lifecycle policy – if the lifecycle policy was much less than the buyer's lifecycle, then the risk is high as the buyer is forced to invest more effort in upgrades, a measure similar to this could be included in the future.

The next step was to analyse the buyer's strength using the measurement factors described in Table 7.

BUYER STRENGTH	EXPLANATION
Buying volume	Buyer's spend as a percentage of the supplier's total revenue
Demand growth	Buyer's market growth
Buyer's capacity utilisation	Can more volume be sold?
Attractiveness of market share	Attractiveness of buyer's market share to supplier
Financial strength	Profitability, turnover
Cost/price structure	Buyer's margins on the COTS product cost
Substitution potential	Are there alternative products?
Entry cost for substitute product	Cost to make in house or to change supplier.

Table 7 Buyer Strength Measurement Factors

The measurement results are consolidated in a matrix that shows the relative power of the buyer-supplier relationship.

4.5.2 Analysis of Buyer-Supplier Strength

4.5.2.1 Non-Critical Quadrant

As these are low value products, with many alternative suppliers, the buyer's power is high. The buyer's strength could be further increased if product architecture could support standardised product with little to no customisation.

4.5.2.2 Leverage Quadrant

The analysis found that buyer's strength was dominant for products in the leverage category. However, suppliers in this segment will try to differentiate their product, which can increase lock-in. If the product architecture can more easily support interchangeable products, then the buyer will be in a stronger position to alternate suppliers, thereby increasing negotiating power to reduce costs and/or influence suppliers.

4.5.2.3 Bottleneck Quadrant

All suppliers in this quadrant were found to have a dominant power position. The buyer is highly dependent on the supplier and because of the lock-in situation and the supply market complexity; a close co-operative relationship is needed so that the buyer can have some level of influence or co-operations regarding vendor-

controlled change. The strategic approach is to reduce the impact of vendor controlled change to a minimum by investing in the buyer-supplier relationship.

4.5.2.4 Strategic Quadrant

Buyers desire strong co-operative balanced relationship with the suppliers of products that are strategic. Kraljic recommends that based on the balance of power, buyers follow exploit, balance or diversify strategic thrusts in order to maximise buyer power and have strong relationships for strategic products. However, the case study results found that the balance of power for all strategic products was with the supplier, Neptune was effectively a 'captured client' or locked-in. According to Kraljic, this implies a 'diversify' strategic thrust, i.e. substitute suppliers. However, this was seen by the workgroup as just one option for handling a dominant supplier. As there was a high degree of lock-in, the discussion revolved around what relationships was it possible to change and how could it be done. It was recognised that with some strategic products, it would not be possible to shift to a balanced relationship. This was mainly because there was no incentive for the supplier. In comparison to other buyers, Neptune was relatively low volume, and the telecom market was not that important to the supplier. The analysis focused on evaluating two alternatives (1) options available if staying with a dominant supplier, and (2) options available to increase the buyer's strength.

There were two scenarios if the buyer chose to stay with a dominant supplier:

In the first scenario, this risk in continuing with a dominant supplier was acceptable, the supplier held a monopoly position, and Company X's buying volume was very low in comparison to the supplier's total market share. However, there were not that many challenges in the relationship, which was felt to be satisfactory so the consensus was to stay as is and to accept the situation. Substituting with an alternate supplier would not provide much business or relationship gain – there would still be lock-in once the agreement was signed. This typically happened with products from technology leaders.

The second scenario occurred in cases where the relationship with the supplier was not satisfactory, but there were opportunities to increase co-operation and to have a true strategic relationship, with common strategic intent agreed between the two companies. The major difference in this type of relationship is that opportunities could be seen that would benefit both the buyer and the supplier. In the case of one supplier, these benefits were 'common knowledge'; it had been assumed but never formally discussed with the supplier's management team. Hence when quality and lack of technical support negatively affected the relationship, mistrust was created when the supplier did not meet expectations.

There were two scenarios that could increase the buyer's strength:

The first scenario occurred when the relationship with a dominant supplier was not satisfactory, and there were very few possibilities to improve. These products were identified as strong candidates for supplier substitution, even at significant cost. This aligns with the Kraljic's 'diversify' strategic thrust.

The second scenario involves taking action to move quadrants. This effectively means determining how to move the product from the strategic quadrant to the leverage quadrant in order to leverage or take advantage of a less complex supply market. This involves changing the product requirements and Neptune's internal architecture so that more standardised products could be used. The goal would be to use products where the buyer could leverage the less complex supply market.
This type of strategy was especially important when the buyer could see no opportunities to have a more co-operative relationship with an existing supplier.

4.5.2.5 Buyer-Supplier Relationship: General Findings

Kraljic (1983) recommends that buyers maintain relationships with parallel suppliers to reduce risk for strategic products – this is not possible in software as strategic products were found to have a high degree of 'supplier lock-in', and can

often only be purchased from one supplier. The risk reduction alternatives for software are building co-operative or strategic relationships or diversification to a new strategic supplier, or substitution with a leverage product.

One interesting finding was the interpretation of 'strategic product or supplier'. While many products that offered significant growth opportunities, or specialised capabilities that were deemed as strategic, there had been no strategic intent agreed between the management of the buyer or supplier. Suppliers frequently called themselves 'strategic partner' but this was actually meaningless in practice (without having agreed strategic goals). The workshop discussion highlighted different viewpoints. The view from the sourcing manager was that strategic partnerships involved risk-sharing, therefore the supplier should invest more in the relationship by giving additional technical support and expertise to support the buyer's strategic growth intent. This in turn would secure sales revenue for the supplier. However, the view from the COTS supplier manager was that supplier was aware that company X was already locked-in to its unique technology, the future sales revenue was secured, and the supplier saw no need to give more support than agreed. This immediately pointed to the need to have meeting with the senior management of both companies to clarify the situation and to explore if a common strategic intent could be agreed where both companies could benefit.

The analysis of the buyer-supplier relationships has also provided interesting insights into changes in supplier strength over time. The two main contributors were changes in supplier's financial strength and in supplier's technology.

Changes in supplier's financial strength could increase or decrease the overall supplier strength. Supplier's financial strength had changed over time due to supplier growth from increased market share or through mergers and acquisitions. Initially, the buyer constituted a large percentage of the supplier total revenue. In the majority of cases, this percentage had reduced over time, meaning the supplier

was now less dependent on the buyer. There was also one case where the supplier market share had not grown and thus the buyer became stronger.

Changes in technology had either increased or decreased supplier strength. When a technology had matured, this led to increased competition with more substitution possibilities, both commercial and open source. Some suppliers were in a weakened position, (the relationship with these suppliers could now be leveraged), and some had maintained their strength by differentiating their products. Others had increased their strength by becoming the dominant design, creating entry barriers for potential competitors, or by investing in replacement technologies and forcing the customer base to follow.

4.6 Strategic Action Plans and Competitive Advantage

The final step of the portfolio approach is concerned with the development of actions plans to realise the strategic approaches. Many of the proposed action plans were generated during discussion and review of the results with the cross-functional team (Appendix A, Table A.2).

The actions were consolidated into short term and long term strategic actions per COTS product and presented to the senior management team for prioritisation and approval (Appendix A, Table A.3). Table 8 gives a high level summary of the most common actions.

CLASSIFICATION	Short-Term Action	Long Term Action
Non-Critical Product	Simplify administration, standardised design handling	Investigate open source alternatives
Leverage Products	Negotiate cost, influence vendor-controlled change	Reduce cost of ownership, Implement vendor-free architecture to enable substitution as needed
Bottleneck Products	Closer relationships to influence vendor-controlled change	Investigate if there are any potential joint value-add activities
Strategic Products	Remain as is; Take actions to balance the relationships,	Investigate alternatives to move some products from strategic to leverage (e.g. update Neptune architecture so a more 'standard' COTS product could be used); Create strategic relationships (identify strategic intent per product and agree with supplier's management team.

Table 8 Summary of Action Plans

Non-Critical Products

Action plans include standardising integration and handling across all applications using the COTS product. These types of products would effectively become 'plug and play'. Many of these products were available both commercially and as open source. The main advantage of commercial agreements for these products was the availability of product support. However, many of these products were now mature, so an action to be considered was the possibility of moving to open source components. This would require business case evaluation to determine the cost of the move, but as it would be a once-off cost and reduced the management overhead, it was a viable long term option.

Leverage Products

As there was a good, co-operative relationship with the supplier, the short term option was to stay with the same supplier but to negotiate a better cost based on the current conditions in the supply market. A longer term strategy to reduce cost of ownership of the platform could involve creating a vendor-independent architecture, to reduce the cost of product substitution and to enable Neptune to

take advantage of the supply market. The investment in updating the architecture could be offset by savings in new license costs and maintenance costs.

Bottleneck Products

As the relationships are supplier dominant and these are typically monopoly-type products, with practically no competition, there is a high degree of lock-in. The workshop participants agreed that it is critical to have a good long-term supplier relationship so that there can be some influence over vendor-controlled change.

Strategic Products

As the relationships were all supplier dominant, the strategic alternatives are to stay as is or build a co-operative or strategic relationship with existing suppliers in order to influence the vendor controlled changes, such as product evolution, lifecycle and quality, thereby leading to improved usage of the product. The agreed strategies for products that were not necessarily fulfilling a long-term strategic role, included diversification by substituting with either another strategic product or with a leverage product where the relationship can be more in favour of the buyer.

4.6.1 Competitive Advantage

The strategic goals for COTS products now contain a mix of differentiated management approaches to the relationships, as well as a set of action plans to ensure that the buyer can gain more influence on vendor-controlled change by means of more balanced relationships. An important benefit was that by gaining a better understanding of the market complexities, and the supplier and buyer strengths, Company X now knows where it can optimise supplier relationships and where it needs to take actions to minimise risks. It was important to get agreement on the level of effort the management team want to invest in the action plans. It was also agreed that the short term actions would be followed up at monthly management meetings and the longer term goals would be included in the strategic planning process.

ABC cost goals are based on reducing the cost of sales and do not see the cost of poor co-operations which is an R&D cost. In this case study, the COTS product cost is relatively low when compared to total development costs, but what is not captured in the accounting system is the cost to development, when forced to adapt to unforeseen changes in COTS products, with no sellable added value to the end-user of the product. The COTS supplier manager (Appendix A, Table A.1) described the case of a strategic product that due to misalignment of lifecycles, required three migrations to new product versions in one project just to keep current with the supplier's maintenance policy. The extra development effort was equivalent to the total cost of sales for that product over two years. The ABC cost reduction goals focused on reducing the cost of sales rather than investing in closer co-operation with the supplier so that lifecycles could be aligned.

4.7 General Findings

The findings indicate that in general all participants found the Kraljic approach very worthwhile and added significant value to the way of working with COTS products. The supplier management categories all made sense and the structured and visual approach were a big improvement on previous reactive approach that was more based on supplier by supplier operative issues and escalations. The management team found the portfolio model provided a structured, visual framework for discussing COTS products, supplier relationships and was a very useful analysis and strategic planning tool.

The customised approach meant that the application of the model was a participative process. The cross-functional group found it was very beneficial to use measurement factors to gauge the business importance and supply complexity, as it gave an 'unemotional' analysis of each product/supplier. Many supplier account managers had built up personal relationships with various stakeholders in the buyer's organisation, so previous information was often biased.

4.7.1 Cross-Functional Approach

It was critical to take a cross-functional approach, especially in a high technology environment. It was found that close co-operation between the technical functions

(product management and product development) and sourcing was essential for managing the buyer-supplier relationship. The workshops included all stakeholders involved in managing the COTS acquisition – sourcing, product management, and development. There were two major benefits to the workshop approach. The first benefit was the information sharing and arriving at consensus when applying the measurement factors. As many COTS products had been introduced many years before, the information exchange on the history with suppliers was invaluable. The second benefit was the interactive and participative nature of the model, this meant that all stakeholders bought-in to the action plans as there was now a deeper understanding of the complexities and level of change both in the supply market, and in buyer-supplier relationships.

4.7.2 Roles and Responsibilities

Roles and responsibilities within the buyer's organisation with respect to the supplier interface had been unclear. The management team found that the classifications in the model could also be used to distribute responsibility and decision-making for supplier management, and to clarify roles and responsibilities regarding decisions related to introduction and management of COTS products. It was proposed that decision making for strategic items be centralised to a steering group consisting of product management, development and sourcing so that a common message was communicated to strategic suppliers; decision-making for non-critical and leverage categories was decentralised to product development units, and for bottleneck items, the main responsibility was with product development to ensure a co-operative long-term relationship.

Chapter 5: Discussion

5.1 Introduction

The purpose of this chapter is to evaluate and analyse the findings in chapter 4, and to show how the results agree or disagree with previously published works as highlighted in chapter 2, the literature review.

The research question was defined as "**can purchasing portfolio management be used as a technique to gain competitive advantage in the management of COTS software suppliers?"** The answer to this question was sought by addressing the following research objectives:

- Determine if Kraljic's classifications and generic purchasing approaches are appropriate for COTS software products
- Determine what insights can be gained by analysing the strengths of the buyer-supplier relationship for COTS software products
- Determine if action plans resulting from the purchasing portfolio approach can lead to competitive advantage in the management of COTS software suppliers.

The findings are discussed by addressing each of the three research objectives that are based on the application of the purchasing portfolio management approach in a COTS-based development context.

5.2 Classification and Strategic Approaches

The first research objective of this study is to **determine if Kraljic's classifications and generic purchasing approaches are appropriate for COTS software products** by discussing the findings from implementation of the first step in the portfolio management technique.

5.2.1 Classification of COTS Products

The purpose of this step is to analyse the company's purchases to determine how the purchase situation should be managed. The case study found that the Kraljic (1983) classification and purchasing approaches are both appropriate and valuable for managing COTS software products. This is consistent with other purchasing portfolio case studies (Olsen and Ellram (1997), Gelderman and Van Weele (2003)).

Morisio and Torchiano (2002) also proposed a classification of COTS products according to non-technical characteristics; however this is used to further understand the assessment and technical integration aspects of COTS, rather than management purposes. Anderson and McAuley (2006) recommend that COTS product are classified based on the type or competitive structure of the COTS product (unique, niche or mass-market) and matched with an appropriate supplier management approach but do not describe how this can be done.

Using the Kraljic approach, the COTS products are classified according to impact on business and supply complexity. The findings indicate that mature products that follow well defined standards can be classified as non-critical or leverage purchases. Leverage products are important for the company's business and competitive strategy, and as there are multiple suppliers, the buyer can leverage this situation, especially if the product architecture can support interchanging of COTS products. Products that are unique, niche, and where suppliers hold a dominant design or a monopoly situation, are classified as strategic and bottleneck purchases. There is a high degree of lock-in with suppliers of bottleneck and strategic products as there are few or no alternative suppliers.

The main conclusions from the classifications of COTS products are as follows:

The Kraljic approach improves on recommendations from Morisio and Torchiano (2002), and Anderson and McAuley (2006). The portfolio classification offers a structured and comprehensive classification approach that considers supply market

complexities as well as the importance of the product to business strategy. The process of identification and weighting of measurement factors that contribute to the company's competitive strategy was a key benefit in the classification of COTS products as this customises the approach to the company's contact and provides linkage between the COTS product and sustaining competitive advantage.

A key benefit of the Kraljic approach is that it can be customised to each company's context and competitive environment. The business impact describes factors internal to the firm that can be weighted according to strategic importance, thereby linking the COTS product to competitive strategy. The supply complexity describes factors external to the company that make the purchase difficult to manage. In the case of the COTS products, factors related to technology lifecycles and standardisation were used to capture the changing COTS market conditions (Foster (1997), Ulkuniemi and Seppanen (2004)).

The classification is also useful in understanding the current situation with supplier relationships, specifically why there was very poor co-operation with some suppliers and very good co-operation with others. There was very little co-operation from strategic and bottleneck suppliers (no strategic goals co-defined, not enough investment in the relationships), the suppliers were either niche players, or monopolies and knew that the buyer was a locked-in customer. The company had not communicated what was important in the relationship due to their company and industry context (e.g. the non-technical attributes such as lifecycles, quality and delivery). There were excellent relationships with products in the leverage and non-critical categories. These suppliers had intense competition, as products were highly standardised (java components, protocol communications) or mature technology.

5.2.2 Strategic Purchasing Approaches

The recommended purchasing approaches for all categories of COTS products provide valuable guidance in managing COTS (Table 9).

Classification	Recommended Purchasing Approach
Non-critical	Standardise and Consolidate
Leverage	Leverage Volume
Bottleneck	Assurance of Supply
Strategic	Partnership

Table 9 Classifications and Recommended Purchasing Approaches

It can be concluded that some adjustment should be made to customise the recommended approaches to the software industry, especially for the bottleneck category. As an example, while the approach to minimise supply risk by assuring supply is valid for the bottleneck category, the manufacturing concepts of spreading volume across a number of suppliers to reduce supply risk are unfortunately not usable in the software context, and this reduces the power and influence of the software buyer considerably. Further customisation and elaboration of the strategic approaches and recommended actions for the software industry could be a topic for further research.

Additionally it was concluded that some products in the strategic quadrant were found not to be truly strategic as they did not contribute to product growth, but had been classified as strategic because of the high volume spend, and the lack of alternative suppliers that could meet the same quality requirements. The proposed strategic approach to these products was to investigate how the buyer's product architecture could be updated so that more standardised products could be used. This effectively meant determining how to move the product from the strategic quadrant to the leverage quadrant in order to leverage or take advantage of a less complex supply market. This finding substantiates Gelderman and Van Weele (2003) conclusion that while moving strategic directions is not described in any of

the portfolio models; experienced purchasing professionals extend the use of Kraljic's model by developing strategies to move categories in a portfolio model.

5.3 Analysis of Buyer-Supplier Relationships

The second research objective is to **determine what insights can be gained by analysing the strengths of the buyer-supplier relationship for COTS software products.** This research objective is answered by discussing the findings from the results of the second and third steps in the purchasing portfolio approach. The purpose of these steps is to analyse the company's current buyer-supplier relationships to determine strategic actions dependent on whether the balance of strength in the relationship is in favour of the buyer or the supplier.

5.3.1 Buyer and Supplier Strength

While Kraljic assumed the power positions for non-critical, leverage and bottleneck categories, this study has also used the later research by Caniels and Gelderman (2005) that quantified the power assumption for all Kraljic categories.

The classifications and recommended purchasing approaches based on the expected and the observed power balance in the buyer-supplier relationship are summarised in Table 10.

Classification	Theoretical Power Balance (Expected)	Actual Power Balance (Case Study Observation)
Non-Critical	Buyer Dominant	Buyer Dominant
Leverage	Buyer Dominant	Buyer Dominant
Bottleneck	Supplier Dominant	Supplier Dominant
Strategic	Buyer Dominant	No cases found
	Balanced	No cases found
	Supplier Dominant	Supplier Dominant

Table 10 Comparison of Theoretical versus Actual Power Balance

The conclusions from the analysis of the buyer-supplier relationships are summarised per category.

Non-Critical and Leverage Categories

According to expected theory (Kraljic (1983), Olsen and Ellram (1997), Caniels and Gelderman (2005)), the buyer strength in the non-critical, and leverage

quadrants is expected to be high, and thus the buyer is expected to have more influence over the supplier. The conclusion is that the findings in the case study support this theory.

Strategic and Bottleneck Categories

The overall conclusion from analysis of the buyer-supplier relationships in the strategic and bottleneck quadrants was that all the suppliers of products in these categories held the dominant power position. There were no cases of strategic products where the buyer held a dominant or balanced power position. The findings indicate that the need to influence suppliers in the strategic and bottleneck categories is critical as these products can cause significant risk if there is not a co-operative relationship. This supports Anderson and McAuley's (2006) findings that niche products require solid co-operation between the buyer and the supplier. Thus a balanced buyer-supplier relationship is most important for these categories and it is critical for buyers to invest effort in co-operative or strategic relationships to reduce risk and optimise competitive advantage.

There are a number of conclusions on the strategic alternatives available to the buyer that can be summarised as follows:

As there were no cases of strategic products where the buyer held a dominant or balanced power position, Kraljic's exploit strategy was not valid for COTS products in this case study. This is similar to Olsen and Ellram's (1997) opinion, but the reason for the unsuitability is slightly different. Olsen and Ellram (1997) are concerned about the 'consequences' of exploitation, whereas in this case the strategy doesn't hold because of the nature of the dependency and lock-in in the software context which reduces the strength of the buyer. This result concurs with Caniels and Gelderman's (2005) empirical evidence that even in the strategic quadrant suppliers dominate.

When the buyer has no influence over vendor controlled changes, then this requires a strategic decision to either remain as is or seek an alternative supplier

where there is a more balanced relationship. This can be done either by moving quadrants to take advantage of a less complex supply market, or by substituting with another strategic supplier. The decision is based on a trade-off between the importance of the product to the competitive strategy, the state of the relationship and the substitution effort.

When the supplier dominates, the buyer can chose to 'stay as is' (if the situation is satisfactory) and invest no effort in changing the unbalanced relationship. Caniels and Gelderman (2005) also propose that the supplier dominates even satisfactory partnerships and suggest that unbalanced relationships may not be troublesome. This also aligns with findings in this study where there are some cases were the buyer is willing to accept the supplier dominance as the relationship, while not balanced, is still satisfactory. These cases occurred when the COTS supplier held the dominant technology standard, had high entry barriers and more or less no competition. As it was a dominant technology, changes were well communicated and other vendors quickly adopted new versions so there were less challenges in handling quality, interoperability and maintenance.

When the buyer considers the product no longer to be strategic, the action can be to move quadrants. This effectively means determining how to move the product from the strategic quadrant to the leverage quadrant in order to leverage or take advantage of a less complex supply market. This type of strategy was especially important when the buyer could see no opportunities to have a more co-operative relationship with an existing supplier.

Finally, Torchiano and Morisio (2004) describe a situation where the COTS buyer could hold a dominant position in a monopsonistic market condition, where the buyer was the main revenue source for a small company. However the findings indicate that this is a high risk situation to be avoided due to risk of IPR issues, lack of supplier capacity to support a large market, or even possible acquisition of

supplier by the buyer's competitors. If the product has high strategic value for the buyer, an alternative strategy often taken is for the buyer to acquire the supplier.

5.3.2 Changing Market Conditions

The analysis of supplier strength also provided some interesting conclusions regarding the impact of changes in the market over time Changes in growth, financial strength and technology lifecycles could increase or decrease supplier strength. These changes had significant impacts on the buyer-supplier relationship and the strategic options available to buyers.

Many suppliers' product technologies, which had been novel when the product was initially purchased, had now matured and reached the end of the technology lifecycle. The supply complexity had reduced and there were now many competitors with similar products which reduced the supplier's strength and increased the buyer's strength. Over time the product had 'naturally' moved from the strategic quadrant to the leverage quadrant. This is a new finding in the use of purchasing portfolio management and demonstrates the importance of monitoring changes in the marketplace over time. Without analysing both the market complexity and the supplier strength for the product, the buyer would be unaware of this change. The options now available to the supplier included price negotiation, terms and conditions, or moving to an alternate supplier, dependent on the business case and of course the desired relationship with the supplier.

Suppliers had also increased their market penetration by growing market share or by means of acquisitions, and were much 'bigger players' than when the COTS purchase was originally made. This changed the strength in the buyer-supplier relationship and meant that the buyer had much less influence on the supplier and the supplier's product evolution. In this case, even if the technology had matured, the supplier had managed to protect their market position by maintaining entry barriers.

Buyers need to take these changing market conditions into consideration in the management of COTS products. As Ulkuniemi and Seppanen (2004) recommended "buyers need to understand and influence the market, particularly its development over time, to fulfil their strategic needs."

5.3.3 Influencing Vendor-Controlled Change

Market watch activities and co-operative or strategic relationships have been recommended as a solution to influence vendor-controlled change and to continually assess options (Yang et al., (2005), Boehm and Abts (1999), Anderson and McAuley (2006)) but there has been no research on how to successfully use these recommendation to influence suppliers. Merola (2006) found that market watch is not easy in practice as suppliers are slow to divulge future plans or roadmaps.

This study has found by analysing the market using the Kraljic approach, that a market watch activity is not sufficient to manage evolution and continually assess options. Buyers need to understand how, or if, they can influence the supplier and to do this they need to be aware of the power balance in the buyer-supplier relationship. As the buyer strength was found to be low in the bottleneck and strategic categories, the buyer has little opportunity to influence the evolution of the product unless the buyer builds a long term co-operative or strategic relationship with the supplier. As the buyer strength is high in the non-critical and leverage categories, the buyer has more possibilities to influence the product evolution.

Therefore, if the buyer needs to influence vendor-controlled change such as the product evolution, a close relationship with suppliers is critical. As Merola (2006) discovered, suppliers will not easily divulge information if there are not co-operative relationships in place. If there is a true strategic relationship with joint strategic intent, the ability to influence vendor-controlled change can be high. Alternatively if there is a close and co-operative relationship (e.g. with supplier of strategic or bottleneck products), while the buyer may not be able to directly

influence the vendor-controlled change, the co-operation will ensure that there is a good information flow and the buyer can proactively plan for future change rather than be forced into a reactive approach (as in the case of Anderson and McAuley (2006), Merola (2006)).

5.4 Strategic Actions and Competitive Advantage

The third research objective concerns **"how the action plans resulting from the purchasing portfolio approach can lead to competitive advantage**." This objective is concerned with findings in the final step of the portfolio approach – the development of actions plans that support the strategic approaches.

The portfolio technique can be used to identify supplier management strategies and actions plans but it is important to connect these to the company's competitive strategy in order to achieve competitive advantage. According to Porter (1980), companies can gain competitive advantage by optimising purchasing power and minimising power of suppliers. The Kraljic approach results in differentiated strategic options to optimise purchasing power and minimising power of suppliers. The Kraljic portfolio model aligns supplier management strategies with the company's competitive strategy by managing risk and optimising returns based on factors identified by the company that contribute to sustainable competitive advantage. This follows the approach recommended by Wagner and Johnson (2004).

The resultant management strategies (see Table 11) can include both short and long term actions to realise the management strategies. The action plans are completed on a per product basis and agreed across the organisation so there is a clear and consistent message given to suppliers.

Classification	Power Balance	Strategic Approaches
Non-Critical	Buyer Dominant	**Standardise and consolidate**
Leverage	Buyer Dominant	**Leverage** (negotiation or substitution)
Bottleneck	Supplier Dominant	**Supply Assurance** (co-operation)
Strategic	No cases found	-
	No cases found	-
	Supplier Dominant	**Diversify** (Substitute) **Balance** (close co-operation or strategic partnership) **Accept** as is (unbalanced, minimal co-operation) **Change category** (Re-architect to take advantage of supply market, e.g. move product to Leverage category)

Table 11 Summary of Strategic Action Plan

The Kraljic model gives explicit consideration to the strategic role of the various relationships, and where the firm will invest in and leverage supplier-buyer relationships. Companies can create uniqueness by optimising capabilities of suppliers. A unique configuration of buyer-supplier relationships structured according to strategic, bottleneck, leverage, and non- critical strategic approaches can create barriers to imitability, thereby creating competitive advantage as posited by Barney (1995). An effective buyer-supplier relationship that optimises the industry supported capabilities available as COTS products, can lead to opportunities for business growth, reduced development costs and reduced complexity. These are the same advantages identified in the COTS literature as driver for using COTS products (Yang et al. (2003), Boehm and Abts (1999), Albert and Brownsword (2002).

Strategic goals for COTS products are often ABC- based on the Top 10 revenue suppliers, with no bearing on whether the supplier was strategic or a basic commodity. These goals do not recognise the cost of poor buyer-supplier co-operations which manifested as a development cost when projects had to adapt to unforeseen changes in COTS products, with no sellable added value to the end-user of the OSS product. The ABC cost reduction goals focused on reducing the

cost of sales rather than investing in optimising suppliers relationships to gain competitive advantage.

5.5 Comparison and Critique

5.5.1 Comparison to other Case Studies

Other case studies on the purchasing portfolio approach have mainly been in a manufacturing context, the COTS software industry has some different characteristics to the manufacturing industry. The analysis of the supply market complexity highlighted some differences between manufacturing and software industries that should be understood when purchasing COTS products. Firstly, it is rarely possible to follow the recommended approach for complex supply situations, 'spread risk by spreading volume' that is, using two or more suppliers to supply the same product. COTS products need to be integrated with the buyer's product architecture and software buyers are effectively 'locked-in' once the COTS product has been integrated. As the buyer has not control of future changes to the source code, there is a dependency on the supplier as long as the product is in use. The degree of lock-in can be related to the degree of standardisation of the COTS product and effort required to integrate with the buyer's product architecture. Products that have a high supply complexity (few competitors, unique or leading technology) can be very difficult or impossible to substitute due to the lack of 'similar' products. In summary, the COTS software market complexity is higher than that in manufacturing due to the high degree of lock-in with suppliers and the high substitution costs. This is primarily caused by lack of product standards, and complexity of integration. Standardisation of COTS products is unlikely due to the rapid development and complex nature of the software industry (Ulkuniemi and Seppanen, 2004). This significantly reduces the possibility for the buyer to decrease supply risk in comparison to the manufacturing industry.

5.5.2 Critique of Purchasing Portfolio Approach

The purchasing portfolio is often considered a valuable tool for developing differentiated purchasing and supplier strategies. However portfolio models have been criticised, specifically for their simplicity (Dubois and Pedersen, (2002),

Olsen and Ellram (1997)), limited measurement factors (Wagner and Johnson (2004), Olsen and Ellram, (1997)) and lack of prescriptive management guidelines (Cox, 1997). However based on the findings in this study, the simple approach, the ability to customise the measurement factors and management guidelines was more a benefit than a hindrance, especially when a company is using the approach for the first time.

This study found that it was beneficial to take a simple approach, especially the first time a company uses the purchasing portfolio concept when it is important to generate buy-in from all stakeholders. The purpose of the initial case study was to evaluate if this is really a worthwhile methodology for determining strategies for COTS software suppliers. Experience gained in the first iteration can be used to refine the model and the measurement factors in later iterations.

The measurement factors were based on the company's own environment, that is, customised to the software industry and the company's business context. A number of Kraljic's factors were not used as they had no relevance to the software industry. This approach generated more buy-in to the final result as stakeholders had reached consensus on each factor, how it would be measured and what weighting was needed to reflect the characteristics of the company's environment. This study found that ultimately each company must consider what are the most important factors based on their industry context and strategic direction and customise the model based on experiences. As well as the measurement factors, the activities related to the recommended strategic approaches were also customised. While many of the guiding principles and activities were applicable, activities related to securing volume and spreading volume across multiple suppliers customisation were not applicable in software industry.

A benefit to the customised approach was that the application of the model became a participative process. If the measurement factors had been complex or if the management guidelines had been prescriptive, this could have limited the valuable

information flow and the fit with the company's context. The end result would have been less valuable. The author agrees with Olsen and Ellram (1997) who suggest that if dimensions are very complex, there may be too much focus on developing measures and categorizing the elements, and not enough focus on realizing the full potential in terms of resource allocation and communication.

This study agrees with other portfolio management case studies (Nellore and Soderquist (2000), Olsen and Ellram (1997, Gelderman and Van Weele (2003)) that have found that portfolio models are an excellent way of organising and classifying information. The structure approached and the use of measurement factors gave an 'unemotional' input to the analysis of each product and supplier.
The cross-functional perspectives are a key element of the success of this approach. It was found that close co-operation between the technical functions and sourcing was essential for COTS software. The workshops included all stakeholders involved in managing the COTS acquisition – strategic sourcing, strategic product management, R&D. There were two major benefits to the workshop approach. The first benefit was the information sharing and arriving at consensus when applying the measurement factors. The second benefit was the interactive and participative nature of the model, this meant that all stakeholders bought-in to the action plans as there was now a deeper understanding of the complexities and level of change both in the supply market, and in buyer-supplier relationships. The case study found that the Kraljic framework and the customised approach, facilitates these important discussions to a large extent. This is consistent with findings in other case studies (Olsen and Ellram (1997), Gelderman and Van Weele (2003)).

5.6 Conclusion

The conclusion of the study is that the case study findings extend the current COTS-based development literature and the purchasing literature by using the purchasing portfolio management approach in the COTS software domain. This addresses the gap in COTS literature where management of the external context has been recommended but no techniques have been researched. It also extends the

purchasing literature by providing more insights into the usage of portfolio models in the software domain.

Although the study is limited to one company, the study findings are valuable as a generalisation due to the large sample size of COTS products and the fact that the same COTS products are widely used across the software industry.

Chapter 6: Conclusions, Limitations and Further Research

6.1 Introduction

The purpose of this chapter is to present the conclusions of the research, outline the limitations of the study and recommends possible areas for future research.

6.2 Conclusions

The motivation for this research was to address the gap in the COTS literature by evaluating the usefulness of purchasing portfolio management as a technique to create differentiated supplier management strategies for competitive advantage, based on the strategic importance of the COTS product and the external context.

Analysis of the COTS literature suggests that while there are many benefits to be gained from using COTS products, there are also many disadvantages (Reifer et al, 2003). The disadvantages and challenges identified in the literature indicate that COTS buyers are in reactive mode, are highly dependent on COTS suppliers and appear to have very little influence on product evolution or other types of vendor-controlled change (as seen in Anderson and McAuley (2006), Torchiano and Morisio (2004), Boehm and Abts (1999)). In order to gain control of the situation, COTS buyers cannot assume that COTS suppliers operate in a mature and stable market; rather the market is under constant change, driven by the pace of technology development and competitive forces, and it lacks product and industry standards in many areas. Buyers need to understand and influence the supply market and its development over time (Ulkuniemi and Seppanen, 2004). This requires regular analysis of the market, and of the buyer supplier relationships. As there can be different types of COTS product with different supply market conditions, there can also be different types of buyer-supplier relationships based on the importance of the COTS product to the buyer's business, and based on complexity of supply market conditions for that product (Van Weele, 2005).

The purpose of this study, based on the challenges and recommendations in the COTS literature, was to determine if purchasing portfolio models are an appropriate technique to gain competitive advantage in the management of COTS software products.

The most important finding of this study was that purchasing portfolio management is a valuable structured technique to classify COTS products, to analyse the buyer-supplier relationships and to determine what actions need to be addressed to gain competitive advantage. This is consistent with purchasing and supplier relationship management research (Kraljic (1983), Ellram and Carr (1994), Olsen and Ellram (1997), Nellore and Soderquist (2000), Dubois and Pedersen (2002), Gelderman and Van Weele (2001), Caniels and Gelderman (2005), and Van Weele (2005)).

The Kraljic approach provides a structured and comprehensive classification approach that considers supply market complexities as well as the importance of the product to business strategy. The classification is beneficial in providing linkage between strategic importance and supply complexity, using measurement factors that are customised to the buyer's context. The recommended strategic approaches all provide valuable guidance for managing each category of COTS products and identifying where the buyer should focus attention to gain the most benefit by reducing risk and optimising factors that are important to the business.

The analysis of the buyer-supplier relationship for each quadrant provided very valuable information as the strategic approaches and actions that can be taken are related to the power-balance in the buyer-supplier relationship. An additional benefit from the analysis was the understanding gained on how, or if the buyer could influence the COTS supplier. This is a very important aspect in COTS-based development, were the majority of the challenges and disadvantages are attributed to the lack of buyer influence on vendor-control change (Boehm and Abts (1999), Morisio et al., (2000), Yang et al (2005), Merola (2005), and Anderson and McAuley (2005)).

Ulkuniemi and Seppanen (2004) in their analysis of the COTS market also recommended that "buyers need to understand and influence the entire market, particularly its development over time, to fulfil their strategic needs." The findings in this case study emphasise this recommendation. The pace of technology development causes many changes in the supply market, and buyers need to take this into consideration when managing the usage of COTS products. It is not sufficient to 'market watch' and react - by using the purchasing portfolio technique COTS buyers can make things happen to their own advantage. The analysis of the supply complexity and of the supplier's strength indicate that the COTS market place is indeed rapidly changing, especially due to the fast pace of technology lifecycles, and the competitive forces in the supply market. The findings indicate that a structured and detailed market analysis should be performed on a regular basis, at least annually. The COTS supply market is evolving and many changes can occurs that affect the buyer-supplier relationship and the level of dependence – supplier growth, maturing technologies, mergers and acquisitions, and changes in product direction.

The output of the portfolio analysis is a set of strategic options that can be prioritised to optimise competitive advantage. Short and long term actions are formulated to realise the strategic options. The final action plan can be included as part of a company's strategic planning process. It is important not to just focus on cost reduction as in ABC-based supplier goals; the strategic options provide a new set of goals that can increase competitive advantage by means of closer co-operation with suppliers. An effective buyer-supplier relationship that optimises the industry supported capabilities available as COTS products, can lead to reduced development costs, reduced complexity and opportunities for business growth. Companies can create uniqueness by optimising the capabilities of suppliers. A unique configuration of buyer-supplier relationships structured according to strategic, bottleneck, leverage, and non- critical strategic approaches can create barriers to imitability, thereby creating competitive advantage as posited

by Barney (1995). According to Porter (1980), companies can gain competitive advantage by optimising purchasing power and minimising power of suppliers. The Kraljic portfolio model aligns supplier management strategies with the company's competitive strategy and the resultant management strategies and action plans can be used to maximise buying power and minimise supplier power.

6.4 Implications for Practice

The findings in this study suggest that the same portfolio analysis should be repeated at least annually as input to the company's annual goal setting process. This would achieve two benefits. Firstly, the purchasing and supplier management strategies could be linked into the organisation's strategic management process. The supplier management goals and objectives could be changed from being primarily cost-reduction driven, to a more qualitative approach that could include supplier-related goals to achieve technology leadership and product innovation. This would connect the usage of COTS products to the company's competitive strategy. Secondly, the findings indicate that changes in the COTS market can have significant impacts on the buyer-supplier relationship, for example, the existing COTS product may need substitution with an updated or new product, prices could be re-negotiated based on using mature rather than innovative technology. Hence repeating the Kraljic analysis on a regular basis will enable the company to proactively handle changes in the external environment and to optimise the supplier portfolio accordingly.

6.5 Limitations

While the study is limited to one case company, the fact that the case company uses a large number of COTS products, adds more credibility to the findings because this constitutes a large sample of COTS products and of buyer-supplier relationships. Case studies in the COTS literature at least in the author's knowledge have a smaller sample size and often focus on challenges with a small

number of ‘troublesome’ COTS products where there is a high degree of dependence on the supplier.

The second limitation is that this study deals with only one company, which is representative of a specific segment of the software industry, telecommunications software; and develops a specific type of product, a software system that is multi-technology, incorporates a large number of COTS products and is sold on to an end user. The challenges raised in the COTS literature are compounded when dealing with a large number of COTS products, and when the buyer has the same maintenance responsibilities towards end users as proprietary code. However, the same COTS software products are used across many sectors in the software industry and the same findings may or may not apply to other sectors. This could be the subject for further research. In some cases, there might be some ‘specialisation’ to the telecoms industry (e.g. robustness, quality), but as the software industry has grown in size and complexity, these ‘specialisations’ are now appropriate in many other segments that develop large software systems.

The second limitation is related to the measurement criteria used to develop the models. While findings related to the appropriateness of the model for COTS-based software development can be generalised, details such as the measurement factors may be specific to the company and industry context. The telecommunications sector of the software industry has some characteristics (e.g. robustness, quality, long lifecycle), that may not be as important in other software sectors. Some specifics are particular to the telecoms industry – the fact that the quality attribute can be system critical may not apply when the same product is used in other software systems. Thus the measurement aspects of case study depth have limited generalisability.

The third limitation of the study is that it is completed at a particular time period and is therefore a snapshot in time. The fast pace of software technology lifecycles and market conditions mean that the findings may be different in one, five or ten year's time. However this can also be seen as an opportunity for further research – it may not necessarily be viewed as a limitation because both the buyer's competitive strategy and the supply market are both changing, so it will actually be beneficial to take a number of snapshots over time to see trends in the supply market. The case study finding was valuable as due to the experience level and year of service of the participants, the case study was able to capture what had changed both with the company's product strategy and the supply market over a five to ten year time period.

6.6 Further Research

Future research could include more extensive empirical testing of the usefulness of the portfolio approach. The research methodology should start with case studies to capture the important aspects of the implementation process. It is difficult to compare the use of the portfolio approach because several company-specific factors such as technology, norms and values vary in different companies.

Much of the literature and case studies on purchasing portfolio management are based in non-software contexts. Further customisation and elaboration of the measurement criteria, strategic approaches and recommended actions for the software industry could be a topic for further research.

Although the case study contain a large sample size of COTS products, a qualitative approach to data gathering and analysis was taken mainly due to time constraints. Future research could use a combination of qualitative and quantitative approaches, thereby providing more conclusive generalisations.

Longitudinal studies in companies could provide information about the long-term impact and usefulness of a purchasing portfolio approach. This would demonstrate if the portfolio approach becomes more sophisticated as users become more experienced. Experience over time may lead to the fine-tuning of what measurement factors are most applicable when calculating business impact and supply risk, and what factors does the company consider important or valuable in the buyer-supplier relationship. Experience over time will also show if the challenges related to the COTS software market diminish when the strategic action plans and appropriate buyer-supplier relationships are in place.

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Appendix A List of Empirical Material Gathered

Table A.1 Buying Company's internal interviews

Person	Date and Duration	Interviewee Expertise Area	Topics Covered
A Sourcing Manager	02-10.06 (2hours) 06-11-06 (1 hour) 24-02-07 (2 hours)	COTS sourcing and supplier relationships	COTS suppliers in general, strategic purchasing goals, supplier negotiation possibilities, relationships with specific COTS suppliers
B COTS Supplier Manager	16-01-07 (2hours) 22-02-07 (2 hours)	COTS supplier relationships, development issues	COTS suppliers in general, relationships with specific COTS suppliers
B Product Manager	16-01-07 (2hours) 22-02-07 (2 hours)	Strategic Product Management	Relation of COTS products to product strategy, relationships with specific COTS suppliers
C Development Manager	02-10.06 (2hours) 06-11-06 (1 hour)	Software engineering and management	COTS issues generally, relationships with specific COTS suppliers
D Supply Manager	16-01-07 (2hours)	Supply	Financial data – annual cost of sales for COTS product

Table A.2 Cross Functional Workshops

Date	Description	Participants
14-12-06	Company internal workshop to discuss Kraljic Approach	Product Management, Development, Sourcing and Supply Managers
25-01-07	Company internal workshop to present and discuss the Kraljic approach	Strategic Product Management. Product Development, Supply, Strategic Sourcing, Product Release Management, Product

		Line Maintenance
22-01-07 25-01-07	Customisation of measurement criteria, 'dry run', refinement of measurement criteria	Strategic Sourcing, Product Development
26-02-07	Data collection for population of Kraljic Model	Strategic Product Management. Product Development, Strategic Sourcing,
28-02-07	Data collection for population of Kraljic Model	Strategic Product Management. Product Development, Strategic Sourcing,

Table A.3 Company Review Meetings

Date	Scope of Meeting	Participants
18-12-06	review of supplier challenges, consequence analysis	Senior management (Operational and Project Steering Group)
05-03-07	Discussion of Results, identification of action plans	Product Management. Product Development, Sourcing,
12-03-07 18-03-07	Presentation and prioritisation of action plans	Senior management (Operational and Project Steering Group)

Table A.4 Company Documents

Type of Document	Content Description	Use of document in the analysis
Product Strategy Description	Strategic product direction	Product growth
Product Architecture Description	Describes Neptune product architecture, components and interfaces.	Identification of COTS products, level of standardisation and general usage
Project A Final Report, Project B Final Report	End of project review describing lessons learned and opportunities for improvement.	Identification of lessons learned and challenges related to COTS products.
Supplier A Evaluation Review	Results of supplier evaluations based on interviews with users.	Identification of challenges and issues in the buyer-supplier relationship
Supplier B Evaluation Review	Results of supplier evaluations based on interviews with users.	Identification of challenges and issues in the buyer-

		supplier relationship
Cost of Sales Reports	Royalty and maintenance payment to suppliers	Volume cost for each supplier

Table A.5 Supplier Review Meetings

Date	Topics Covered	Use in Analysis
04-09.06 11-09.06 09-10.06 20-11-06	Assessment of supplier performance on quality, delivery, technical support, interoperability, roadmap alignment, and product evolution.	Indication of the buyer-supplier relationship strength

Glossary

COTS Commercial-of-the Shelf

IEEE Institute of Electrical and Electronic Engineers

SEI Software Engineering Institute

ICCBSS International Conference on COTS-based Software Systems

OEM Original Equipment Manufacturer