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Total cost of procurement

Analysis of current awareness and model considerations for adoption and efficient utilization

Master's thesis in
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ABBREVIATIONS

ABC	=	Activity based costing
AHP	=	Analytical hierarchy process
ASN	=	Advanced shipping notice
BI	=	Business intelligence
COGS	=	Cost of goods sold
EDW	=	Enterprise data warehouse
EOQ	=	Economic order quantity
ERP	=	Enterprise resource planning
IPR	=	Intellectual property rights
LCC	=	Low cost country
MES	=	Manufacturing execution system
OCR	=	Optical character recognition
PSM	=	Purchasing and supply management
RFQ	=	Request for quotation
RPA	=	Robotic process automation
RONA	=	Return on net assets
TAC	=	Total acquisition cost
TCO	=	Total cost of ownership
TCP	=	Total cost of procurement
TCS	=	Total cost of sourcing
TLC	=	Total landed cost
TPM	=	Traditional procurement market
SCM	=	Supply chain management

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ABSTRACT:
Globalization has changed the operating environment for many organizations within manufacturing industries. To remain competitive, most of the organizations have decided to focus on their key competencies, while other activities have been outsourced to external suppliers. As a result, the value of externally procured components and services has increased when compared to the total value of produced goods. Different approaches have been suggested in literature for organizations to measure and evaluate costs related to external procurement.

Objective of this thesis is to identify how case organization can develop and improve its measurement and evaluation practices related to total cost of procurement within supply management framework. The theoretical framework for the thesis is based on management literature and academic publications related to procurement and total cost of ownership, which were then combined to total cost of procurement concept. To reach the research objective, organizations existing procurement cost measurement practices and awareness related to total cost of procurement concept was studied and evaluated. To collect the relevant research data, qualitative and quantitative research methods were applied.

As a managerial contribution of the thesis, improvement activities and development opportunities are recommended for case organization. The improvements mainly include enhancements to procurement cost data availability and accuracy. Positive attitude towards total cost of procurement within respondents was highlighted as an enabler for adoption. Finally, it was proposed that a proof of concept for measurement model should follow this thesis to determine if actual model can be built according to the proposed concept.

KEYWORDS: PROCUREMENT, TOTAL COST OF OWNERSHIP, TOTAL COST OF PROCUREMENT, MANUFACTURING INDUSTRY

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TIIVISTELMÄ:
Globalisaation on muuttanut yritysten liiketoimintaympäristöä valmistavan teollisuuden alalla. Säilyttääkseen kilpailukykynsä, useimmat organisaatiot ovat keskittyneen avainosaamiseensa ja ulkoistaneet muut toiminnot ulkoisille komponenttivalmistajille sekä palveluntuottajille. Tämän seurauksena, ulkoa hankittujen komponenttien sekä palveluiden arvo on kasvanut huomattavasti verrattuna valmistettujen tuotteiden kokonaisarvoon. Kirjallisuudessa on ehdotettu useita eri menetelmia hankintaan liittyvien kustannusten mittaroimiseen sekä arviontiin.

Tämän opinnäytetyön tavoitteena on tunnistaa kuinka kohdeyritys voi kehittää ja parantaa käytänteitään liittyen hankinnan kokonaiskustannusten mittaroinnissa ja arvioinnissa. Opinnäytetyön teoreettinen viitekehys nojaa hankintaa ja kokonaiskustannuksia käsittelevään johtamiskirjallisuuteen sekä akateemisiin julkaisuihin. Näiden kahden viitekehyksen pohjalta yhdistetään oma konsepti hankinnan kokonaiskustannuksille. Tutkimustavoitteen saavuttamiseksi arvioidaan kohdeyrityksen nykyisiä menetelmiä hankintakustannusten mittaamiseksi sekä selvitetään hankinnan kokonaiskustannuksien tunnettuutta. Tutkimustiedon keräämisessä käytettiin sekä kvalitatiivisia että kvantitatiivisia tutkimusmenetelmiä.

Opinnäytetyön tuloksena, kohdeyritykselle esitetään liikkeenjohdollisia toimenpide-ehdotuksia koskien parannustoimenpiteitä sekä kehittämismahdollisuuksia. Esitettävät parannusmahdollisuudet koskevat pääasiallisesti hankintakustannusten saatavuuden sekä tarkkuuden parantamista. Kyselyyn vastanneiden työntekijöiden positiivista asennetta hankinnan kokonaiskustannuksia kohtaan pidetään puolestaan positiivisena mahdollistajana mittauskäytänteiden kehittämiseksi. Opinnäytetyön lopuksi ehdotetaan, että kohdeyrityksen tulisi suorittaa ehdotetulle hankinnan kokonaiskustannus mallille soveltuvuusarviointi, jonka pohjalta voidaan määrittää onko lopullinen malli mahdollista rakentaa ehdotetun konseptin mukaisesti.

AVAINSANAT: HANKINTA, KOKONAISKUSTANNUKSET, HANKINNAN KOKONAISKUSTANNUKSET, VALMISTAVA TEOLLISUUS

1 INTRODUCTION

During the past decades, globalization has transformed business framework for many organizations that have been operating at industrial manufacturing environment. Instead of competing at local markets with limited number of familiar customers and known competitors, the manufacturing organizations are now participating at global marketplace which is often characterized with a fierce competition between many players that are offering similar solutions to the same end customers, while being located at the other side of the globe. To thrive in this highly competitive environment, many of these organizations have decided to concentrate more on their key competencies while outsourcing the non-core activities to be performed by external component and service suppliers.

The increase in the number of outsourced activities has also changed typical cost structures within these organizations. In other words, the costs that were formerly included in internal manufacturing costs or operations costs, are now more likely to be considered as procurement costs. This has led to a situation in which the share of costs related to externally purchased components and services has increased notably in comparison to the final value of goods sold (Kusaba, Moser and Medeiros Rodrigues 2011).

Typically, there has been different outsourcing strategies for the manufacturing organizations to implement. In practice, these strategies have included sourcing from traditional procurement markets, such as Western Europe or North America, or from low-cost regions like Eastern Europe and Asia, where the cost of human labor especially has been low. While the decision to enter low-cost sourcing markets might have been influenced by multiple factors, one of the key objectives has been to achieve procurement cost reductions. In other words, the manufacturing organizations have assumed that lower total cost of procurement can be achieved if the components and services, are purchased from regions with low-cost structures, although this might increase the cost related to other procurement activities.

While many of the manufacturing organizations acknowledge that procurement costs extend beyond purchase price and have notable impact to the overall cost structure of goods sold, there is no academic evidence that manufacturing organizations would be systematically implementing practices such as total cost of ownership to evaluate full scope of these costs. Rather, the evaluation seems to be typically based on limited number of cost elements which are considered important for the specific procurement scenario and are easily available from organizations accounting systems. While the selection of relevant cost elements seems often to be based on individual considerations, the weight or amount

of these cost elements also tend to be relatively inaccurate which reduces the validity of the evaluation. Additionally, it seems that procurement cost evaluations are often performed only once for the specific procurement decisions and there is a lack of continuous performance evaluation practices based on total cost of procurement information.

In overall, it could be considered rather worrying that organizations are performing business decisions with major financial impacts based on assumptions of relevant attributes and impacts, or by without having the valid information to support with the correct decisions (Najafi, Dubois and Hulthén 2013). Additionally, it is relatively typical that success of these business decisions is evaluated based on the same incomplete or inaccurate data which was used while making them. As a result, organization has possibly made an incorrect decision, but is not aware of undesirable outcome.

While this thesis constantly emphasizes the importance of procurement costs and supports use of cost-based performance measurement and evaluation practices to select and evaluate suppliers, this thesis doesn't support the idea that these decisions should be based only on the cost evaluation and that the lowest cost alternative should always be selected. Rather, the thesis aims to illustrate importance of extending procurement cost evaluation beyond price and encourages manufacturing organizations to broaden the current scope of evaluation. This should be done to ensure that when procurement cost data is utilized for decision making, the evaluation would be based on valid information which is based on real activities and their cost impact.

1.1 Research objectives and research questions

The main research objective for this master's thesis, is to identify how the case organization could develop and improve its practices related to the total cost of procurement measurement and evaluation. Based on this objective, considerations for TCP model development, cost elements and measurement model structure will be provided. This consideration will be done with an assumption that TCP measurement will be applied within supply management framework and data is used for supplier evaluation and comparison.

For being able to provide considerations for TCP measurement development and model structure, current state of case organization needs to be evaluated. This includes identification of current TCP measurement practices, evaluation of existing TCP awareness in

the case organization and evaluation of available procurement cost information. As a result of this evaluation and examination, development potential for increased TCP utilization and adoption steps will be discussed.

To reach the main research objective, current cost measurement and evaluation practices within procurement process need to be studied and evaluated. To conduct this study, three research questions will be set:

1. How total cost of procurement can be measured in supply management framework and what are the measurement practices acknowledged by literature?
2. What is the current organizational awareness related to the total cost of procurement and how organization is currently evaluating and measuring costs related to procurement process?
3. What is the organizations readiness to develop its practices related to total cost of procurement measurement and how the organization would like to use this information?

In addition to answering previous research questions, also the organizations existing procurement process needs to be considered, so that the most relevant procurement activities with cost impact can be identified. These cost elements will be emphasized, when the considerations for TCP adoption and model development will be provided.

As a result of this master's thesis, the case organization should be able to develop roadmap for the model development itself. This means that the organization can identify the most relevant cost elements that should be included in the model already from the start. At the same time, input for model development is provided so that organization can recognize such cost information which is already available from the information systems or could be easily made available. This would enable organization to first establish its TCP measurement practices based on already existing information, while adding more cost elements in later stages of development. Additionally, tool and structure for creating the measurement model will be suggested.

1.2 Key concepts and area of focus

This thesis is focusing on the costs that occur procurement process is performed. While variation for definition of procurement exists within supply management and logistics literature, in this thesis, procurement is considered as the top-level process for all other functions that are required from the organisations to acquire components or services that are needed for production (van Weele 2010: 6-7). These functions are sourcing, purchasing, logistics and supply management. In addition, activities related to quality management can be incorporated within the previous functions.

For being able to evaluate full range of procurement related costs, total cost of ownership was selected as the most suitable approach. By a definition, total cost of ownership aims to reveal all costs that are resulted when an organisation acquires, utilises and finally scraps component or service (Ellram 1995a). While total cost of ownership can be utilised to evaluate full scope of different cost elements, the focus of this thesis is limited to costs that are resulted during the procurement process and can be impacted by procurement decision makers. Therefore, a limited approach to total cost of ownership is proposed. This concept is called total cost of procurement.

These three concepts: procurement, total cost of ownership and total cost of procurement are in the core of this thesis. Therefore, these concepts will be extensively discussed and introduced during the theoretical part of the thesis.

When the procurement process was evaluated and examined, it was noticed that the framework contains multiple different concepts, and the vocabulary related to these concepts might be slightly parallel and therefore create confusion. For example, what is the relationship between procurement and supply management. While this terminology is considered during the theoretical part of this thesis, the relationship between different levels can remain confusing, and therefore alignment between terminology can be useful. While these observations could be included in the conclusion of thesis, they are considered important to achieve mutual understanding of phenomena, and therefore they are presented already at introduction.

To distinct differences and relationships between different processes, functions, activities and tasks, four-level hierarchical structure is used in this thesis (figure 1). Procurement process is presented at the top-level of the model. Activities within procurement process are performed by functions, therefore functions are located between process and activity level. To perform an activity, one or multiple tasks are required. While the costs are

mainly created from activity level, tasks form the fourth and lowest level in this categorisation and influence the cost impact related to each activity. As the costs are considered at the activity level, also the actions related to capturing procurement costs should be targeted to activity level.

The purpose of this distinction between process, functions, activities and tasks is used to clarify relationships between activities that are performed at different levels during the procurement process. Use of this hierarchical model aims to provide more comprehensible use of vocabulary, instead of dividing activities into sub-activities and so on. Different categories also help to identify different characteristics and objectives related to each action. While direct connection might not exist between different functions and activities, it doesn't mean that functional relationship or overlapping couldn't exist. It is important to understand that this categorisation is used in the context of this thesis and different use of terminology can be found from literature.

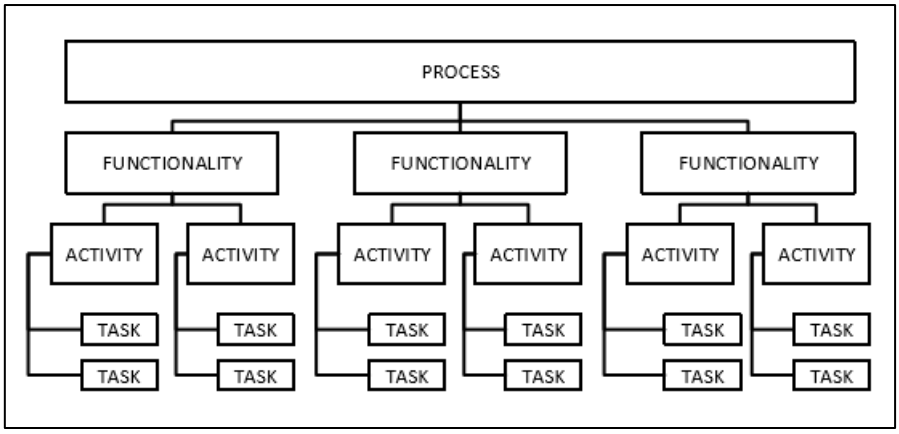


Figure 1. Process hierarchy applied in this thesis

1.3 Limitations and restrictions

The purpose of this thesis is to evaluate how the case organisation should develop its procurement cost management practices towards total cost of procurement concept. In the context of the thesis, the evaluation is limited to the procurement process, instead of extending the scope over the whole lifecycle of purchased components. This creates a distinction between total cost of procurement concept, which is applied in this thesis, and total cost of ownership which has been recognised and examined extensively in the procurement literature. In practice, TCP is a limited application of TCO, which concentrates

only on activities that are performed between make-or-buy decision and having the purchased components available for production.

While the empirical study of the thesis also considers the use of total cost approach in indirect procurement environment, the primary focus of this thesis is limited to direct material procurement. This means that all the evaluations and model considerations are performed with an assumption that procurement costs will be related to purchasing direct components that are used during manufacturing process. Therefore, the scope of procurement activities and cost elements are mainly typical for direct procurement instead of indirect procurement.

Additionally, direct materials procurement is approached from a point of view where component design is property of case company, and components with similar specifications and qualities can be procured from multiple different sources. In other words, technical requirements from the buyer are more important driver for supplier selection than available market offerings. Regardless of this assumption, research and development activities can be performed in collaboration with suppliers, and therefore these activities will be included in the scope of the thesis and TCP approach.

While many of the existing procurement total cost studies concentrate on evaluating the sources or amounts of total costs related to global sourcing, the focus of this thesis is limited to studying how procurement cost management and measurement practices could be improved and developed, so that full extent of procurement costs would be considered. Due to selected approach and objectives, the thesis doesn't include any comprehensive total cost evaluation related to individual purchased components or procurement scenario. However, the availability and validity of most important cost elements will be evaluated separately, so that possible development actions can be proposed.

Because the empirical research of this thesis is performed in a context of a one single case company, also the findings and recommendations are limited into this case company context. Regardless of this limitation, some of the recommendations can be applicable for similar type of companies or procurement organisations operating within global sourcing markets and manufacturing industries. For other organisations, the results might provide ideas for their own adoption and development activities.

1.4 Structure of the thesis

This thesis is divided into eight main chapters to create clear and comprehensible structure. The first chapter provides introduction to the topic and defines research objectives and questions. In addition, key concepts for the thesis focus area are introduced and presented, so that these concepts would be familiar in the later stages. Also, the limitations and restrictions applied for the thesis will be presented and discussed.

The second and third chapters are building the basis for theoretical framework of this thesis, and they provide the required information for establishing the concept for total cost of procurement and empirical research. In the second chapter, procurement in global manufacturing environment will be discussed. The chapter is divided into three sections, which concentrate on procurement process, procurement costs and impact of procurement to organizations financial performance.

Theoretical framework related to total cost of ownership will be presented in the third chapter. The objective of the chapter is to present how TCO has been approached in literature and what should be considered when TCP approach and practices will be adopted. Also, the third chapter is divided into more detailed sections. These sections focus on key concepts that are related to TCO measurement which is based on activity based costing and typical TCO applications. Additionally, aspects related to TCO adoption and measurement model development will be introduced, while also presenting possible barriers that should be recognized before implementation.

After the two theoretical chapters, the fourth chapter aims to combine these two theoretical frameworks into the concept of total cost of procurement. This means justifying the need for selected approach and describing the objectives that would be targeted when TCP is applied. Finally, some key principles for TCP model will be introduced.

Empirical part of the thesis begins from the fifth chapter by providing introduction to the research methodology and case company. Key elements in this chapter are related to describing how the research was performed and what kind of research methods were applied. Also, validity and reliability of research results will be discussed.

Actual presentation and analyses of empirical research results is performed in the sixth chapter, which is again divided into smaller sections with more detailed focus areas. The discussion will continue with considerations related to TCP adoption in chapter seven.

This chapter aims to combine insights from theoretical framework, TCP concept and empirical research findings related to organizational and technical factors. As a result, a proposal of actions towards higher TCP utilization will be presented.

The thesis will be concluded in the eighth and last chapter. The purpose of this chapter is to summarize research results and findings into managerial implications and provide suggestions for next steps of TCP adoption.

2 PROCUREMENT IN GLOBAL INDUSTRIAL ENVIRONMENT

Procurement process includes all activities that are required from the purchasing organisation to ensure availability of right materials at right place and time (van Weele 2010: 6-7, Waters 2009: 304)). This means that procurement is a combination of strategic activities, such as sourcing and supply chain management (SCM), and operative activities like purchasing and logistics (Mangan, Lalwani, Butcher & Jawadpour 2012: 406). Procurement can refer to acquisition of materials from both, external and internal sources. Due to the limitations of this thesis, procurement is examined as an inter-organisational activity where materials and components are acquired from external sources and the process requires collaboration between multiple supply chain participants.

The importance of procurement has been growing during the last decades due to the increased competition between companies operating in a global market place. In a modern industrial environment, many organisations have chosen to focus on their core competencies to achieve competitive advantages against their competitors. Thus, many of the non-core activities, such as component manufacturing for example, have been outsourced and are now purchased from external suppliers that are often more capable or specialised in performing that specific activity (van Weele 2010: 18). In other words, outsourcing enables companies utilize expertise of external organisations, while releasing internal resources to other activities that create more value (Kumar & Kopitzke 2008).

Increased amount of externally procured materials and components have led to a situation where procurement has increased its potential to be one of the strategic activities that can generate competitive advantage for a company and have positive impact on bottom line profitability (Schulze, Seuring & Evering 2012). In industrial context, procurement often represents the biggest individual source of cost for many companies (Degraeve & Roodhooft 2001). Depending on the field of industry, the cost of purchased components can reach up to 80% of the value of its goods sold (Batson 2008, Montgomery, Jennings & Pfund 2011, Fawcett, Jones & Fawcett 2012). While the share of purchased components can vary between value propositions in different industries, the increased importance of procurement process has been widely acknowledged. (Degraeve & Roodhooft 1998, Kusaba et al. 2011, Mangan et al. 2012: 166-168).

In addition to the importance of procurement process, also the complexity related to procurement has been increasing because of global competition. While global market place has meant that the customers and competitors are located around the world, it has also led to a creation of global sourcing markets, where suppliers can be placed far away, and

goods are shipped between distant locations (Johnson, Sawaya & Natarahanathiram 2013). As a result, supply chains have become more extensive and new activities are required from the procurement organisation when materials are delivered from one country to another and between economic zones.

Reasons why companies have decided to enter global procurement markets instead of concentrating on local sourcing have been studied quite extensively. Main objective of these studies has been to find out why companies are willing to accept the increased complexity and well-known risks related to global sourcing operations in comparison to sourcing from local suppliers or internally (Schoenherr, Tummala and Harrison 2008). Some of the key drivers for global procurement include limited availability of certain technologies or know-how, target to enter new sales markets by first establishing presence via procurement activities, and requirements from stakeholders to have certain number of components from specific place of origin. While previous factors have been reported as notable drivers for global procurement, the most important objective for companies to enter international procurement markets has been cost reductions and savings resulted from a lower purchasing price. (Monczka & Trent 1991, Kumar, Andersson & Rehme 2010, Cagliano, De Marco, Rafele & Arese 2012, Johnson et al. 2013).

Cost reductions have been especially relevant objectives when companies have entered Eastern European or Asian supply markets. According to Lorentz, Töyli, Solakivi and Ojala (2015), sourcing from these low-cost countries (LCC) has been increasing constantly during the last years. Decision to enter LCC supply markets has often leaned on the assumption that lower production costs can be achieved in countries with lower labour costs, and it will automatically result into lower cost of purchased materials and components. This kind of thinking has been especially supported in businesses with high demand of human labour. The cost of global procurement is a sum of all activities that are required to get the components available at a place of requirement. With global and more complex supply chain, also the cost structure of procured components extends notably beyond purchasing price itself.

The purpose of this chapter is to introduce global procurement in industrial context. Special attention will be given to activities included in procurement process and how these activities are creating costs. In addition, different procurement strategies and financial importance of procurement will be discussed. The theoretical contents of this chapter will be utilised when considerations for total cost of procurement model will be provided. For example, description of procurement process helps to identify different activities that can be included in the measurement model, and information about procurement costs can be

utilised when different cost elements are prioritised for measurement. The need for TCP measurement, on the other hand, can be justified with the information about financial impacts of procurement performance.

2.1 Procurement process

Traditionally procurement has been categorised as one of the support activities in organisations value chain (Porter 1985: 37). This means that the objective of procurement process is to support organisations primary activities, mainly operations. Porter (1985: 41) also describes procurement as an organisation wide function that also serves the purchasing needs of other support functions. Because procurement doesn't only cover purchasing of direct materials, it can't therefore be categorised as primary activity. As defined in key concepts, we are classifying procurement as a process instead of activity. This helps us to distinct individual activities that are performed as part of procurement process and related to specific functionality.

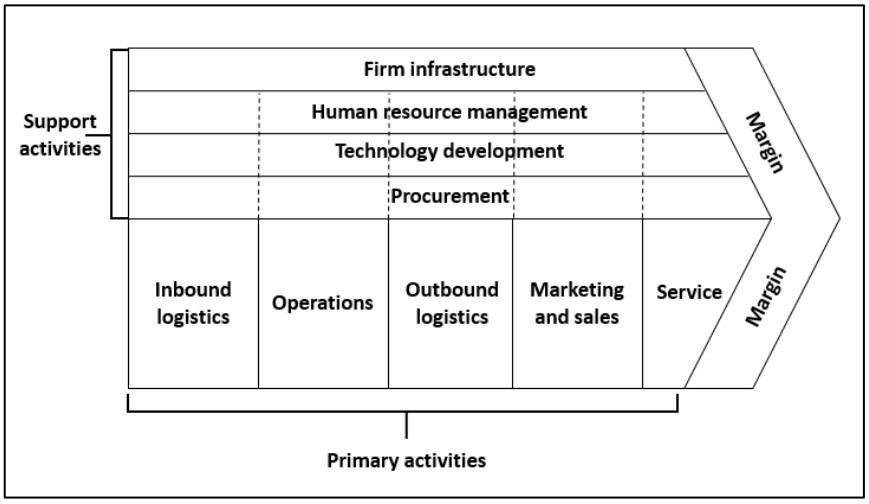


Figure 2. Value chain model as described by Porter (1985).

The definition for procurement process used in this thesis includes inbound logistics, which Porter (1985: 39-40) categorises as a separate primary activity that includes activities such as warehousing, goods reception and inbound transportation of purchased materials (van Weele 2010: 6). In our definition for procurement, inbound logistics is included as a function within procurement process because of two important reasons. First, inbound logistics need to be arranged by the procurement organisation to meet its main

objective of getting the components available in correct place. Secondly, inbound logistics includes significant amount of activities that are especially typical in global procurement process.

Based on the limitations used in this thesis, slightly different definition for procurement and grown importance of purchased components, it could be argued that procurement of direct materials shouldn't be only considered as a support activity. This is way of thinking is supported by the idea that direct materials are used as a critical part of organisations value proposition, and therefore procurement of direct materials would meet the definition of primary activity by Porter (1985: 38). Porter (1985: 41) also emphasizes that procurement has critical role in management of organisations overall cost structure, financial performance and quality of final products. Thus, such process should not be left without proper management attention.

As mentioned already before, procurement process includes all activities that are required from the purchasing organisation to ensure that required materials are available at correct place. This means that functions such as sourcing, purchasing and inbound logistics can be seen as part of procurement responsibilities. In addition to these functions related to flow of materials, procurement organisation needs to also process information related to requirements and offerings and take care of financial flow towards suppliers. This creates connection between procurement process and supply chain management function. Therefore, scope used for procurement process in this thesis, includes sourcing, purchasing, inbound logistics and supply management functions. (van Weele 2010: 6-7, 8, Waters 2009: 304).

Due to its relatively broad range of responsibility, each function in procurement process can have slightly different scope and target of attention. For example, sourcing can be defined as a strategic function that is responsible for finding and selecting of suppliers, creation of supply agreements and management of supplier relationships. Sourcing is also responsible for defining correct procurement strategy for each sourcing scenario. Meanwhile, purchasing can be seen more as an operative activity that is responsible for making purchasing transactions and arranging the change of ownership with the most efficient way. Similarly, the scope of inbound logistics can be defined as operative and its responsibility to ensure that purchased materials are delivered from supplier to place of requirement. (van Weele 2010: 9-10, Waters 2009: 304).

Figure 3, illustrates simplified description of procurement process and its main functions. While these functions are illustrated mainly as consecutive, it is important to understand

that there might be activities that are overlapping between functions, and that activities might also have different sequences of occurrence. This means that while some activities need to be performed only once for each supplier, some are done continuously or required to be repeated every time when purchase order is place.

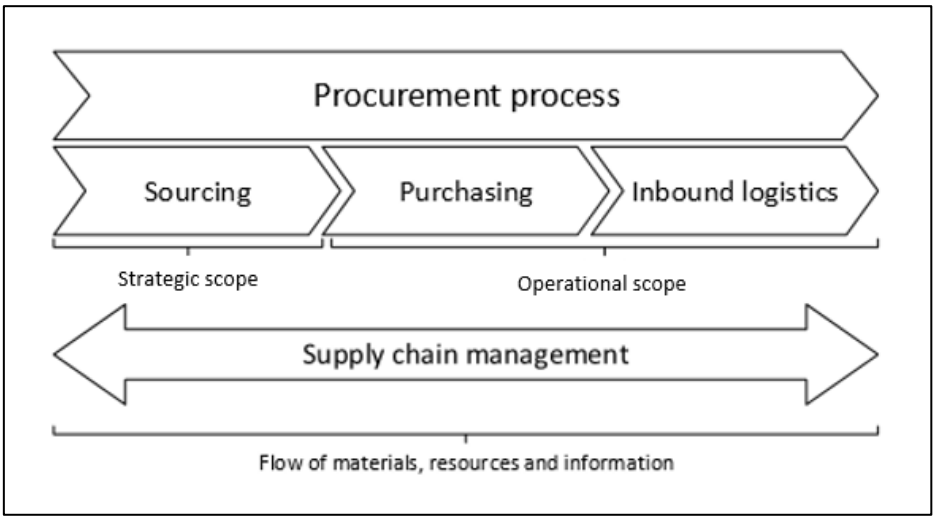


Figure 3. Main functions included in procurement process (modified from van Weele 2010: 9)

Each of the functions in procurement process is a collection of individual activities that need to be performed by the function for it to succeed. Individual activity can be considered as an action that is performed and which requires consumption of specific resources, for example time, work or money. Different procurement scenarios might demand different activities to be performed. For example, some of the activities in sourcing function might not be relevant in a certain type of procurement scenario and can be left outside. On the other hand, same activities might be the most important ones in another scenario. In following sections, main objective and scope are defined for each of the four functions with examples of typical activities included in them.

2.1.1 Sourcing

Sourcing has a strategic scope within procurement process and it is responsible for determining and implementing proper strategies for each procurement scenario (van Weele 2010: 10). Typically, the activities within sourcing function take place in the beginning of procurement process and can be considered as pre-transactional activities (Ellram 1993). For example, sourcing is often taking part in a make or buy decision. This means that sourcing is involved when certain materials are required by production process and

information about external sources are requested. As part of this decision, sourcing needs to identify need and requirements for materials, and transfer this information to detailed specification so that it ca be used later in procurement process. In addition, sourcing needs to identify potential suppliers, request quotations, and define proper procurement strategy for the situation and select correct supplier to supply materials. (Waters 2009: 308-311)

After identification and selection, sourcing is responsible for ensuring that supplier is capable of manufacturing required materials and components. This means that sourcing function needs negotiate commercial agreements and terms of delivery, perform audits and ensure that supplier manufacturing process is producing materials and components that conform to all requirements. In practice, sourcing function might need to actively support in production ramp-up, provide training for supplier employees and validate suppliers manufacturing process and quality. All these activities can be described as pre-transactional because they are performed to enable successful purchasing transaction, where the ownership of materials and components is transferred. (Waters 2009: 308-311)

It is important to understand that the scope of previous activities is dependent on each specific procurement scenario. For example, ramp-up of new supplier, often requires a lot more efforts from sourcing function than adding new materials into the scope of existing supply relationship. It is also characteristic for sourcing function that some of the activities need to be performed only once for each supplier or procurement situation, while some activities are repeated continuously or by regular basis during the lifecycle of relationship between supplier and procurement organisation. These continuous activities are performed in all stages of procurement process and are connected to all functions.

In addition to identifying new supply alternatives and material requirements, sourcing is responsible for managing existing supply base. This means supplier relationship management and supplier development during the whole lifecycle of the relationship between supplier and procurement organisation. These activities are performed to ensure supplier quality in different dimensions, such as product, service, process and organisational quality and as a result to strengthen long-term competitive advantage of procurement organisation and its supply chain (Li, Humphreys, Yeung & Cheng 2012). Active involvement in supplier development and evaluation also creates connection between sourcing function and quality management within supply chain.

In industrial manufacturing context, sourcing function has often been centralised to maximize full purchasing power of the procurement organisation. At the same time this enables sourcing function to leverage good relationships with fewer number of key suppliers

and this way achieve better long-term performance. While the price is often the key driver for sourcing decisions, it is generally acknowledged that also other elements should be included in the process. For example, supplier quality, delivery and production capabilities, geographical location and financial status are mentioned as important factors when sourcing decisions are made in industrial context. (Krajlic 1983, Degraeve et al. 1998).

To achieve best possible combination between different drivers, sourcing function needs to make strategic decisions that are following the whole organisations strategic objectives and enable competitive advantage. Traditionally three different strategies have been used by organisations to achieve competitive advantage against their competitors. These strategies are cost leadership, differentiation and focus strategy. In addition to making decisions based on the selected strategy, it is the responsibility of sourcing function to integrate suppliers with organisations strategic objectives. (van Weele 2010: 185-203).

In industrial environment, where wide range of different materials and components are procured from several suppliers, sourcing function often needs to determine most suitable sourcing strategy for each procurement scenario. To assist in this process, procured materials and components and suppliers can be placed into portfolio, where they are categorised based on their financial impact and supply risk. For example, strategic components that represent notable cost in product value, typically require more attention from procurement organisation than components with low value. Same applies if material can be bought only from one supplier instead of multiple sources of supply. (van Weele 2010: 185-203).

Based on the portfolio analysis and requirements identified for each product and supplier category, a proper sourcing strategy needs to be determined for each procurement scenario. According to van Weele (2010: 214), three important questions need to be addressed by the organisation at this point. These are proper number of suppliers for each material or component, geographical location of supplier and relationship type between procurement organisation and supplier. By having multiple suppliers for specific component, often reduces the amount of supply risk, while the administrative costs and prices can be higher than in single-sourcing scenario. As listed before, the drivers for global procurement can be diverse. On the other hand, local sourcing is often supported when components have high strategic importance and technical complexity. Finally, relationship type for each individual supplier should be determined. While suppliers that supply bulk components that have small financial impact and supply risk, can be managed at arm’s length and with smaller amount control, good relationships should be developed

with strategic suppliers. For example, good relationship with strategic suppliers might be needed to enable product development and improved value proposition.

These strategic decisions should be aligned so that sourcing function enables procurement process to achieve lowest total cost of ownership for purchased materials and components. For example, Degraeve et al. (1998) state that good relationships with reduced number of suppliers have resulted to better long-term performance between suppliers and procurement organisation. This, on the other hand, has enable procurement organisation to achieve lower TCO by implementing more efficient production strategies. The connection between TCO and sourcing strategy is also highlighted by van Weele (2010: 214), who mentions TCO as a key criterion for decision making between local and global supply alternatives.

2.1.2 Purchasing

In procurement process, purchasing is the operative function that is responsible for ensuring material availability with the most efficient way. In this process, purchasing function utilizes the inputs that have been created by sourcing function. In practice this means that purchasing function arranges the delivery of materials from suppliers to the place of requirement by collaborating with suppliers, that have been selected by sourcing and per agreements that sourcing function has negotiated with those suppliers. Purchasing function is combination of pre-transactional, transactional and post-transactional activities.

To perform its task efficiently, purchasing needs to identify when and where specific materials are required by the operations. This information is often communicated proactively to suppliers in form of purchasing forecasts and more accurate purchasing specifications. Internally purchasing function often takes responsibility of defining proper inventory and buffer levels so that material availability can be secured while keeping the inventory turnover rate as short as possible. With these pre-transactional activities that take place before the change of ownership, purchasing function aims to secure undisrupted flow of materials towards downstream operations.

In addition to communicating about material requirements and planning of material flows, purchasing function initiates the flow of materials by placing purchase orders to supplier (Waters 2009: 304). In addition, purchasing function is responsible for proactively monitoring the order process until the goods have been received. In practice this can include development of order routines, rescheduling of deliveries, expediting and solving problems related to material availability. (van Weele 2010: 31).

To enable efficient delivery of purchased components and lowest total cost, purchasing function needs to optimize flow of materials from suppliers to production. In practice this can be done by implementing strategies such as just-in-time and demand driven replenishments. In addition, purchasing needs to actively define and adjust batch sizes so that the most economic order quantities (EOQ) can be achieved. In other words, material replenishments should be planned so that the sum of ordering costs and inventory costs can be minimized (van Weele: 262).

It is important to understand that purchasing functions ability to optimize material flows can be dependent on supplier characteristics. For example, supplier delivery performance might lead to situation where purchasing function needs to maintain additional safety stocks to create buffers against risks of shortages caused by poor quality of supplier components. In addition, it can be possible that supplier's production process creates limitations to possible adjustments to order quantities, and long distance with high transportation costs forces purchasing function to order with quantities that are not optimized.

Purchasing function is also responsible to ensure that materials and components delivered by supplier are meeting the quality requirements and other specifications. This activity can be performed with multiple different ways. For example, purchasers can proactively communicate with supplier and ensure that suppliers understand all the requirements and how delivery should be performed. In addition, documents and inspection reports can be requested from supplier as a proof of quality. Finally, purchased materials can be inspected as part of goods reception process. It is important to understand different activities that purchasing function performs to ensure conformity of purchased materials because these activities are creating costs in form of resource utilization. On the other hand, cost of quality failure can be a created if poor performance of supplier can't be identified by purchaser. In worst case scenario, this might result into materials shortages, production downtimes and late deliveries to end customer.

Because activities in purchasing function can often be repetitive and require lot of communication between supplier and procurement organisation, efficiency can be achieved by utilizing technological tools and communication methods. For example, materials requirement planning via ERP systems can increase accuracy in supply planning and ease monitoring of purchasing process. In addition, communication towards suppliers can be enhanced with EDI solutions and web-based portals, where information can be shared between supply chain participants. By implementing these tools and practices into procurement process, decrease in transaction costs can be achieved because of better resource

utilization and more efficient flow of information. (van Weele 2010: 375; Mangan et al. 2012: 176-177)

2.1.3 Inbound logistics

Inbound logistics is included into the definition of procurement process used in this thesis. This is because main responsibility of procurement process is to ensure that correct materials are delivered from supplier and made available for production. In practice, this process requires that inbound logistics as a function and logistic activities are integrated into the procurement process. As part of the process, inbound logistics performs post-transactional activities to ensure that material is physically delivered from supplier premises to the place where materials are required. In global procurement environment, the importance of inbound logistics is even greater as material flows stretch longer and more activities are required during the process.

While the activities included in inbound logistics function are often outsourced to third-party operators such as carriers or logistic service providers, it is a responsibility of logistics function to arrange these activities and often also carry the cost created form them. The range of logistics activities is highly dependent on the geographical location of supplier as the amount and complexity of activities increases when materials need to be delivered long distances, across boards and between economic zones. In addition, the applied terms of delivery can impact the scope of activities required in specific procurement process. For example, some incoterms allocate financial and operational responsibility of transportation to suppliers, while others shift the responsibility to procurement organisation (Mangan et al. 2012: 159-160). It is important to recognize the impact of different delivery terms as it might have significant impact to the cost resulted from transportation of materials.

Typical activities that are often performed by inbound logistics function include arranging transportation for purchased materials, taking care of customs procedures, organising goods reception and in-house material handling, and taking care of warehousing before materials are taken into the production. The scope of these activities is often related to three factors: requirements related to material or components, supplier performance and geographical location of supplier. For example, some materials might require special type of transportation or more secure packing. Supplier performance, on the other hand, might cause disruption to logistics operations and might create need for expediting delivery with

more expensive transportation methods or establishment of unnecessary safety inventories. The impact of geographical location, in turn, is related to activities that are needed when materials are transported globally. For example, these activities can be related to customs processes, declarations of origin and other actions that are not needed when materials are not delivered across borders.

While the scope of each individual activity might vary between different materials and suppliers, it is useful to notice that the scope of almost each activity is increased when materials are purchased globally instead of locally. For example, when materials are delivered for long distances, they often need to be protected and packed more securely. This increases the requirements for packing activity at supplier end and demands more resources from in-house material handling when goods are received. Meanwhile, the scope of logistic activities is often decreased when materials are only delivered only for a short distance. For example, level of inventories and requirement for warehousing can be reduced because of shorter replenishment lead time and need of packing can be minimised when materials are not vulnerable for environment.

As the carriers and third-party logistics operators often play important role in the efficiency of inbound logistics function, the relationship between them and procurement organisation should be managed in a similar way that is done with suppliers. In practice this means that carrier and third-party operator performance should be measured proactively, and operations should be constantly developed together to achieve higher performance and efficiency. To enable efficient inbound logistics function, undisrupted flow of information should be secured in a similar way that is needed during purchasing function. This can be done by information systems that integrate suppliers, carriers and procurement organisation, while allowing them to share information.

2.1.4 Supply chain management

According to the traditional definition, supply chain management includes the management of all activities, information and financial resources that are needed to secure efficient acquisition of materials and services required by manufacturing operations (van Weele 2010: 18). Based on a more contemporary way of thinking, SCM focuses on enabling and securing efficient flow of materials, information and financial resources between supply chain participants. In other words, SCM as a function within or collateral to procurement process, aims to ensure that materials are efficiently delivered downstream, from suppliers towards operations and customers, financial resources are moved

accordingly upstream towards suppliers, and information between different supply chain partners are shared to both directions. (van Weele 2010: 253-255).

Instead of considering supply chain as a simple, one-level, linkage between suppliers and procurement organisation, modern definition regards supply chain as a multi-level network of different participants who are collaborating towards shared goal of increasing value perceived by end customer (Mangan et al. 2012: 10-12). Based on this definition, SCM is more likely seen as a management of networked relationships between procurement organisation and other independent organisations who are taking part within supply chain activities. The common objective for these networks is to increase value that supply chain delivers to markets, and therefore allows it to achieve competitive advantages against other operators within the same markets.

While different approaches to define relationship between procurement and SCM exist, this thesis has obtained one where SCM is included within procurement process and is collateral to other functions within procurement process. In other words, while this approach regards sourcing, purchasing and logistics as more operative functions, that are required to acquire materials from suppliers, SCM is considered as a supportive function within procurement process, which objective is to create an infrastructure for efficient procurement operations. In practice, this means that SCM as a function is responsible for development and maintenance of efficient procurement tools, processes, practices and measurement systems.

While this definition means that no actual procurement activities are performed within supply chain management function, SCM still has an impact towards procurement costs due to its responsibility of developing efficient tools and processes for collaboration with different supply chain participants. For example, EDI infrastructure between procurement organisation and suppliers can lead to higher efficiency in purchasing activities, and therefore reduce the transactions cost of purchasing. Similar results can also be achieved by other e-procurement solutions, such as web-based portals, which increase the efficiency of collaboration. Another example of process efficiency achieved via SCM tools, is the supply chain finance solutions, which enable procurement organisations to achieve more beneficial payment terms, while suppliers can maintain required and efficient cash flow by getting their receivables quickly.

While the SCM mainly impacts procurement costs indirectly via efficiency of activities performed by other functions, also some of the investments related to SCM should be

included when supplier specific total cost of procurement is measured. For example, investment to more efficient collaboration tools should be recorded to supplier level procurement costs, and then allocated to each purchase done from that supplier. If the investment then enables organisations to collaborate more efficiently, the positive cost reductions should be achieved when normal procurement process is performed. For example, if procurement organisation has invested into supplier specific procurement tool, which reduces the transaction cost related to each purchase, this should be taken into notice when transaction costs are measured for this specific supplier.

2.2 Procurement costs

Variety of different costs are created when organisation performs activities as part of procurement process. While some of these costs, such as component price, are easy to understand, evaluate and follow, others might be harder to identify and measure. For example, costs related to warehousing, material handling and quality issues might be difficult to recognise and evaluate especially if they are related to utilisation of resources and proper methods for capturing different costs have not been established. To better comprehend the full variety of costs, procurement organisation should aim to identify how the different activities are creating costs, evaluate the impact of these costs and categorise them into groups based on their characteristics.

One of traditional ways to categorise procurement costs, is to divide them into external and internal costs based on the point of appearance (Smytka & Clemens 1993). In their model, Smytka et al. (1993) define external costs as a sum of price, discounts, ordering costs, transportation, supplier visits, tooling and technical support. Internal costs, on the other hand, are created by nonconformities, expediting, inventory carrying and possible production downtime. The difference between these two main categories is that external costs are directly influenced by supplier performance and capabilities, while the internal costs can be business specific and highly dependent on internal factors.

Similar way of categorising procurement costs has also been used by Ellram (1993), who divided costs into three categories that are pre-transactional, transactional and post-transactional costs. Pre-transactional costs in this categorisation are mainly related to sourcing activities and include costs related to searching and selection of new suppliers and adapting them into supply chain. Purchase price, transportation costs and quality inspection, on the other hand, are examples of transactional costs that occur when the purchasing

activity itself is performed. Finally, post-transactional costs are often related to possible failures in the process, such as production downtime caused by missing or defective components, rework and cost of returns.

Category	Characteristics
Fixed cost	Variation in activity level doesn't influence cost in a short time frame. Instead the cost remains unchanged. Problematic with longer period when all costs could be defined as variable.
Variable cost	Cost that changes in direct proportion in relation to activity. If level of activity is increased, the cost is affected similarly. Assignment to correct activity is especially important for these costs as incorrect assignment leads to deviation in measurement. Also, important to assign directly into right activity instead of allocating indirectly.
Semi-variable cost	This category contains costs that have characteristics from both, variable and fixed costs. For example, cost might be fixed in between of certain intervals, but varies in steps when the intervals are passed. In practice, it is important to differentiate variable and semi-variable costs.
Direct cost	Direct cost can be fixed, variable or semi-variable. These costs can be directly assigned to specific activity without allocations.
Indirect cost	Fixed, variable or semi-variable cost that is related to support required by activity, but not possible to assign cost directly to that activity. For example, in procurement process, cost of communication is related to process, but also utilised by other activities. Critical approach to indirect costs might be often useful, as some costs might later be revealed as direct.
Relevant cost	Cost that is important for decision making process as it changes because of activity or decision that was made. Often companies might overlook certain costs and don't recognise them as relevant. As a result, decision making is based on partial information.

Table 1. Traditional cost categories and their main characteristics (Ellram & Siferd 1993).

Ellram and Siferd (1993) also identified six main activities that contribute to total cost of ownership. These activities are communications, delivery, management, price, quality and service. In addition to identifying these activities, the authors present traditional model for classifying the costs based on their characteristics (see Table 1). Ability to

classify different costs is important for cost measurement practices, as it enables to understand how different costs are related to activities and how they might be affected if changes in activities occur.

In the procurement process, it would be especially important for decision makers to recognise what are the relevant costs related to individual procurement decisions. For example, how the available supply alternatives vary in costs related to their performance and capabilities, or if supplier's geographical location can make difference. If the procurement decision makers are able to efficiently recognise relevant costs, also costs that don't make difference between alternatives can be left outside of comparison.

In addition to these traditional approaches, also other ways of categorising procurement costs have been used during past years. While the approach to categorise, these costs is often similar, different ways to emphasise costs can be recognised. For example, Holweg, Reichart and Hong (2010) define three groups that are static, dynamic and hidden costs. In this categorisation, static and dynamic cost include similar factors than previous categorisations. For static costs include price and transportation, while dynamic costs include factors such as cost of poor quality and expediting. More importantly it is useful to understand category of hidden costs as all cost factors might not be easy to recognise. These costs are often indirect and might be related to changing procurement environments. For example, cost related to traveling, currency fluctuations and supplier relationship management might often be underestimated. In a modern procurement environment, with increased amount of different activities, it is especially important for procurement organisation to understand whole extent of activities that are impacting to total cost related to procurement process.

The characteristics of modern procurement process can be recognised in a model used by Platts and Song (2010). In their study, the authors divided procurement costs into ongoing costs that occur regularly during the relationship between supplier and procurement organisation, and one-time costs that are only performed once or occasionally. On-going costs can be related to purchasing transaction itself or supplier relationship management, while one-time costs are often related to the initiation phase of supplier relationship. In practice, these one-time costs could be considered as a basic investment that need to be paid back with savings reached with lower ongoing costs.

While it is important that procurement organisations can categorise costs based on their impact and characteristics, it is equally important that companies can identify the most

relevant costs for each procurement scenario. In the literature related to international procurement, wide range of cost factors have been identified. These cost factors include categories such as manufacturing, inventory, shipping, expediting, finance, oversight, binational trade (Johnson et al. 2013).

In the following five sections, procurement costs in global environment are discussed in more detail. The sections have been established in a similar way that was used by Ellram et al. (1993), but instead of having six categories, three sections are determined according to the main functions in procurement process. In addition, two separate sections are dedicated for price and supplier quality costs, as these factors have been identified as important contributors to the total cost related to procurement.

In this categorisation, price is determined as a flow of financial resources that are transferred from purchaser to supplier as a compensation for activities that supplier has performed. All the other cost categories are considered as an additional cost that are extending beyond the price. These additional costs are a result of activities that are performed by procurement organisation or third parties, such as transportation companies. While the amount of additional costs has often been underestimated by the decision makers, it has been discovered that total amount of these costs might sometimes even outnumber the purchasing price (Johnson et al. 2013).

2.2.1 Component price

Purchasing price is one of the main cost elements present in procurement process. Because price is agreed between supplier and purchaser, it is often easy to compare different supply alternatives based on the price that they are offering for the similar materials. Also, the evaluation of procurement performance has often been concentrating on achieving the lowest possible price. This has encouraged purchasing managers to select lowest price, instead of considering the overall value generation potential (. This has been especially typical for companies that have been looking cost savings from LCC sourcing markets, with assumption that low purchasing price, achieved especially with low labour cost, will lead to smallest possible total cost for procurement (Canbolat, Gupta, Matera and Chelst 2008).

In an environment where increased focus has been given for the lowest possible purchasing price, it has been easy for procurement decision makers to rationalize the selection of supplier who was offering the lowest price. On the other hand, the ability of suppliers to compete with price is often limited due to specifications and requirements that have been

strictly defined by the purchaser. In manufacturing industry, the design of the purchased material or component might often be property of procurement organisation, and therefore, raw materials and production methods are predefined for all supplier alternatives. When the need manufacture according to tight specifications set by purchaser, the difference in prices can be seen to originate from process performance, manufacturing capabilities and lower process costs. In other words, the price is a result of suppliers internal cost structure, and different prices offered by suppliers are connected to different cost structures between the companies. The importance of understanding suppliers internal cost structure has been emphasized by Song, Platts and Bance (2007) and Zsidisin, Ellram and Ogden (2003).

While the price is quite straightforward cost element and easy to evaluate, there is important factors that need to be considered when comparison is made between supplier offerings. According to Smytka et al. (1993) and Song et al. (2007), extended definition for price also includes possible price reductions and discounts that supplier is offering if certain terms are achieved. In the global procurement environment, price might also include taxes and duties that would be additional in other offerings. Also, the possible currency fluctuations should be considered, if materials are purchased with different currency. In their research, Song et al. (2007) conclude that while currency fluctuations in some situations might have positive impact, they might also create unexpected impacts that might neutralise all other cost savings that would have otherwise been achieved. The major impact of currency fluctuations to cost of procurement are also supported by Schniederjans and Zuckweiler (2004). Actions to protect companies against negative impacts of currency fluctuations were proposed by Bartram (2008). These actions are mainly related to financial instruments such as currency derivatives and operational hedges.

It is also important to understand that while the delivered component might be identical between the different offerings, the price might include also other elements that would normally be categorised into some other cost categories. For example, this kind of difference might be a result of incoterms used in supplier offerings. While one supplier applies incoterm that defines transportation as supplier's responsibility, the other supplier might use incoterm that shifts the responsibility for purchasers. Thus, the price offered by one supplier might include all costs that are related to transportation, while in the other offering, the cost of transportation would be added on top. In general, it is important to acknowledge the impact of applied incoterm as it defines the responsible party for arranging the transportation, loading of materials, having insurances and bearing the cost of these activities.

While the characteristics of price as a cost element are evaluated base on model by Ellram et al. (1993), couple of interesting observations can be done. Firstly, price should be seen as a direct cost which can be assigned to activity of purchasing materials from a specific supplier. In addition, price can also be defined as relevant cost as it is important for the procurement decision making, there is differences between different supply alternatives and total cost related to procurement is impacted from these decisions. Evaluating the variability of price is harder than the previous characteristics. Based on agreement between supplier and purchaser, it could be considered that price is a fixed cost at least for a contract period. On the other hand, possible discount that are connected to order quantities, might result into a situation where price has semi-variable characteristics. It is also important to understand that possible currency fluctuations might lead to situation where price is variable, although the variation is not related to the level of activity in that case. Due to these characteristics of price as a cost element, it would be good for measurement purposes that the actual price paid to supplier is used for evaluation purposes, instead of using agreement prices.

2.2.2 Sourcing costs

Sourcing is a continuous activity that has an important role during the whole lifecycle of a supplier-purchaser relationship. Therefore, the costs related to sourcing function, are a result of pre-transactional, transactional or post-transactional activities. In addition, the costs can be one-time or ongoing, meaning that they might occur only once during the relationship or continuously. The costs related to supplier introduction, can be shown as an example of first category, while costs related to continuous supplier development are belonging to latter group. In their study, Weber, Hiete, Lauer and Rentz (2010) identified multiple additional cost elements that were related sourcing functionality. For example, activities such as supplier selection, evaluation and development were having notable impact on additional costs related to procurement process. The importance of these activities was even higher when sourcing activities were targeted into LCC procurement markets instead of traditional procurement markets (TPM). A reason for this was, that operating in LCC markets requires more effort from sourcing function compared to TPM.

The pre-transactional costs resulted from a sourcing function are mainly created when the procurement organisation aims to identify potential suppliers, performs audits against them and validates their processes. Also, possible support with production ramp-up and new product introduction can be considered as part of pre-transactional activities. According to Platts et al. (2010), these kinds of costs are mainly occurring only once for

supplier or material, and therefore, seen as one-time costs. Other activities that create costs as part of sourcing function, may include information collection related to new suppliers, participation in tradeshow and fees paid to external consultants. Also, the cost related to utilization of resources from other organisation, such as engineering, should be included. With new suppliers, also administrative activities related to opening new supplier accounts and alignment in purchasing systems are often required. (Degraeve et al. 2001; Song et al. 2007).

Pre-transactional sourcing costs might also include creation of tools and manufacturing equipment that are needed in production. The cost of these tools and equipment might be paid by procurement organisation, especially if the design of purchased component is property of purchaser. The cost of special tools, production models and moulds can be surprisingly high. In their study, Platts et al. (2010) reported that in some companies, tooling costs were covering 60 percent of total set up costs. In addition to cost elements already mentioned, training and preparation of new suppliers, and validation of their processes might require that employees from procurement organisation travel to and spend time in supplier premises. Costs related to traveling into supplier premises should be categorised into sourcing costs (Platts et al. 2010).

Ability to recognise pre-transactional costs related to procurement process is especially important from supply base management point of view. For example, when a company is evaluating the need for introducing new supplier instead of using existing ones to deliver new component, it should be able to understand the cost that is associated to identification and introduction of new suppliers. In a way, pre-transactional costs in sourcing function describe how much it costs to start relationship with new suppliers. To achieve savings in long-term, this cost would need to be covered with the savings reached with a lower purchasing price and other procurement costs, when compared to already existing supplier. The payback time for new supplier introduction can therefore be calculated based on pre-transactional costs related to sourcing and potential savings that will be achieved with new supplier.

The on-going sourcing costs are mainly associated to transactional and post-transactional activities. In practice, these costs are closely related to supply management and supplier relation management, which both are critical activities for efficient procurement process and in achieving competitive advantage. Two important activities within sourcing function are supplier development and supplier performance evaluation. The costs related to both activities are mainly a result of resources required to perform these activities or investments to enable supplier development.

Supplier development often requires close collaboration and communication with supplier. This can lead to increased cost of communication especially if the suppliers are located far and traveling is required to enable personal interaction (Platts et al. 2010). To develop supplier competence and performance, sourcing function might also need to organize trainings for suppliers. A cost of these trainings should be followed and allocated for specific supplier relationships. This should be seen as especially important if trainings are required for LCC suppliers to enable them to deliver materials with lower price than already existing suppliers. According to Weber et al. (2010), supplier development created 6.4% of non-price costs related to sourcing from LCC markets, while it was not included in ten most important non-cost elements for suppliers in TPM.

Another important part of continuous sourcing activity is the on-going supplier performance evaluation. This activity creates costs when sourcing personnel needs to collect and analyse data related to supplier performance. Technological solutions are often required to ease the process of handling large amounts of information. If the supplier performance requires more detailed follow-up or intervention in form or workshops, additional meeting or negotiations, additional costs might be created.

It is also important to understand that ending the relationship with a supplier might result into post-transactional sourcing costs. While these costs often occur only once, they might have notable influence when the total cost of doing business with specific supplier is evaluated afterwards. In the end of relationship, sourcing function might need to take care of tools and equipment that are owned by the purchaser and remove them from supplier premises. In addition, sourcing function needs to ensure that supplier can't violate any intellectual properties of purchaser and create harm that way.

As described, a wide range of different costs are related to sourcing function. Categorisation of these costs as a group is therefore very challenging. For example, when cost is resulted from validation of purchased component, the cost could be determined as direct and therefore assigned directly to that material. On the other hand, if costs are related to supplier development in general, it might be impossible to accurately assign these costs for each individual material. Therefore, allocation based on specific set of rules might be required for these indirect costs. While characteristics of individual cost elements might be hard to evaluate, the relevancy of these cost elements for procurement decision making should be easy to understand. If higher sourcing costs can be expected from one supply alternative compared to other, it should have impact to supplier selection due to possible consequences to procurement organisations ability to achieve lowest possible total cost.

2.2.3 Purchasing costs

The cost created by purchasing function is often closely related to performance of the purchasing transaction itself. For example, transactional activities in purchasing function include processing of purchase orders, recording of confirmations and communication between different parties (Zeng & Rosetti 2003). Weber et al. (2010) identified that costs related to ordering reached almost 5 percent when sourcing from TPM. In addition, costs can be created from activities such as forecasting, billing and payment (Platts et al. 2010). Difference in costs related to these activities can be a result of communication channels that are utilised between supplier and purchaser. For example, technical solutions, such as EDI and e-procurement tools, might enable easier and more efficient communication between the parties and therefore require less resources for information processing at both ends. According to Ferrin and Plank (2002), the ease of transaction will lead to more efficient utilisation of resources and therefore reduce the transactional costs that are resulted from purchasing function.

In a global procurement environment, the higher procurement cost might also be a result of increased requirement for proactive follow-up of purchase orders. This will require more resources as performing of typical purchasing task will require more time and effort compared to normal situation. In some situations, it is even required that purchasing function oversees manufacturing of purchased materials in person (Colakoglu & Caligiuri 2008). This means that employee from procurement organisation needs to travel to supplier premises and supervise that process is performed accordingly. In this case, additional follow-up creates costs in form of travelling expenses and extra salaries. (Kumar et al. 2008; Young, Swan, Thomchick & Ruamsook 2009; Johnson et al. 2013).

One of the most important goals for purchasing function is to perform procurement transaction as efficiently as possible. Often this requires that purchasing personnel can determine economic order quantities (EOQ). For example, Ferrin et al. (2002) highlight that unnecessarily small order quantities may lead to additional purchasing costs that are a result of purchasing functions inability to determine EOQ. Costs resulted from non-optimised order quantities might be relevant for supplier selection, when suppliers have limitations for minimum and maximum lot sizes. In these cases, purchasers are not able to optimise purchasing batches according to EOQ, due to these limitations. In the long run, this might leave to a situation where additional costs, especially related to order processing and transportation, are over presented in total cost related to procurement. Good

knowledge of additional procurement costs related is critical enabler for purchasing decision makers when they are optimizing flow of materials.

Purchasing function is also responsible to ensure that purchased materials are produced according to requirements and specification (van Weele 2010: 238). This can be ensured with different activities such as supplier quality assurance and quality inspection. These activities result into costs that are related to prevention of quality failures. Individual tasks related to these activities might include inspection materials and documents. Due to differences in supplier quality performance, materials purchased from different sources might require different scope and type of inspections. For example, materials from high quality supplier might need to be inspected only occasionally and based on samples, while all components from other supplier needs to be checked before they can enter into production. In the cost categorisation used in this thesis, costs from activities related to quality inspection are included in purchasing costs, while costs from supplier quality failures are included in category of supplier quality costs. (Degreave et al. 2001).

The post-transactional costs related to purchasing function are related to activities such as invoice handling. These costs should be taken into consideration, especially is suppliers have different capabilities related to performing invoice process. For example, accuracy of financial documents and possibility for electronic invoicing system, will increase efficiency in flow of financial resources. In addition, payment terms between purchaser and different suppliers may vary. Longer payment terms might lead to increased utilisation of working capital, while negative impacts might reflect to supplier operations. As a solution, procurement organisations have implemented different types of supply chain finance (SCF) solutions that will enable benefits for both parties (Wuttke, Blome, Heese & Protopappa-Sieke 2016).

The classification of procurement costs might be relatively hard. This is because purchasing costs are mainly related utilisation resources during transactional activities, therefore they can be closer to indirect costs instead of direct. For example, the cost related to order processing needs to be allocated to multiple materials if they are purchased at the same time. The relevancy of purchasing costs should also be carefully evaluated when information about procurement costs are used for supplier selection. In other words, procurement organisation should try to identify if certain purchasing cost can be different between suppliers and therefore can create difference.

2.2.4 Logistics cost

Logistics is one the most important sources of procurement costs especially when procurement is extended to global markets (Zeng et al. 2003; Pumpe & Vallée 2015). This category includes costs that are related to activities such as inventory management, transportation and material handling (Zeng et al. 2003; Weber et al. 2010). In practice, the logistics cost is relevant always when materials are manufactured in different location compared to the place of requirement.

Mainly the logistics costs can be connected to post-transactional activities that are often on-going and occur always when transaction performed. In their case study, Platts et al. (2010) recognised that transportation costs were responsible for 6 percent share of total costs related to procurement. At the same time, the cost related to warehousing was even higher, reaching up to almost 9 percent. Similar results were also identified by Weber et al. (2010), who examined differences between procurement cost structures in TPM and LCC sourcing and by Zeng et al. (2003) who found out that total landed cost (TLC) might reach almost 30 % of finished product value.

As discussed earlier in the price section, the cost related to transportation can be partly or fully included in the purchasing price itself. This is a result of commercial terms applied in the transaction (Young et al 2009; Mangan et al. 2012: 159). Still, it is fairly common in manufacturing industries that procurement organisation takes the responsibility to organise transportation and collect the costs separately. According to Zeng et al. (2003), transportation cost includes freight charges, consolidation of deliveries, transfer fees, and pick-up and delivery costs. In addition to these, Platts et al. (2010) identify insurances as one of the elements in transportation costs, and in addition, recognise that longer transportation lead times might also result into costs that are related to the loss of sales or production downtimes related to material shortages. To decrease risks related to shortages, procurement organisation might need expedite deliveries by using faster, but more expensive transportation methods. Expediting has been identified as one of the key logistics costs by Holweig et al. (2010) and Platts et al. (2010). Platts et al. (2010) even identified transaction where expediting had resulted almost into 20% growth in additional costs related to specific purchase. In addition to previously mentioned costs, Ferrin and Plank (2002) identified a list of logistics costs related to procurement. This list contained costs related to activities such as increased demand for scheduling and risk related to unstable freight rates.

The cost of logistics, and especially transportation costs, can be seen as especially relevant for procurement decision making in international context. This is because the cost of transportation is dependent on the materials that need to be transported, distance between dispatch and delivery locations and required mode of transportation (Johnson et al. 2013; Young et al. 2009). The longer the distance is, the higher the cost will be. In addition, the weight and shape of purchased materials might influence the transportation cost. Additionally, special requirement for transportation will add their own share to the total cost. According to literature, parameters such as delivery distance and weight, have been typically used for evaluation of transportation costs (Johnson et al. 2013).

While there has been overall decreasing trend with transportation costs, it is important to understand that notable fluctuation of transportation costs can occur due to external factors such as fuel costs, taxes, custom fees and other surcharges (Alard, Bremen, Oehmen and Schneider 2010; Johnson et al. 2010; Slack and Gouvernal 2011). In addition, there might be notable differences between geographical locations of export ports and the transportations costs might be changing differently between these locations (Slack et al. 2011). Changes in these cost elements might have notable impact to total costs for procurement process, especially if organisation has emphasized sources that are located far away. Due to dynamic factors related to transportation costs, it is important that organisation would be able to trace these costs separately for each individual delivery.

In addition to transportation, also activities related to warehousing and inventory management are creating costs that are relevant for procurement process (Weber et al. 2010). For procurement decision making, these costs are especially relevant if they are different between available supply alternatives. From this perspective, inventory management costs include possible safety stocks and additional safety times that company is applying against poor supplier quality or unreliable delivery accuracy (Ferrin et al. 2002). While safety stocks increase the value of inventories in general, safety stock has impact by increasing the inventory turnover as a result of additional days that components are stored before actual requirement. In their study, Canbolat et al. (2008) identified that 25 days of additional safety stock was required when components were procured from China. The additional costs related vendor managed inventories, can also be included to the category of inventory costs (Ferrin et al. 2002).

Long transportation distances within supply chain may result into increased level of inventories, longer inventory turnover time and higher stock values. This can be related to fact that purchasers need to increase order quantities to reach EOQ, when transportation

cost is higher due to longer distance. Increased inventories, combined to longer replenishment periods, can also increase the risk of obsolescence materials (Platts et al. 2010). This is especially typical if materials have limited usage time or design is frequently updated. It is important that procurement organisation understands that all inventory cost is not dependent on the sources of supply. For example, additional inventory and obsolescence can also be a result of poor production planning or changes in production schedule. These costs should not be used for making decision between sources of supply or for supplier evaluation. Meanwhile, it is important that procurement decision makers are able to collect relevant information about those inventory costs that are different between suppliers.

Finally, also the handling of purchased materials creates costs that are categorised into cost of logistics (Zang et al. 2003). These costs are mainly related to activities such as packing, loading and goods receiving. Differences in these costs may be created between suppliers if purchased materials for example need to be packed differently due to mode of transportation or length of delivery (Young et al. 2009). Additional cost might be generated if materials need to be covered against weather or moisture. Often this kind of requirement increases the cost at both ends, dispatch and delivery, related to packing and unpacking. In some cases, packing requirements might even require use of specialised tools, equipment or protection.

The cost of material handling, especially related to goods reception, can be decreased with collaboration between the parties. For example, by using technological solutions, supplier might provide correct documentation for goods reception accurately and as a result logistics function at purchaser organisation can be performed more efficiently. One of the examples of this kind of collaboration is the advanced shipping note. Finally, also possible preparations required for materials before providing them to production, can be included to material handling costs (Platts et al. 2010). In practice this can mean that some materials need to be cleaned and washed from protective substance's before they are ready for use. Need for using this kind of protection can be a result of longer delivery distance and therefore activity is not required for local suppliers. As a result, cost of this activity can be relevant for supplier selection.

2.2.5 Supplier quality costs

While the activities related to supplier quality development and prevention of poor supplier quality were incorporated into sourcing and purchasing functions, supplier quality can also result into costs that can't be easily assigned to these functions. These costs are mainly related to failure of supplier quality and activities that are required when required level of quality is not met. According to Chen & Yang (2003), cost related to quality issues were reaching up to 30% of manufacturing costs in U.S. based industries. As a result, costs related to poor supplier quality can be a major driver to total costs related to procurement. Similarly, it has been recognised that improvements in supplier quality can lead to decrease in total costs (Larsen 1994). As a result, it is important that procurement organisations understand how investments to supplier quality might have decreasing impact to cost of supplier quality failures and, as a result, into total cost. To elaborate importance of supplier quality, Noshad & Awasthi (2015) recognised that poor performance related to any of four dimension of supplier quality: product, service, process and organisation, can lead to similar costs.

From supplier perspective, quality failure costs can be divided into two categories. Internal quality costs occur when failure is identified before materials are delivered to purchaser, while external quality costs occur when components have already reached purchaser or, the worst case, end customer. If the scope of evaluation is extended to cover whole supply chain, instead of supplier's own perspective, internal quality costs could also cover all the failures that were observed during activities performed by procurement organisation, while external costs are only created after products have been delivered to markets.

The cost resulted from those internal quality failures that occur already at supplier's own process, are often included in material prices in a form of additional overheads. On the other hand, if supplier isn't able to deliver materials on time, possible shortages in purchasers' production might result into supplier quality failure costs. Actions by procurement organisation are also needed when defect is identified during its own production operations or in incoming inspection. Related activities might include actions to secure material availability, rework and root cause analyses.

Costs related to production disruption due to poor supplier quality are one of the most important risks related to supplier quality failures. These disruptions can be either a result of suppliers' inability to deliver materials due to internal failures, or defected materials that are observed during production operations. In the worst case, these quality failures

may lead to full stop in production operations (Batson 2011). This kind of scenario might result into notable quality costs. For example, Canbolat et al. (2008) identified that one day stoppage in engine manufacturing, might have led to costs of 150 000 US dollars.

When poor supplier quality is recognised during production operations, or thus other activities within procurement process, additional actions might need to be performed by procurement organisation. As mentioned earlier, these activities might include rework of already assembled products, additional inspection of materials and inventories, and waste material handling. Due to dismantling, also other components might become obsolescent. The cost of these scrapped components should also be included into quality costs related to supplier responsible for original defect. It is also important to identify that high variability in the characteristics of purchased components might lead to inefficiency in production operations. For example, additional machine adjustment might be needed if subsequent components are not close to similar. All those costs that are resulted from poor supplier quality, should be collected and allocated to procurement costs, especially if purchasers can't claim these costs from supplier (Batson 2011).

If supplier quality defect reaches customer, the cost related to this external failure might be increased notably. The cost in this scenario might be related to recalls, rework, losses of sales and reputation. In addition, decreased customer satisfaction might decrease potential for future sales. Examples from computer and automotive industries have shown that costs related to external failures of supplier quality can lead to hundreds of millions of dollars (Moltzen 2006). According to Steven, Dong and Corsi (2014), the amount of supplier related to recalls have been increased at the same time with outsourcing of production. This observation highlights the importance of evaluating suppliers' ability to meet quality requirements and measuring costs related to supplier quality.

As suppliers might have different capabilities related to quality performance, costs related to supplier quality can be categorise as relevant costs for procurement decision making. Some of the costs related to supplier quality can also be directly assigned to specific activity, while some might have indirect characteristics. Similarly, some quality costs might be fixed as similar activity is required always when quality failure occurs. Meanwhile, scope of some activities might be changing for each case, and therefore cost element should be seen as variable. Due to range of these different activities and their characteristics, procurement organisation should be able to track each activity separately and collect related costs based on the scope of that activity.

When supplier quality costs are evaluated from procurement organisations point of view, they can be classified as both direct and indirect costs. Costs related to rework, production downtime or late deliveries resulted from poor supplier quality can be relatively easily assigned to individual supplier and purchased component. On the other hand, if poor supplier quality leads to decrease in customer satisfactory or shortened service cycles, cost allocation might be needed to allow correct emphasis based on impact.

2.3 Procurement process, financial performance and competitive advantage

As mentioned in the beginning of this chapter, companies operating in global manufacturing industries are nowadays procuring increasing amounts of materials and components from external sources. While the share of externally procured materials can vary notably between different industries, the cost of these components often represents over 50 percent of the total cost of goods sold (COGS) (van Weele 2010: 13). For example, some studies have reported that externally procured materials are responsible for up to 80 percent share of total costs (Batson 2008; van Weele 2010: 13; Montgomery et al. 2011; Fawcett et al. 2012). Typically, the share of costs related to external procurement are highest in industries such as automotive manufacturing, retail and consumer electronics. Due to increased costs related procurement process, its impact to organisations financial performance has grown importance.

While the role of purchasing activities were already emphasized by Krajlic (1983) and companies have been adding more focus on outsourcing, the strategic importance of procurement process and its impact to financial performance has still been widely underestimated in practice. This could be problematic in an environment, where organisations ability to manage spend related to procurement will have direct impact on the overall financial performance. This is especially important within industries where procurement costs create high share of total operating costs. For example, according to Degraeve, Roodhooft and Doveren (2005) and Zsidisin et al. (2003), high share of procurement costs will allow companies to pursue significant costs savings by applying correct procurement strategies, which would positively impact overall cost structure. Similar possibilities have also been recognised by Ellram, Zsidisin, Siferd & Stanly (2002), who report that purchasing and supply management (PSM) activities can play important role for organisations overall performance, and that long-term positive impact of PSM initiatives should be recognised. On the other hand, the authors emphasize that PSM initiatives can lead to both, positive

and negative, impacts for overall performance, and therefore, careful planning, evaluation and alignment with strategic objectives are required. The purpose of this section is to illustrate how procurement process impacts organisations financial performance and how procurement process should be aligned with strategic objectives.

A good way to illustrate how procurement process impacts organisations financial performance is to show the impact of procurement costs to the return on net assets (RONA). This can be described by applying DuPont analysis with different cost structures. Traditionally DuPont analysis has been used to simulate how changes in organisations cost structure or sales volume impact financial profitability. Use of DuPont analysis allows decision makers to understand relationship between costs and revenue more thoroughly. In practice, DuPont analysis helps decision makers to allocate resources more accurately so that expected results can be achieved. (van Weele 2010: 12-14).

Following three figures illustrate how different cost structures impact organisations profitability based on DuPont analyses. The first scenario is used to define baseline cost structure, which can be then compared to the two-alternative scenario. While the financial figures used in these examples are not based on real data, they should be realistic for companies operating within manufacturing industries. In practice, total revenue was set so that organisation would reach 13 percent sales margin. At the same time, the cost of procurement was defined as 75% of COGS, while other costs would present the remaining 25 percent. Based on these figures, and assumed total capital employed, the organisation would achieve 15 percent return on net assets. The cost structure is illustrated in figure 4.

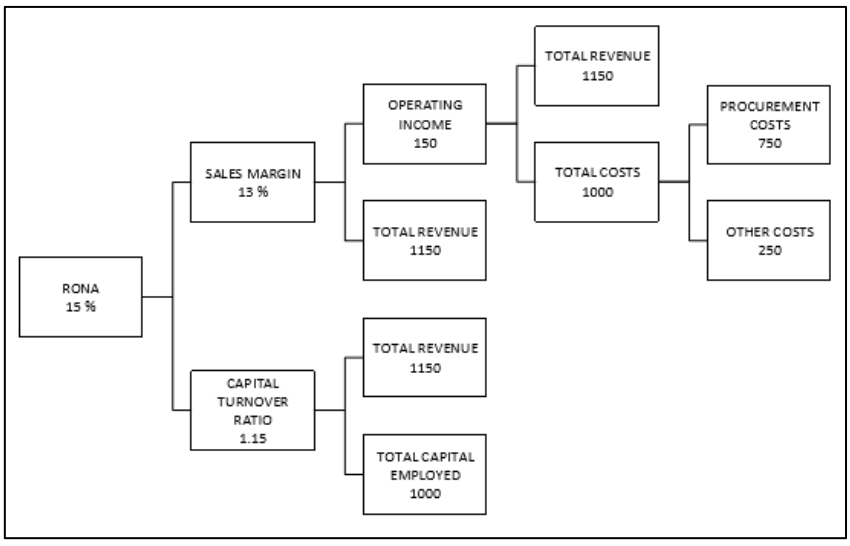


Figure 4. Example of RONA calculation based on DuPont matrix (modified from van Weele 2010: 13).

Displayed in figure 5, organisation has focused its resource into increasing revenue from sales. As a result, the amount of sales revenue has been increased with 5 percentages, while the cost structure otherwise has remained the same. Based on this assumption, also the total costs, including the procurement costs, have been increased in same proportion. As a result of efforts to increase sales revenue, the organisation is able to increase its RONA to 15.75 percent.

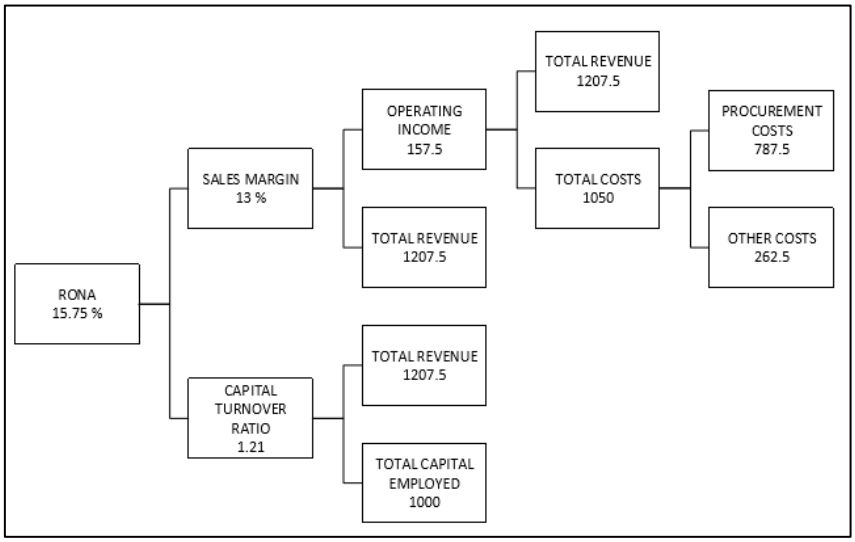


Figure 6. Alternative DuPont scenario with impact of increased total revenue (modified from van Weele 2010: 13).

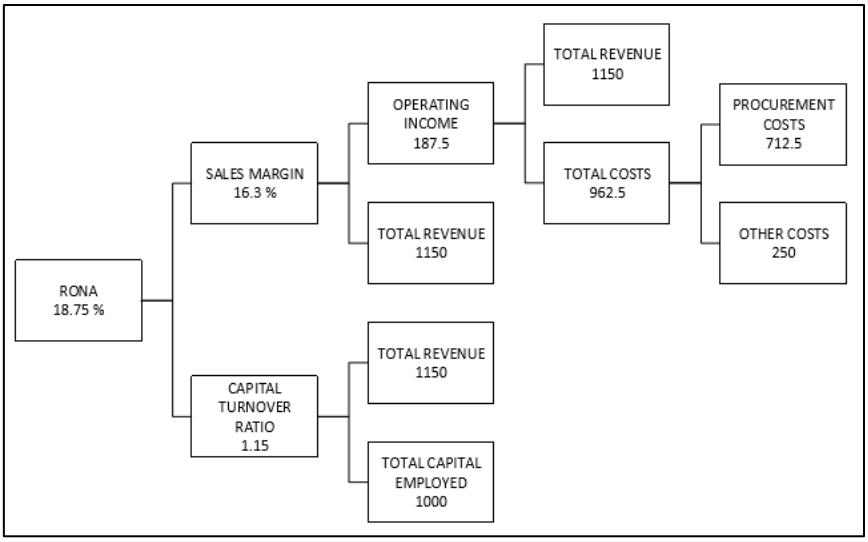


Figure 5. DuPont scenario illustrating impact of procurement cost savings (modified from van Weele 2010: 13).

Figure 6 illustrates the impact of procurement costs to RONA. In this scenario, the organisation has focused its efforts to reduce the procurement costs by five percentages, while other costs and total revenue has remained without changes. The decrease in procurement costs in this scenario has led to almost 4 percent increase in RONA, with total figure of 18.75 percent.

When the alternative cost structures presented in figures 5 and 6 are compared against each other, the impact of procurement costs to organisation financial performance can be observed. While the examples are theoretical and assume that total costs are directly related to increase of revenue, the impact and effectiveness of procurement cost changes can be understood on a theoretical level. It is also important to understand that while reduction in procurement costs offers possibility for organisation to efficiently enhance its financial performance, possible growth in procurement costs will have similar negative impacts. As a result of impact that procurement costs might have to financial performance, it is important that organisation is interested how these costs are created and aims to measure them as total.

As described in earlier sections, the procurement costs are a result of multiple cost element resulted from different activities performed during sourcing, purchasing and logistics functions. In addition, costs related to failures of supplier quality should be important contributor to total costs related to procurement. Therefore, price reductions shouldn't be considered as only alternative for improving organisation financial performance by reducing procurement costs. Instead of purchasing price, the source for cost reductions can be found from on-going cost elements, such as logistics costs or supplier quality costs.

In addition to procurement cost reductions, increased RONA can also be achieved by reducing the required amount of capital employed by operations. In the context of procurement process, this can be achieved by negotiating longer payment terms with suppliers or by reducing the level of inventories. Like mentioned earlier, payment terms are agreed with suppliers as part of sourcing function and different supply chain finance models can be applied to increase efficiency in flow of finances. Inventories, in form of buffer stocks and order quantities are highly dependent on procurement decisions. By decreasing inventories and negotiating better payment terms, procurement organisation can decrease amount of required working capital, and enhance financial performance. (van Weele 2010: 14).

The importance of procurement cost management has also been highlighted as a source of competitive advantage by Zsidisin et al. (2003). As a result of significant share of procurement costs and increased supplier impact on organisation operations, the authors also suggest that procurement organisation should have leading role in cost management efforts related to supply operations. The authors also suggest three important activities where procurement organisation should be involved in. These activities are measuring total cost of ownership, target costing and supplier cost structure evaluation. With active involvement in these activities, procurement organisation can improve its role as a strategic process and provide increased contribution to organisations financial performance.

In addition to spend management, procurement process can also improve organisations potential to generate revenue with different ways (van Weele 2010: 13). For example, close collaboration with suppliers can be extended to innovations and product development activities. Collaboration with suppliers on these activities may increase organisations potential for higher sales revenues and therefore increase financial performance. On the other hand, poor supplier collaboration and failure to integrate suppliers as part of supply chain, may led to poor supplier quality and customer satisfaction, and finally decrease organisations ability to generate profits.

While the procurement process has direct impacts to organisations financial performance, its importance as a source of competitive advantage should also be recognised. The importance of supply management activities for competitive advantage, are especially highlighted in manufacturing industries, where organisations have chosen outsourcing to enable them to concentrate on their own key competencies. As a result, suppliers are actively involved in forming overall value proposition and competitive advantage should be considered as a result of abilities of entire supply chain.

According to Rajagopal and Bernard (1993), the most suitable procurement strategy might not be the one that minimizes the total cost, but instead it is the one that is aligned with organisations strategic objectives. With a non-vertically integrated supply chain, it is important to identify that well defined external procurement strategy will strengthen organisations ability to position itself in the markets and compete against other supply chains. As a result, strategic procurement will enable organisation to achieve higher customer satisfaction, and therefore maintain its competitive position.

The development of competitive procurement strategy can be divided into three stages. In the beginning of strategy development, organisation should be able to collect information from supply markets. Based on this information, organisation needs to identify,

evaluate and select potential supply alternatives. In practice, this decision can include decisions whether to source from TPM or LCC markets, and how many suppliers should be involved. (Rajagopal et al. 1993).

As part of the second stage in development of procurement strategy, organisation should make decisions about suppliers and start to integrate them as part of supply operations. Important decisions during this stage include supplier selections, determining correct contract types, performance reviews and supplier development. Especially the importance of supplier development has been highlighted as a source of long-term competitive advantage (Li et al. 2012). (Rajagopal et al. 1993).

Finally, the procurement organisation should actively maintain and develop its procurement strategy according on changes in competitive environment. Rajagopal et al. (1993) argue that competitive advantage can be maintained by allocating resources into five key challenges that are quality, time, technology, improvements in productivity and management of risks. Also, Theodoarkioglou, Gotzamani and Tsiolvas (2006) highlight the critical importance of quality management as part of supplier management and procurement process. This is also supported by Nwankwo, Obidigbo and Ekwulugo (2002) who identified direct relationship between supplier quality and quality performance of whole supply chain. Additionally, a significant positive relationship between high purchasing competence and manufacturing performance was also noticed by Das and Narasimhan (2000), who propose that purchasing has all the potential to become strategic tool and a source for competitive advantage.

Integration of suppliers with organisations value chain, management of supplier performance and supplier development are responsibilities of procurement process. These attributes are also examples from activities that influence organisations competitive advantage and financial performance. Therefore, procurement process should be aligned with organisation strategic objectives, and its performance should be evaluated based on financial figures and its impact to organisations ability to compete in the markets.

3 TOTAL COST OF OWNERSHIP

Requirement to better understand the extensive range of cost elements related to acquisition of materials and components, has already been identified already in 1920's, when the topic of examining additional costs related to supplier selection was first discussed in managerial literature (Ellram et al. 1993). Long historical background is also supported by Cavinato (1992), who records that the idea of total costs was also approached during 1940's when procurement organisations were aiming to compare costs between two logistics alternatives, warehousing and transportation.

Although, the existence of additional procurement costs has already been acknowledged for a while by procurement decision makers, there wasn't notable academic research or development of business practices considering the use of total cost of ownership as part of procurement decision making until 1990's. For example, Ellram et al. (1993) observed that only minor progress had been done to integrate total cost concept into supplier selection and supply base management.

In the beginning of 1990's, driven by previous development towards global business and procurement environment, the academic interest towards total cost or ownership was increased. One of the most important drivers for this development, was the increased amounts of capital that organisations were spending related to activities within procurement process. At the same time, it was also recognised that organisations were lacking tools and methods to measure and analyse whole extent of costs resulted from acquisition of materials and components.

According to Ellram et al. (1993), there was a shortage of both, logical systems for measurement and data collection, as well from knowledge on relevant attributes that should be measured. Thus, TCO was proposed by Ellram et al. (1993) as general framework for analysing the full scope of procurement related costs. Similar approaches to evaluate total costs were also proposed with concepts such as total costs, life cycle costing and product life cycle costs (Ferrin et al. 2002). Other similar concepts have been introduced with titles such as zero-based pricing, total acquisition cost and transaction cost analyses (Weber et al. 2010).

Ellram has been one of the key contributors to TCO framework, especially within procurement context. As a result of her studies and multiple publications, Ellram has been involved in developing TCO concept to be used as a tool and philosophy for procurement cost management. In her articles, Ellram has focused on different TCO measurement

practices, approaches and applications. In addition, Ellram has examined the adoption and development of TCO practices, and possible barriers that procurement organisations might expect while adopting the concept. (Ellram 1993, 1995a, 1995b; Ellram et al. 1993).

According to Ellram, TCO is a tool for purchasing decision makers and a philosophy that aims to reveal all costs that are related to doing business with a specific supplier, or resulted from an acquisition of materials, components or any other purchased item from external sources. In practice, this scope aims to cover all costs from make-or-buy decision to the end of purchased components lifecycle. As a concept, TCO aims to identify the most relevant cost elements that are related to key purchases performed by the organisation. In addition to revealing sources of procurement costs, TCO approach also aims to financially quantify all the costs resulted from activities that are performed during procurement process (Morssinkhof, Wouters & Warlop 2011). This means that also activities that don't have direct cost impact, should be included in the scope of TCO measurement framework.

The scope of key purchasing activities contributing to TCO, as defined originally by Ellram et al. (1993) are displayed in figure 7. In this model, key activities are categorised into six main categories, which include management, delivery, service, communications, price and quality. The range of activities included in these categories extend from supplier management to customer relationships, and from inbound logistics process to maintenance and service operations. In addition, typical activities performed as part of procurement process are included in the model.

Other notable contributors to TCO framework have been Degreave and Roodhooft (1998, 1999a, 1999b, 2001), who have studied the use of total cost of ownership as part of strategic procurement, and in decisions such as supplier selection. Similarly, the use TCO in global sourcing decisions have been examined by Wouters, Andersson and Wynstra (2005) and Alard et al. (2014). In addition, Ferrin et al. (2002) examined how TCO models were applied in practice by procurement organisation and what cost drivers were applied in these models. Similar approach to define TCO has been adopted by all the previous authors. For example, Degreave et al. (2005) states that TCO reflects the resources that have been used while performing purchasing related activities, and that the approach aims to measure all the costs and benefits that is resulted from a relationship with a sup-

plier. Degreave et al. (2000) also emphasize that TCO quantifies all costs that are associated with procurement process throughout the organisations value chain, with a systematic and objective approach.

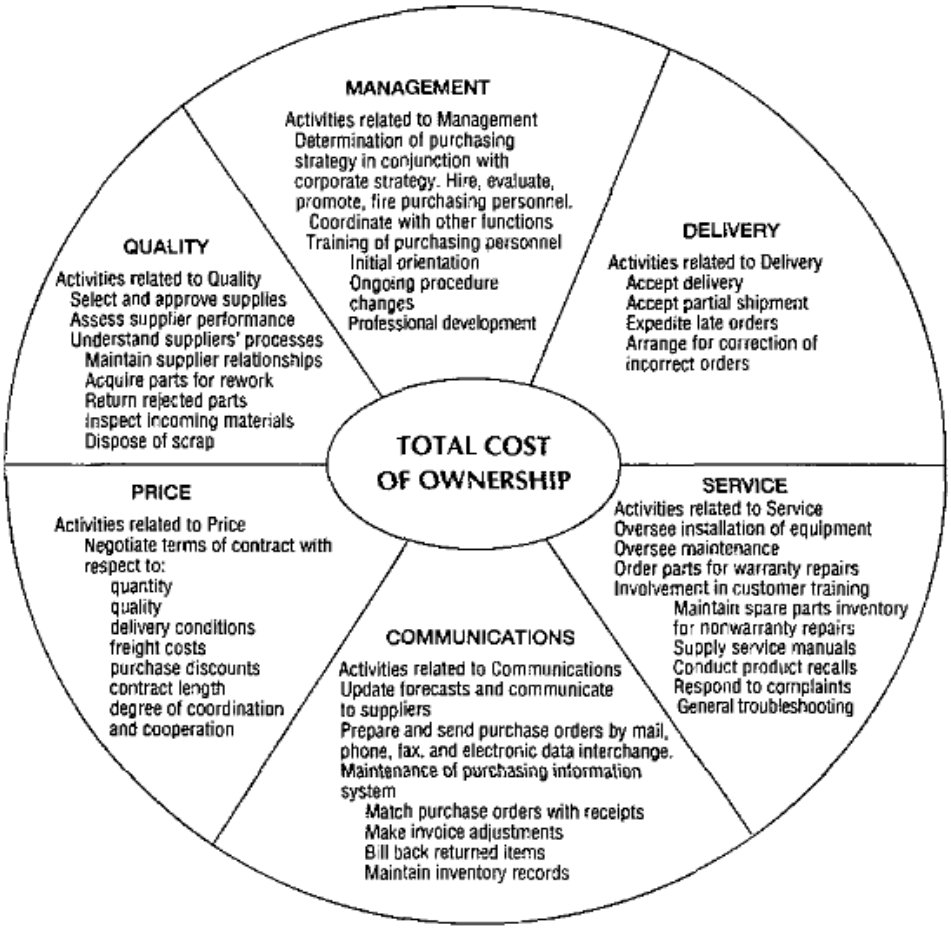


Figure 7. Purchasing activities contributing to total cost of ownership (Ellram et al. 1995).

As described earlier, two important objectives for TCO measurement should be recognised. While TCO aims to provide an efficient tool for procurement decision makers, it should also be seen as a cost management philosophy. For procurement decisions makers, TCO aims to provide long-term procurement cost information in a structured and efficient way. This enables organisations to identify true costs related to different procurement alternatives more easily, and thus helps to evaluate these scenarios against each other. In addition, TCO allows organisations to identify cost elements which are most relevant for decision making and connect them into activities that they are resulted from. From more philosophic point of view, TCO drives procurement organisations to consider the whole

cost structure related to purchases, extending the scope of evaluation beyond price and organisational boundaries. (Ellram 1993; Zsidisin et al. 2003; Wouters et al. 2005).

As a tool for evaluating procurement costs, TCO is strongly connected to the principles of activity-based costing (ABC) (Weber et al. 2010). Common objective for both these tools is to identify and allocate cost elements into smaller units, based on the activities that they are originally resulted from. While both tools share similar objectives, the TCO approach is more detailed as the cost will be categorised into smaller groups. For example, TCO aims to study costs related to individual components, suppliers and combination of these two. In addition, TCO approach expands the evaluation into inter-organisational context, while ABC is often limited to internal scope. In practice, this means that TCO is determined as a result of activities performed by the procurement organisation internally, by its supplier or by third-parties such as carriers. Therefore, all activities performed within procurement process are included, regardless of the party that was responsible for performing these activities. To extend its inter-organisational scope, TCO approach also encourages supply chain participants to actively share information related to procurement costs, and thus it promotes transparency, while also increasing the demand for trust and commitment (Zsidisin et al. 2003). In addition, it should be considered, that TCO is not limited only to costs that are directly created from activities within procurement process. In some cases, also the relationship between supply chain participants can impact the TCO. (Wouters et al. 2005).

Total cost of ownership can be applied to multiple purposes within procurement context. For example, it can be used for supply base management, as it supports decisions related to supplier selection. On the other hand, TCO practices can also be applied to supplier development as a tool to monitor supplier performance and to identify most critical development opportunities. In addition, TCO information can be applied to operative decision making within procurement process to set up most efficient replenishment strategies. The different applications for TCO in procurement context, will be discussed later in this chapter.

In addition to different TCO applications, this chapter aims to discuss about different aspects that are related to TCO measurement within procurement process. For example, key concepts, such as cost drivers, will be introduced. In addition, aspect related to adoption and establishing TCO measurement practices will be introduced and discussed. Finally, the risks and barriers related to TCO adaptation will be presented, so that similar issues can be acknowledged when the adoption of TCP practices will be considered.

3.1 Key concepts for TCO model based on ABC principles

To enable successful implementation of total cost of ownership measurement practices, couple of key concepts related to TCO needs to be first described. In the literature, TCO is often defined as an extension of activity-based costing (Weber et al. 2010). This means that TCO model can be established based on ABC principles while extending its scope into inter-organisational environment (Degraeve, Labro & Roodhooft 2000; Wouters et al. 2005). The use of ABC approach in supplier selection and evalautaion has been supported by Roodhooft and Konings (1996) and Degraeve et al. (2000) by stating that use of ABC models for supplier selections provide objective and systematic way for quantifying costs that are related to procurement process and different supply alternatives. In addition, it allows purchasing decision makers to simulate alternative scenarios and evaluate how changes in different attributes, such as cost structure or supplier performance, might affect the final amount of total costs. ABC model also allows organisations to increase their internal awareness about the activities that are required by each process (Degraeve et al. 1998). The use of ABC in procurement environment has also been studied by Askarany, Yazdifar and Askary (2010), who also identified that ABC allows organisation to identify value-adding activities, improve understanding about relationship between activities and cost, and improve overall performance and profitability.

The biggest challenge with ABC approach is that it requires large quantities of data from accounting systems, so that all relevant costs could be captured. On the other hand, while organisations are often suspicious towards development of more extensive information systems, the cost and required effort related to development of such systems are often overestimated. (Degreave et al. 1999b)

One of the core factors in TCO model based on ABC, is to identify such activities that are required when organisation makes purchases. Due to inter-organisational approach, these activities can be performed internally, by suppliers or by third-parties. A cost impact is a result of performing these activities. The objective of TCO measurement is to capture all costs that are related to these activities. Therefore, creation of TCO model based on ABC, needs to be started by defining the business process and activities included (Schulze et al. 2011).

It is important to recognise that variation of required activities might exist between different procurement scenarios. As a result, the structure of procurement costs might be different between scenarios, and therefore decision makers should be able to identify the activities that are most relevant for each decision. This creates challenge for development

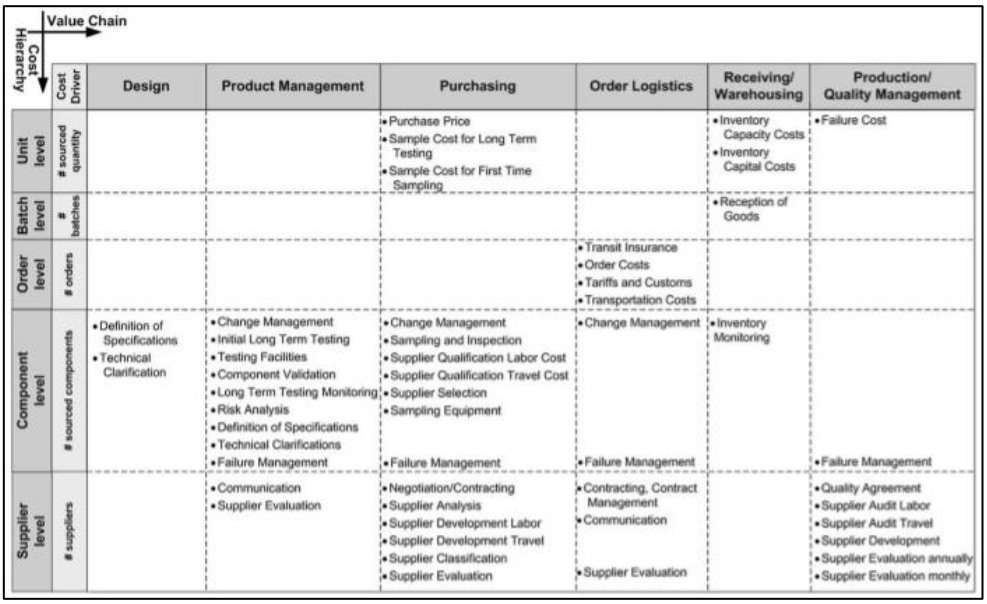
of TCO measurement practices as it might not be possible to determine standard model which would be applicable for all situations.

Another important concept for TCO measurement is cost drivers, which can be defined as factors that impact the level of each activity, and therefore have influence to its costs (Degreave et al. 1999b). Schulze et al. (2012) also highlight that cost drivers create the workload that are reflecting each activity. In total, 13 cost driver categories were identified in a study performed by Ferrin et al. (2002). Some of the categories, such as quality, logistics, initial price, supplier reliability and capability, transactions cost and inventory cost can be considered relevant when direct materials are purchased for productions operations. At the same time, categories like maintenance, operations cost and life cycle costs are more relevant when machines and equipment are purchased for long-term usage. In overall, these categories included almost 300 different cost drivers that are impacting the level of activity required by the process. Identification of relevant cost drivers is a second step in formulation TCO model based on ABC.

After the activities within procurement process and relevant cost drivers have been identified, the activities should be divided into hierarchical categories. Typical hierarchy levels used for procurement process have been unit level, batch level, order level, product level and supplier level (Degraeve et al. 2005; Weber et al. 2010). These levels describe how often specific activity is typically performed and what is the main target of that activity. For example, supplier selection activity is performed at supplier level, while goods reception can often be performed at batch level. Typically, activities within supplier or product levels don't occur regularly, while activities related to order, batch and unit levels are required every time that materials or components are purchased. (Degraeve et al. 1999b).

Hierarchical structure also allows allocation of indirect costs from higher levels of hierarchy towards unit level. For example, costs related to supplier level activities can be allocated to all components that are purchased from that supplier. Similarly, if multiple components are purchased simultaneously with same purchase order, costs that occur at order level can be distributed to those items. According to Degreave et al. (1999b), establishing hierarchical levels will be essential for model formulation as it also allows quantification of such selection criteria that have earlier been only evaluated qualitatively.

Figure 8, illustrates how procurement activities were categorised by Weber et al. (2010) based on hierarchical cost levels and stages in procurement value chain. Similar categorisation could be applied to different procurement scenarios and environments, to display the activities related to procurement process, and how often those activities occur.



Cost Hierarchy	Cost Driver	Design	Product Management	Purchasing	Order Logistics	Receiving/ Warehousing	Production/ Quality Management
Unit level	# sourced quantity			• Purchase Price • Sample Cost for Long Term Testing • Sample Cost for First Time Sampling		• Inventory Capacity Costs • Inventory Capital Costs	• Failure Cost
Batch level	# batches					• Reception of Goods	
Order level	# orders				• Transit Insurance • Order Costs • Tariffs and Customs • Transportation Costs		
Component level	# sourced components	• Definition of Specifications • Technical Clarification	• Change Management • Initial Long Term Testing • Testing Facilities • Component Validation • Long Term Testing Monitoring • Risk Analysis • Definition of Specifications • Technical Clarifications • Failure Management	• Change Management • Sampling and Inspection • Supplier Qualification Labor Cost • Supplier Qualification Travel Cost • Supplier Selection • Sampling Equipment • Failure Management	• Change Management • Failure Management	• Inventory Monitoring	• Failure Management
Supplier level	# suppliers		• Communication • Supplier Evaluation	• Negotiation/Contracting • Supplier Analysis • Supplier Development Labor • Supplier Development Travel • Supplier Classification • Supplier Evaluation	• Contracting, Contract Management • Communication • Supplier Evaluation		• Quality Agreement • Supplier Audit Labor • Supplier Audit Travel • Supplier Development • Supplier Evaluation annually • Supplier Evaluation monthly

Figure 8. TCO cost driver hierarchy and value chain matrix (Weber et al. 2010).

3.2 Use of total cost of ownership and applications in procurement environment

Many applications have been identified in the literature for total cost of ownership approach in the context of procurement process. For example, Ellram et al. (1995) propose that TCO analysis should be applied already when the organisation decides whether some activities should be outsourced or not. In practice, the authors propose that TCO analysis enables organisations to better understand the full scope of costs that are related to both alternatives, internal manufacturing or external procurement, making or buying. Importance of detailed evaluation of outsourcing costs is also highlighted by the authors, as the need for outsourcing is often explained and justified with objectives related to cost reductions. To meet these objectives, good understanding of existing state should be first established. In addition to proactive evaluation of outsourcing decisions, TCO can also be applied for ex-post evaluations that consider the decision itself (Alard et al. 2014). In

other words, the organisation should measure and follow up the cost effects that were resulted from its decision.

Generally, TCO has been identified as an effective tool to increase organisations internal awareness related to the costs that are resulted from external procurement (Ellram 1993). For example, Ellram and Siferd (1998) mention that TCO approach provides better knowledge about indirect cost elements related to procurement. In addition, also Weber et al. (2010), recognize TCO as a useful tool to analyse and measure costs resulted from the activities related to procurement in international procurement environment, while Alard et (2014) used it to categorise the cost elements based on their source functions and activities.

Additional applications for TCO, acknowledged by the literature, include recognition of improvements in supplier performance, allocation of volume between suppliers and enabling important process changes in the supply chain context. In addition, TCO can be used for collecting data for supplier negotiations, as it allows procurement organisation to quantify and present true costs related to doing business with a specific supplier. Similarly, TCO data can be used to proactively anticipate costs related to specific purchases, based on supplier performance or cost structure of similar purchases or suppliers. In other words, based on historical cost patterns and behaviour, procurement organisation should be able to evaluate how costs will be structured in similar scenarios. For continuous improvement initiatives, TCO provides information about improvement targets and allows organisation to concentrate resources to the most critical ones. Finally, TCO also increases cost transparency along the supply chain participants and procurement process. (Ellram 1995; Chen et al. 2003; Brement, Oehmen & Alard 2007, Caniato, Ronchi, Luzzini, Brivio 2015, Visani, Barbieri, Marta, Di Lascio, Raffoni, Vigo 2016).

In addition to the relatively extensive list of TCO applications that was already mentioned, TCO approach can also be utilised in the broader context of supply base management. In the framework of this thesis and its focus area, the use of TCO for supply base management is considered as one of the primary applications for the TCO approach. This means that TCO is applied as a tool for evaluating different supply alternatives and procurement scenarios, to compare suppliers against each other's, and for supplier performance evaluation and supplier development.

Supplier selection is one of the most discussed TCO applications based on the amount of coverage it has received in the literature. The requirement to apply TCO information to supplier selection decisions, was already addressed by Ellram (1995), who argued that

TCO provides an approach that considers organisations internal costs related to purchasing and recognises the impact of supplier performance instead of only focusing into the purchase price. In addition to previous aspects, the author considers TCO as a broader approach than other similar concepts, such as, lifecycle costing, zero-based pricing and cost-based supplier evaluation. For example, TCO aims to include pre-transactional and transactional costs into the evaluation, while approaches such as lifecycle costing tends to have more weight on capital costs, maintenance and disposal of an asset, which often occur in the end of lifecycle. Similarly, zero-based costing and cost-based supplier performance evaluation, are considered as more limited approaches, as they tend to investigate suppliers cost structure, instead of expanding the evaluation into inter-organisational context.

In addition to new supplier selection, Ellram (1995) also identifies that TCO data can provide important information about performance of existing suppliers, and therefore, it provides support for the continuous supply base management. By on-going evaluation of suppliers and supplier related activities, procurement organisation can focus on those aspects that have the highest potential for value creation or are responsible for highest cost impacts. Ellram (1995) also proposes that TCO based supplier evaluation provides data to assess the original supplier selection decision. In other words, procurement organisation would be able to evaluate if smaller total costs could have been achieved by selecting different procurement alternative or if the current procurement strategy should be adjusted to achieve higher efficiency. Based on Ellram (1995) it is supported that the two key applications for TCO measurement, supplier selection and supplier evaluation, should be combined into the same TCO model as these activities are closely related and potential synergies can be achieved.

The use of TCO for supplier selection has also been studied by Degraeve et al. (1999a & 1999b). By applying a TCO approach based on information about price, quality, reliability, delivery terms, service and supplier location, the authors aimed to developed efficient model for supplier selection. This model was used for supplier selection decision, with multiple supply alternatives and volume allocation between multiple sources. By implementing the model that was developed by the authors, the case company would be able to determine more efficient supply base and volume allocation for a specific material category. In practice, by applying the model, total procurement costs were decreased with 10 percentages, in comparison to existing cost. Based on the impact of procurement costs to organisations total profitability, illustrated with DuPont –model, similar impact to RONA would have required notable increase in sales volume.

Similar cost saving potential was also proven in a later study by Degreave et al. (2005). This study defined a company-wide management information system, which was developed so that organisation would be more capable to determine efficient procurement strategies. Instead of applying the model into one individual product category, as was done earlier, the authors defined TCO matrix, which would include relevant cost elements from multiple different product groups. As a part of the study, the authors defined most important cost elements for each group and specified actions that would lead to more efficient procurement policy. As a result of the model, a cost saving potential from 6 to 16 percentages, was identified for the total costs related to each of the groups. Degraeve et al. (2000) also performed an evaluation of different supplier selection methods based on TCO, these findings will be evaluated closer in next chapter.

Supplier selection related TCO studies were also conducted by Song et al. (2007) and Platts et al. (2010), who studied the total costs related to sourcing from China instead from local suppliers. In these studies, the authors applied terms of total acquisition cost (TAC) and total cost of sourcing (TCS), while referring to similar approach than TCO. In these studies, the authors were able to identify different cost elements related to international procurement and evaluate their importance. For example, while the quoted price from Chinese supplier could be lower, additional 50% extra cost increase should be anticipated to cover add-on costs. The study also illustrated, that the companies often underestimate the amount of add-on cost with almost half. Another important finding was that sourcing from Chinese markets increases the volatility related to procurement costs. For example, the currency fluctuations might be one of the key elements that finally determine whether the supplier selection decision has been successful for cost reduction purposes.

In addition to previous examples, TCO based supplier selection has also been studied by other authors. For example, Smytka et al. (1993) studied how total cost supplier selection model was developed in a large manufacturing organisation. In this model, risk factors, business needs and measurable cost factors were incorporated in a way that would lead to balanced approach between quantitative and qualitative elements. As one of the key objectives for model development, the authors mention balance between accuracy and simplicity.

Bhutta and Huq (2002) compared TCO approach against the analytical hierarchy process for supplier selection. While the authors identified benefits, such as flexibility and ease of adoption with both approaches, the AHP was evaluated to be more robust with quantitative and qualitative criteria. On the other hand, consistency and supplier performance

measurement were identified as TCO benefits. Modern TCO approach for supplier selection has been introduced by Kanagaraj, Ponnambalam and Jawahar (2016), who created mathematical evaluation method based on hybrid algorithms and concentrating to reliability and costs related to purchased materials.

Finally, TCO approach can also be applied to improve and evaluate organisations internal processes. With the information related to different cost factors and their relationships, purchasing organisation should be able to evaluate different process alternatives against each other, based on their cost impact. In practice, this would mean optimization of order quantities and replenishment lead times. As mentioned by Cavinato (1992), the trade-off cost between inventory carrying costs and logistics costs, was one of the early applications for TCO measurements. In addition, TCO helps procurement organisation to identify non-value adding processes and activities that are performed as part of procurement process. For example, the added value created by actions such as purchasing volume forecasting can be challenged, if it doesn't lead to decreased lead-times and higher delivery performance.

3.3 Adaption and development of total cost of ownership models

While only limited amount of research is available on how to adapt and develop total cost of ownership models for procurement purposes, some of the key studies have identified aspects that should be considered when measurement practices and systems are established. While these studies don't provide universal solution on how the model should be created, multiple authors have identified key factors and characteristics that might influence the validity and applicability of TCO model. The purpose of this section is to discuss about these factors and characteristics, while also introducing couple of key steps that should be followed when TCO measurement practices are implemented in an organisation.

As described earlier in this chapter, TCO measurement models have often been established according to the principles of ABC costing (Ellram 1995a, Degraeve et al. 199b, Wouters et al. 2005, Weber et al. 2010). Therefore, development of TCO models should follow similar practices than with ABC. According to Degraeve et al. (1999a), first step in TCO model development is to identify all activities that are performed as part of procurement process. In practice, this requires that all functions that are taking part in procurement process are involved in process mapping, so that all possible activities can be

considered. Restrictions to the processes should be based on the objectives that have been given for the TCO measurement practices. For example, the framework used in this thesis, will limit product design, research and development activities out of the model, because output from these activities shouldn't create variation to the requirements that are requested from potential suppliers and therefore aren't relevant to supplier selection and performance evaluation processes.

When an activity is performed as part of procurement process, either direct or indirect costs are usually generated. To ensure validity of measurement model, it is important that costs are connected to activity that is responsible for the cost. According to Degraeve (1999a), second step for model development is to identify cost drivers, which are impacting the cost of each activity. Like with activities, also cost drivers should be accurately determined and in accordance with TCO measurement objectives. While correctly defined cost drivers help managers to target attention to biggest challenges, incorrect cost drivers might lead to unwanted behavioural response as managers are measured against factors that they can't really influence (Ferrin et al. 2002). Ferrin et al. (2002) also suggest that modular approach to cost drivers should be applied when TCO models are used for different measurement purposes. In other words, TCO model would include set of core drivers that are applied for each scenario. In addition to core drivers, model would also include set of modular drivers that can be added based on specific needs. While this can be considered as an efficient approach, it is important to notice that similar set of cost drivers need to be applied for each procurement alternative that are compared against each other. As a result, modular cost drivers could for example be applied for each item category, so that all items in that group would have similar cost drivers.

The third step in the creation of ABC based TCO model is to determine hierarchical cost categories (Degraeve et al. 1999b). These categories describe the level where specific activities are performed, and costs are generated. Three categories defined by the authors include supplier, order and unit levels. In a later study, Degraeve et al. (2005) also identified product level and batch level costs as additional hierarchical levels. Similar categorisation was also used by Weber et al. (2010). As described earlier, correct cost categories are crucial for the validity and functionality of TCO model as the allow organisation to allocate costs that are occurring on higher levels of hierarchy towards each individual component that are purchased. For example, costs from supplier level can be allocated to each component that are purchased from that supplier, product cost can be allocated to each unit that is purchased.

According to Degraeve et al. (2000) one of the challenges in TCO model development, is to identify correct balance between different hierarchical cost categories. As part of their comparison of single item and multi-item supplier selection TCO models, the authors identified that models frequently either overestimated or underestimated importance of specific cost categories. For example, it was typical for mathematical multi-item models to underestimate the impact of costs occurring at supplier level. At the same time, single item models tend to overestimate costs at supplier and unit level, while underestimating order level costs. This was especially common for models that didn't include inventory management. Based on these findings, special attention should be given to cost category determination when TCO models are established.

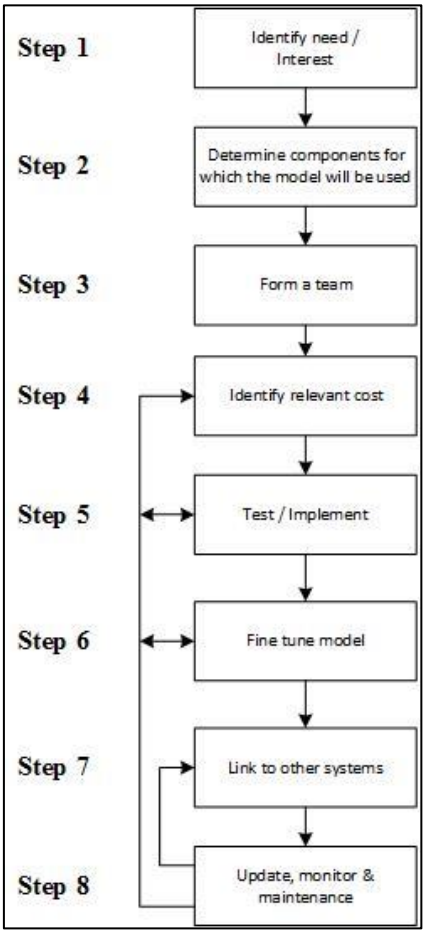


Figure 9. TCO adoption model defined by Ellram (1993).

Similar framework for TCO model development was also introduced already by Ellram (1993). While this framework also included steps listed by Degraeve et al. (1999b), Ellram focused more on overall process of developing TCO model. Eight stages identified by Ellram are presented in figure 9. The strength in Ellram's model is that it provides

comprehensive description of actions that are required for successful model development, instead of concentrating only on technical aspects. In addition, the model also recognises that TCO model needs to be adjustable and dynamic, so that different aspects and attributes can be changed over time.

According to Ellram (1993), first stage in TCO model development is to identify the interest towards total costs measurement. This interest might become from external or internal sources. While internal interest might be related to strategic objectives, external pressure might be initiated from quality programs or standards. While the source for original interest might vary, the authors state that they shared common target to achieve better understanding about procurement costs. Related to the first stage, Ellram (1995) also proposes that most important aspect in developing TCO practices is to plan the process, define where TCO should be applied and focus into those benefits that organisation would like to achieve.

As part of the second stage, target group for TCO model will be determined. This means that model can focus on specific procurement scenario, or to most important purchase categories, while leaving less important items outside of the scope. By determining specific group of interest, more accurate TCO model can be developed without using resources to items that are less relevant for measurement. Additionally, separate TCO models can be established for different procurement categories, such as direct and indirect, if the characteristics between these groups differ notably.

While Ellram (1993) suggest that team for TCO model development is established in stage three, it is important to notice that correlation between stages two and three can occur. For example, if team members are specialised in specific purchase item category, this category might be over evaluated, when limitations for model are determined. On the other hand, after proper interest group has been defined, there is no use to reserve time from team members that are not relevant for that area of interest. In practice this could mean that preliminary team is formed between first and second stage. This team will the participate in the second stage and determine correct interest group. After the second step, composition of the team can be adjusted, so that team members correspond the need. For the selection of team members, the authors suggest that wide range of expertise should be involved as procurement costs are not only generated by functions that are directly taking part in procurement process. In practice this means that team should have participants from functions such as purchasing, sourcing, logistics, quality, engineering, accounting and manufacturing.

Stage four in Ellram's (1993) model is similar to the steps recognised also by Degraeve (1999b). In this stage, relevant costs for procurement process needs to be identified. This can be done by mapping the procurement process and identifying all the activities that generate costs. Due to potentially large list of different cost sources that can be generated from procurement process, the author suggests that only the most critical ones will be included in the model, so that model will remain easy to manage. While the author refers to the Pareto principle and claims that 20% of cost sources are responsible for 80% of total costs, it is also important to notice that while some costs might be important due to large share in overall value of certain component, they might not be relevant for all decisions, because there is no cost variation between different alternatives.

After the relevant cost information has been identified, proper data collection methods need to be determined and established. Proper cost data can be found for example from existing management account systems, enterprise resource planning (ERP) tool or quality management records. Alternatively, some new data sources and records might need to be established as relevant information has not been earlier collected. Information relevancy can be re-evaluated if information isn't easily collectable or other uncertainty, for example towards data validity, exists. When the sources for all relevant information has been identified and new information sources established, proper documentation needs to be recorded. This enables later maintenance and traceability of measurement system. (Ellram 1993).

During the stage five, TCO model will be tested and implemented. As part of testing, cost information is provided to the measurement system, with possible equations used to allocate costs based on cost drivers and between hierarchies. After the TCO model has been implemented, it can be adjusted and fine-tuned as part of the sixth stage. In other words, results provided by the model need to be analysed and verified so that data validity can be proven. If the results provided by the model don't seem valid, source data and cost allocation might need to be corrected. It is also important to notice, that return to the fourth stage might be needed to evaluate relevancy of certain costs that have either been include or excluded from the original model. (Ellram 1993).

The seventh stage in the development process links the model into other management systems, such as supplier relationship management (SRM) systems, training and education programs and ERP system. Integrations between different systems and TCO model is an important element in model development as the availability of cost data has often been recognised as one of the key barriers in TCO implementation. In addition, easy access to source data can also make the model easier to use and understand. The last and

eight stage in the TCO model development process includes continuous monitoring, maintenance and updating of the model. (Ellram 1993).

In addition to proposed development process, Ellram (1993) emphasizes the importance of top management support for TCO model development. This is especially important as TCO drives and enables new approach to analysing efficiency and effectiveness of procurement process. This means that focus is transferred from purchasing price towards whole extend of costs that are generated from procurement activities. In practice, procurement decision will be evaluated against different criteria in the future, and therefore different aspects need to be considered in decision making.

Structured approach to TCO model development is also recommended by Wouters et al. (2005). In other words, the authors propose that mandatory steps need to be followed in specific order to ensure that TCO adoption will be successful. While the authors also highlight importance of top management support, they also emphasize that organisations strategy should be aligned with value-based purchasing. When the procurement process is already oriented with total costs way of thinking, the support for developing TCO measurement practices can also be received from top management. In addition, when strategic alignment and top management support has been secured, TCO development and implementation activities can be performed more easily.

Wouters et al. (2005) also highlight the important role of data validity for TCO model. According to the authors, the use of TCO model is dependent on the adequacy of data that it provides. In other words, a key success factor for TCO model development is to ensure that data used as an inputs and outputs is correct. It is also suggested that data validity can be enhanced when TCO information is applied for performance evaluations and reviews, which encourages to employees to generate valid cost data.

While identifying previously mentioned key aspects in TCO model development, the authors suggest that most important step for successful TCO adoption is a value analysis experience. This means organisations previous experience and routine to quantify costs that are related to procurement process. According to the study, earlier experience on cost-based procurement analysis increases the success of TCO adoption by enhancing the quality of data used as an input, and therefore, also reflecting to validity of output information. (Wouters et al. 2005).

While earlier experience on value analysis has positive impact to data validity, it also improves availability of cost information. This is a result from demand for cost information which, for its part, encourages organisation to generate relevant cost information

for decision making and analyses purposes. While emphasizing value analysis experience to enhance availability and quality of data, the authors also remind that before TCO information can be used for performance evaluation, and with suppliers, the reliability of output information needs to be validated in practice. This requirement is closely related to earlier observation of positive relationship between data adequacy and use of TCO measurement system.

In addition to the critical steps in TCO model development, couple of key characteristics must be determined when TCO model is established. For example, if the model should be dollar or value based. Alternatively, also rating systems have been used to commensurate cost elements into comparative scales. In addition, TCO model can be developed to meet the requirements of one specific procurement scenario, or with a generic approach that would allow organisation to apply TCO model to different procurement scenarios with minor adjustments. Also, TCO models can be targeted to evaluate either multiple items at the same time or only single item at once.

Degraeve et al. (2000) performed an evaluation of different TCO based supplier selection methods to compare their ability to capture costs related to whole procurement process. As a result of their study, the authors found out that models that combine multiple items at the same time, tend to provide more reliable information when compared to single-item models. This is a result of ability to evaluate possible dependencies between item categories. For example, order level cost for each item could be reduced, if multiple items can be combined into same deliveries. Similarly, suppliers might be able to provide discounts based on total volume of sales, instead of bidding on single components.

Furthermore, multi-item models allow organisation to incorporate cost of inventory management into supplier selection decision. This, on the other hand, enables organisation to evaluate trade-offs between different activities and their cost impacts. For example, trade-off between the cost of holding inventory or increasing order frequency.

Accurate information about this type of dependency can be important especially when materials can’t be held in inventory for a long time and frequent replenishments are therefore required. When costs at order level occur more frequently, TCO model should be able to capture differences between suppliers that can provide efficient order processing and those that can’t. For example, significant reductions at order level can be achieved if supplier with EDI capabilities can be selected. Similar trade-off between order and inventory management costs should be evaluated if supplier offers quantity discounts when larger batches would be delivered at once. While this would decrease order level costs

and component price, the cost impact of holding inventory would need to be accurately evaluated. By describing this type of dependencies, TCO model can provide important information for decision makers that are weighing between alternatives. (Degraeve et al. 2000).

One of the key aspects for TCO model development, is to decide whether the model will be based on monetary figures, perceived value or performance ratings. Some of the models might also combine these elements. To support TCO models based on monetary figures or perceived value, Degraeve et al. (2000) identified that dollar or value based TCO approaches outperform rating models by enabling more objective vendor selection. This can be achieved, because models based on monetary figures or perceived value aim to capture real cost impact without any weighs or factors determined by the model developer or decision makers. On the other hand, cost elements without direct financial figure could be more easily included in rating based TCO models.

Monetary quantification and its impact to purchasing decisions was also investigated by Morssinkhof et al. (2011). In their study, the authors analysed how purchasing decision makers value quantifiable information provided by the TCO analyses, in comparison to information that was intentionally left outside of TCO measurement model. As a result, the authors recognised that the appreciation of TCO information was related to the experience of decision makers, and that more experienced decision makers were focusing more on information provided by the TCO analyse. On the other hand, while focusing on TCO data, these decision makers were simultaneously prompting to devaluate attributes that were not included in the model and didn't recognise possible defects in the model.

Based on their study, Morssinkhof et al. (2011) provide valuable insight to factors that should be considered when TCO measurement practices are developed and implemented. For example, while quantifiable financial information can be efficiently used to support decision making, it might lead to situation where decision makers don't consider enough the importance of non-financial attributes that were not included in the model. To reduce the risk of decisions based on incomplete information, the authors propose that non-quantifiable factors should also be made visible in the measurement model, so that they wouldn't be fully ignored. In addition, it is recommended that decision makers are regularly reminded about all the factors that should be included in the decisions.

Useful approach for TCO model development was introduced by Alard et al. (2010) in their TCO study related to global sourcing processes. In their study, the authors identified that TCO model can be used for supplier evaluation or more extensively to procurement

market evaluation. While the supplier evaluation concentrates on supplier specific information and mainly microeconomic factors, the international procurement market evaluation includes macroeconomic cost factors that are not dependent from individual supplier but are similar for suppliers from same geographical region. By understanding, that procurement costs can be divided into supplier and region-specific cost elements, usage applications for TCO model can be extended. For example, by evaluating the typical region-specific procurement cost structure for LCC supplier, total cost structure for similar supply alternatives can be more accurately evaluated before supplier selection. In addition, alternative procurement markets can be compared in a more general fashion, based on macroeconomic cost information.

When TCO information is used for supplier management purposes, the possible effects to buyer-supplier relationship need to be acknowledged when model is developed and adopted into use. In their case study, Zachariassen and Arlbjørn (2011) examined how TCO adoption might impact relationship between supplier and buyer in an inter-organisational context. As a key finding, the authors propose that there is no universal TCO model that can be used with all suppliers, instead differentiated models need to be developed based on different type of supplier relationships. For example, when the same TCO model was implemented in different supplier relationship types, the authors found that adoption had different impacts to supplier relationship dimensions such as communication, perceived relationship risk and trust and commitment.

Based on the study, while some supplier felt that use of TCO information improved communication, enabled learning and helped in negotiations, the others thought that TCO data caused unnecessary discussions and made communication harder. Similarly, relationship risk was decreased in some relationship as a result more accurate and transparent cost data. At the same time, some of the relationships were suffering because there was no common conception of cost information and use of TCO data was already initially perceived negatively. Positive or negative developments on previously mentioned dimensions also impacted the trust and commitment between buyer and supplier. While decrease of trust was related to the unnecessary cost negotiations and experience of being manipulated, trust in some relationships was increased as a result of improved decision making and ability to align goals and objectives. Because TCO adaption can have very different impacts based on supplier relationships, these factors are important to acknowledge when model is developed, and especially implemented as an inter-organisational tool to be used together with suppliers. (Zachariassen et al. 2011).

Finally, Degraeve et al. (2000) highlight that there is no direct relationship between efficiency of TCO model and number of suppliers. In other words, optimal cost structure can be achieved by using different numbers of suppliers for each item or category. Therefore, TCO models shouldn't fundamentally assume that a fixed number of suppliers should be predetermined to achieve the most optimal cost structure for certain procurement scenario.

The purpose of this section was to introduce approaches and important factors for TCO model development, implementation and adaption. This information will be utilised when considerations will be given for TCP model adoption in empirical part of this thesis. In addition, this information will be especially important if TCP measurement practices will be implemented in practice.

3.4 Risks and barriers in total cost of ownership adaption

As described earlier, TCO measurement practices can enhance decision making in procurement process and increase its overall performance, while leading to improved financial performance. Although these benefits, and a need to understand total costs related to procurement process, have already been existing for some time, many organisations have not been able to establish proper measurement practices and model frameworks. In literature, multiple barriers and risks related to TCO adaption, model development and implementation have been identified. These barriers and risks can be related to multiple different factors, such as model development, data availability and validity, and the use of TCO information. The purpose of this chapter is to introduce some of the key barriers and risks to TCO adoption and implementation. Awareness of these factors will be important so that they can be acknowledged when measurement model will be considered in the empirical part of the thesis.

According to Ellram (1993), key barriers for TCO implementation include shortage of available data, corporate culture and end user training. In the study conducted by the author, availability of required procurement cost information was identified as a biggest single issue related to TCO model adoption. More accurately, most of the organisations were struggling with data collection from accounting systems and most of the information needed to be collected manually. In addition, while some of the data was available from the systems, there was a lack of needed metadata that would, for example, describe the source of the cost.

While the accounting and ERP systems currently generate and record procurement related data more accurately, data availability and ease of accessibility might still be an issue for many organisations. This issue might be related to the complexity of accounting systems and simultaneous use of multiple different recording tools. When the data is stored in different systems and generated in different stages of procurement process, it might be hard to track specific cost and allocate it to correct source activity.

In addition to challenges related to data systems, Ellram (1993) highlights that complexity of TCO measurement systems and new approach for performance measurement within procurement process, requires emphasis on training and user support. In practice, the authors suggest that end users need to be trained how to utilise TCO information and what are the objectives driving the new way of working. It is especially important that possible resistance against the new TCO approach is acknowledged, when training and communication is planned. The resistance might occur because TCO implementation also aims to develop the way how organisation understands costs related to procurement, and therefore might impact previous and existing priorities and ambitions.

Similar barriers for TCO adaption have also been identified by other authors. For example, Bhutta et al. (2002) recognised that four major barriers related to adoption of TCO approach. These include overall difficulty and complexity of the approach, lack of standardized model and need for cultural change. In addition, the authors highlighted that differentiated model might often be needed for separate procurement scenarios, and therefore multiple versions for TCO measurement would need to be established.

In their review, Ferrin et al. (2002) also identified some key problems related to TCO adoption. For example, there might be issues caused by limited availability of data or incorrect type of information. In other words, some of the required data might not be collected at all, while some data could be available, but not in an accessible or utilizable form. In addition, the authors also acknowledge the managerial risks related to utilization of TCO information, when different stakeholders might interpret TCO from different perspectives.

In addition, the authors have found out that accurate TCO measurements and models might be hard to comprehend. For example, many organisations don’t really understand how TCO measurements should be performed and how the information provided by the system could be utilised efficiently. The authors also recognise that it is important to make clear distinction between direct and indirect costs, when TCO measurement practices are established. This is because some managers still assume that direct and indirect costs are

connected to each other. In other words, lower indirect costs are often expected as a result of decrease in direct costs. As described in the cost section, such dependency between direct and indirect costs doesn't really exist and indirect costs might be increased when lower purchasing price is pursued. While poor, or even false, awareness of relationships between different costs types should be acknowledged as a risk, TCO is also an efficient tool to increase organisational awareness of such dependencies. (Ferrin et al. 2002).

When total cost of ownership is measured in an inter-organisational context, also possible risks between different organisations and their mutual relationships should be evaluated. This is especially important if TCO information is directly shared towards suppliers or other supply chain partners as part of collaborative initiatives or agreement negotiations. Zachariassen et al. (2011), found out that TCO information can be interpreted very differently by different suppliers. For example, some suppliers were not pleased to receive such information as part of negotiations and felt that unnecessary burden was created between the parties.

Risk related to TCO data validity was mentioned in a study by Wouters et al. (2005). In their study, the authors reported that adequacy of TCO information was one of the key success criteria for TCO adoption. Therefore, poor quality of data should be considered as one of the major risks related to TCO measurement practices. As a result of poor data, the TCO analyses can provide misleading information that will propose incorrect actions to decisions makers. Poor data quality also reduces the applicability of TCO measurement practices and therefore decreases level of potential. In addition, if the decision makers need to manually validate or revise results of TCO analyses, resistance for implementation will probably occur.

Issues related to data quality and objectivity need to be especially addressed if TCO measurement is based on weighted attributes, instead of capturing costs directly. Requirement for thorough evaluation is specifically related to factors associated for each cost object. For example, in some models, costs related to quality or transportation might be over-represented, while some other costs are not considered at all. Risk related to incorrect attribute weights can be especially relevant if initiative for TCO model and measurement is originated from specific event or department.

The barriers and risks identified during this chapter, provide good insight to challenges that organisation needs to recognize when TCO is adapted. For example, availability and complexity of required procurement data should be evaluated already beforehand, so that possible limitations could be considered in the model development and data availability

could be enhanced in the early phases. Also, the issues related to poor quality of data should be addressed proactively, so that incorrect data wouldn't cause any issues during the implementation and therefore reduce efficiency of the tool.

Risks related to organisational culture and inter-organisational dimensions of TCO adaption, should also be proactively addressed. Potential issues related to TCO adoption, can be reduced for example by proactively communicating about the objectives and goals of new measurement practices. Open and transparent processing of procurement data could also improve reliability and decrease the amount of resistance. For inter-organisational adaption of TCO measurement practices as part of supplier collaboration, it could be especially necessary to explain how TCO information will be used and for what purposes. For example, if TCO data is used for supplier evaluation and development, would it also have some impacts to negotiations between the parties.

The objective of this chapter was to introduce and establish theoretical framework for total cost of ownership. This has been achieved by providing insight to historical development of TCO, and how the requirement to understand full range of procurement costs has already been present in managerial decision making and academic interests for a while. During the chapter, TCO was introduced as an inter-organisational application of activity-based costing. Due to this approach, key concepts for ABC based TCO measurement were explained.

Different TCO applications, identified mainly by academics and in literature, were also presented. Primary focus was targeted to those applications, which could be used as part of procurement process and procurement decision making. After introducing these applications, important aspects for TCO adoption were discussed. The purpose for this discussion was to identify important factors that organisations should consider when they adopt TCO measurement practices. Finally, the chapter was closed with a section related to existing barriers and risks related to TCO adoption.

The information presented in this chapter will be utilized in the following parts of the thesis. First, it allows to define concept for total cost of procurement. In addition, it provides support for the TCP model considerations, which will be provided based on the inputs gathered during empirical research.

4 TOTAL COST OF PROCUREMENT

The objective of this chapter is to introduce the concept for total cost of procurement as a tailored application of total cost of ownership. This will be done by combining the two theoretical frameworks, procurement and total cost of ownership, that were introduced during the previous chapters. In other words, the concept of TCO will be applied into procurement process, so that it enhances procurement decision making in a specific procurement environment and is aligned with organisations procurement strategy. Special focus is given to those activities within procurement process, that may lead to different TCP structures and impact decision making between potential supply alternatives.

This chapter is divided into two sections. First, the need for specific procurement related TCO application will be discussed and explained. As part of this discussion, also the relationship between TCO and TCP will be considered. In the second section, key presumption related to TCP approach will be introduced. These presumptions are set to enable more efficient use of the model and categorisation of possible procurement costs.

4.1 Total cost of procurement concept

Total cost of procurement is a limited application of total cost of ownership approach based on activity-based costing. TCP is focused on those activities that are included in the scope of procurement process, and costs that are affected by the decisions made by the procurement organisation. In other words, scope of evaluation starts from the identified requirement for externally procured materials and components and ends when these materials or components have been successfully delivered and are available for production operations. In the context of this thesis, TCP also focuses only on direct materials, instead of other types of purchases, such as indirect materials or services. The relationship between TCO and TCP approaches is illustrated in figure 10.

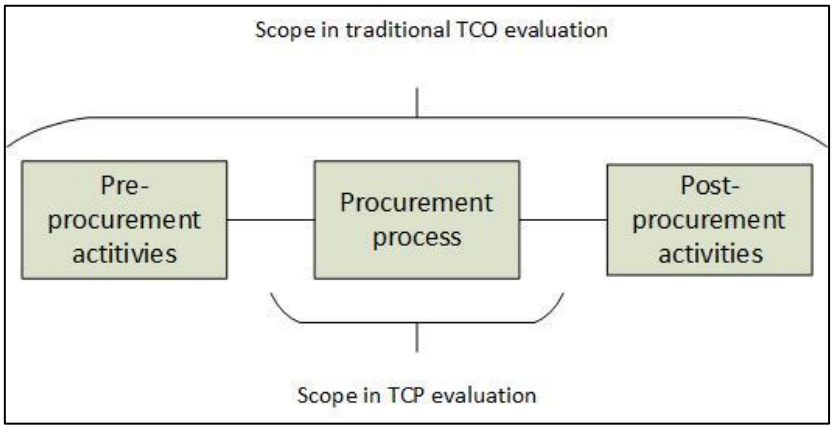


Figure 10. Total cost of procurement in contrast to total cost of ownership

Pre-procurement activities that are excluded from TCP evaluation include factors such as design and product management. From TCP point of view, specifications and requirements for purchased components are considered as predefined characteristics that are resulted from technological requirements and features requested from final product and customer needs. While all the activities that occur before procurement process are excluded from the model, it is acknowledged that procurement decision makers might have interests towards these decisions to ensure that procurement process can be performed efficiently. For example, sourcing function might want to ensure that component design wouldn't be a limitation to available supply alternatives.

Although procurement decision makers might have interest towards design phase, these factors are not included in the TCP scope because it is assumed that all the available supply alternatives should conform to the same requirements and specifications. This assumption is based on main objectives for TCP evaluation, which are related to supplier selection and supplier evaluation in an environment where product design is property of procurement organisation, and therefore all supply alternatives must follow same requirements. In this context, TCP helps with supplier selection when the differences between supply alternatives are mainly a result of supplier performance, capabilities and geographical factors, instead of notably different offerings. In a procurement scenario where suppliers can provide differentiated offerings, TCP evaluation could still be done by excluding price component or by adjusting the price impact accordingly. Another alternative would be to evaluate potential increase of value that can be achieved by selecting one alternative from differentiating offerings.

In addition to the pre-procurement activities, also the post-procurement activities and cost elements are excluded from the scope of TCP evaluation. According to traditional TCO

approach, these activities could for example include marketing, outbound logistics, warranty costs and end of lifecycle costs. Due to TCP focus on direct materials procured for manufacturing purposes, factors such as marketing and outbound logistics can be excluded as both activities are mainly related to the final product, instead of its components and their suppliers. While the component and supplier quality might affect final product lifecycle and warranty costs, it is assumed that these costs are mainly related to design and requirements defined by the purchaser organisation. If supplier would fail to meet these requirements with impact to lifecycle or warranty costs, these costs should be allocated to procurement quality management costs and supplier nonconformity costs.

Figure 11 illustrates traditional activities within TCO scope based on the model used by Weber et al. (2010). In the figure, activities that are separated with dashed line are included in the TCP evaluation scope. In other words, functions and activities such as sourcing and purchasing, inbound logistics, receiving, warehousing and quality management form the basic core of procurement process.

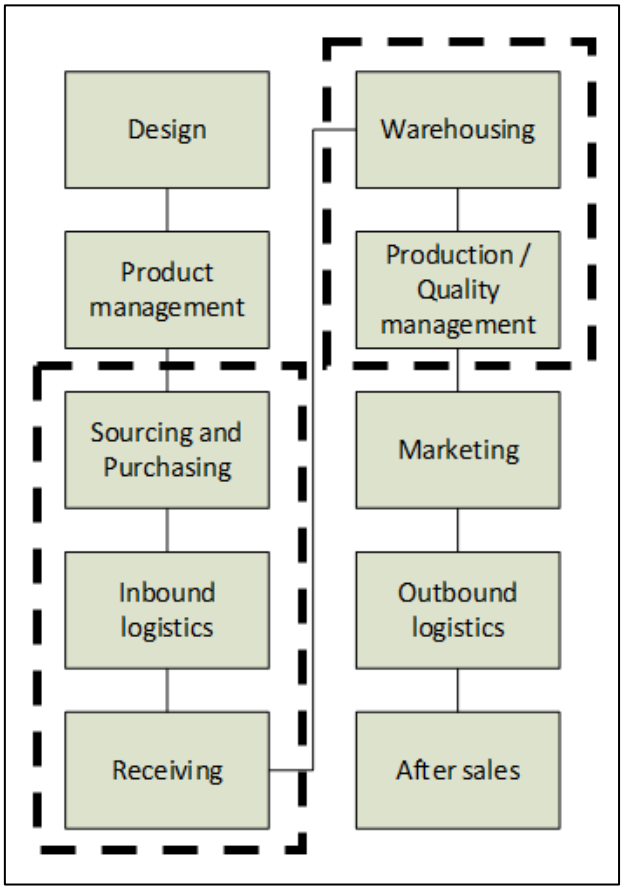


Figure 11. Activities in traditional TCO scope and TCP scope of evaluation (model adopted from Weber et al. 2010)

4.2 Main objectives for total cost of procurement

Two main objectives for TCP approach can be determined. These are proactive evaluation between supply alternatives and reactive and on-going supplier performance monitoring based on the supplier specific cost development. The first objective aims to provide support especially at the early phases of procurement process where potential suppliers are mapped and evaluated against each other. By utilising the available TCP information in this scenario, organisation could identify typical cost structures for similar kind of components and supply alternatives. For example, if the cost of component sourced from low-cost supply markets typically includes certain percentage of additional cost on top of price, similar percentage could be expected also from the forthcoming purchases. Additionally, the TCP information should also provide support when organisation evaluates whether a new supplier is needed or should the resources we put to developing existing supply base.

The second objective, at the same time, aims to provide information about component and supplier related cost development over time. While the development could be related to more general issues such as development of global markets and trade legislation, the cost elements related to supplier performance and capabilities, should indicate supplier performance quite accurately. By following this kind of development, procurement organisation can identify possible development opportunities within its supply base or with individual supplier.

When total cost development is considered in a more extensive scale, the information can provide insights also at more strategic level. For example, if costs are increasing more rapidly in certain group of suppliers, for example from specific geographical location, the sourcing strategy might need to be adjusted properly. This could lead to exit from certain procurement markets while adding more focus on the others.

Finally, in addition to main objectives, TCP information could also be used for internal performance evaluation. For example, procurement organisations ability to select low cost supply alternatives or allocate volumes between different suppliers could be evaluated. Also, it would be possible to align sourcing focus areas and development initiatives based on the information provided by TCP measurement.

4.3 Key principles for total cost of procurement

Due to similar requirements, demanded from all the potential supply alternatives, TCP approach leans on the assumption that differences in the procurement costs are related to characteristics of each supply alternative. In other words, cost differences are a result of suppliers internal cost structure and process capabilities, supplier performance or geographical location of that supplier. This approach has been obtained from the case study performed by Alard et al. (2014).

First of these three dimensions, internal cost structure and process capabilities, mainly reflects to initial price that supplier can offer. With low cost structure and efficient manufacturing process, supplier can provide competitive price for purchased materials and components. Suppliers with inefficient processes and higher cost structures, must offer higher price to cover all the costs related to manufacturing. In other words, when suppliers are not able to differentiate with offerings, price advantage need to be achieved by optimised processes. From TCP point of view, there is no requirement to analyse or understand suppliers internal cost structure in a more detailed manner, although this might otherwise be in the interest of supplier development initiatives.

Differences or variation in supplier performance are considered as sources for additional costs together with geographical location, and it should be possible to categorise all the additional costs into these two groups. High performing supplier with good delivery accuracy, efficient process and quality deliverables, can reduce the amount of transaction costs and involvement especially from sourcing and quality functions. At the same time, poor supplier performance can increase costs that are especially related to supplier quality failures and component shortages related to poor delivery accuracy.

As a dimension, supplier performance related costs also include supplier's capability to operate according to requested processes. For example, if procurement process can be most efficiently performed by using specific set of tools and practices, process cots would be optimised when these elements are implemented with that supplier. Similarly, the process or transactions costs would be higher with those suppliers who are not capable or willing to implement optimal process. The cost of additional resources required by the inefficient process, should be considered for TCP measurement.

Different geographical locations between supply alternatives often has impact to the procurement cost structure especially in a form of transportation costs. In addition, supplier location might impact the administrative cost related to oversight, flow of finance and

materials. Additionally, if the materials are sourced by using different currencies, possible currency fluctuations might lead to decreases or increases in TCP.

In addition to supplier related dimensions, the total cost of procurement is affected by the internal activities performed by the procurement organisation. These activities can include additional warehousing related to poor production planning, internally created quality deviations and inability to operate according to optimal procurement process. As an example, organisations internal requirements might impact its ability to process orders with EOQ. Impact of such activity should be followed as a deviation to optimal process, but this cost shouldn't be assigned to supply alternatives in TCP model, as the source is not related to suppliers and shouldn't therefore be considered when suppliers are evaluated and selected.

Based on above explanations, TCP approach assumes that three primary sources for different procurement costs between supply alternatives, can be identified. These sources are supplier cost structure, supplier performance and supplier location. In addition, procurement costs might be resulted from internal activities related to procurement processes, and from constraints that are similar for each supply alternative. While these internal factors should not be used for supplier evaluation or selection, they can be used to evaluate organisations internal performance and development opportunities. From model development point of view, it would be easiest to exclude these costs.

To enable better utilisation of TCP model, all the cost elements and procurement activities that are included in the model, should be categorised based on the source from which they are related to. In practice, this categorisation enables decision makers to simulate procurement decisions based on the data related to suppliers with similar cost structure, performance or location. While the activities are categorised according to cost source, they can be simultaneously connected to correct hierarchical cost level and responsible function performing that activity.

Example of cost elements included in TCP model have been described and analysed as part of empirical findings chapter and table 2. This comparison has been performed against earlier TCO study performed for case organisations indirect purchasing.

5 METHODOLOGY AND CASE COMPANY

Purpose of this chapter is to introduce the empirical research methods and framework applied in this thesis. While the research objectives, key concepts, focus area and limitations have been already defined in the first chapter, this chapter provides more detailed description on how the empirical part of the study was performed and what was the environment for the research.

During the first section of this chapter, case company will be introduced. This includes brief description of case organisations strategic objectives and business environment. In addition, due to the important role that information technology infrastructure has for TCP concept, IT landscape and available tools will be mentioned.

The second section of the chapter describes research methods that were applied during the empirical research. The section also contains arguments and explanations why these research methods were chosen and how they help to meet research objectives. In addition, the process of data collection is described in the second section. In the third section of this chapter, validity and reliability of research process thesis will be applied, with discussion and evaluation of data quality.

5.1 Case company introduction

The research performed in this thesis is focused on a case company, which operates globally within manufacturing and service industries. The case company provides lifecycle services, systems and products within marine and energy industries, and focuses on environmentally efficient solutions that utilise smart technology. Within its strategy, the case company recognises supply managements importance in maintaining high level of quality and cost efficiency.

As one of the primary objectives for procurement operations, the case company states on-time deliveries, right quality and lowest total cost. While operating in global supply markets and actively optimising its supply operations, the case company also recognises importance of successful long-term relationships with its key suppliers. Added value brought by supplier relationships is also acknowledged in research and development processes, where supplier participation is highly appreciated.

While this thesis aims to evaluate current awareness related to TCP and readiness for more adoption at the level of whole organisation, more detailed research and model considerations focus on specific supply chain environment and procurement scenario. In other words, TCP practices are evaluated, and solution will be considered for a specific supply chain scenario where case organisation is procuring direct materials and components that will be used in manufacturing process. This means that it might not be possible to directly utilize results in different procurement scenario, while there should be possibility to extend findings also into other contexts.

Organisational structure of case organisation is rather complex and different set-ups for performing the activities within the procurement process exist. On the other hand, the basic setting is according to the structure presented in chapter 2. This means that strategic procurement activities, such as supplier selection and negotiations, are performed by sourcing function. Operative tasks such as placing and monitoring purchase orders are performed by purchasing department. Also, the quality management related activities are assigned to purchasing department. The third participant in the process is logistics, which takes care of operative tasks such as material movements and transportation management. Supply management function in case organisation is mainly administrative and governs procurement related tools, reporting practices and development initiatives.

The existing IT landscape, reporting tools and ERP system is relatively complex, and organisations are applying many tools to perform daily work. Currently the core tools include SAP enterprise resource management system and separate systems for indirect procurement and travelling. In addition, there is also separate accounting systems for specific needs. This means that data is scattered into many sources and databases. Many applications also exist for reporting purposes and it could be challenging to identify most suitable tools for the purpose. At the same time, organisation is highly committed to digital development and many initiatives have been taken to improve systems, data quality and availability. This kind of development can be considered good for initiatives such as TCP which are dependent on data provided by different systems and databases.

5.2 Research methods and process of data collection

The empirical research performed as part this thesis, required that different research methods were applied. These methods were used to collect information about organisations existing awareness of TCP approach and current adoption of different procurement cost management practices. The approach of applying qualitative and quantitative research methods, within the same research, is referred as triangulation (Bryman & Bell 2007: 412-413). In practice, triangulation can be applied to increase confidence towards results that have been collected originally by applying one research method and later the results will be validated by applying different approach to evaluate same phenomena.

In this research, combination of quantitative and qualitative methods was designed so, that information was first quantitatively collected from a larger group of stakeholders to obtain high level of understanding about existing awareness and adoption of TCP practices within case company. To increase level of understanding, questionnaire results were processed and clustered, so that possible trends and patterns could be found.

To validate results gathered from quantitative questionnaire, qualitative research methods were applied to verify the results. Because of the focus area for the thesis, qualitative research methods were focusing on a predefined business environment and emphasized the results that were obtained from earlier stages of research. The objective for this approach was to evaluate if the results from organisation wide questionnaire would be applicable to a more specific procurement process and scenario. In addition, it was expected that more accurate information could be received with qualitative research methods. The four primary research methods applied in this thesis, included web-based questionnaire, semi-structured interviews, analysis of available procurement cost data, and evaluation of organisations earlier total cost studies and their results. As a result, both primary and secondary sources were utilised.

Below steps were followed when quantitative research was performed for this thesis (Bryman et al. 2007: 155):

1. Define research problem and objectives for the study
2. Examine earlier studies and existing literature
3. Define expectations for the questionnaire results
4. Create questionnaire based on aspects identified during earlier steps
5. Distribute questionnaire and collect responses
6. Data processing and analyses
7. Results reporting
8. Conclusions

While steps 1. and 2. have already been presented and examined in the previous chapters, activities within steps 3.-5 will be introduced during this and following chapters. Sixth chapter of this thesis is dedicated on analysing the empirical findings and results from both qualitative and quantitative research method. Conclusions and recommendations will be presented within the last two chapters, as part of model consideration and managerial implications.

To collect information about organisation wide TCP measurement practices and other current procurement cost measurement methodologies, a web-based questionnaire was distributed to relevant internal stakeholders within the organisations different business lines. In total, 770 employees who are taking part or related to procurement process, were approached. Employees in the target group were working in functions such as sourcing, category management, purchasing, quality management, logistics and financial services. The questionnaire was open for responses during two-week period. After the first week, a reminder was sent to non-respondents. In total, 156 accepted responses were received for the questionnaire. In addition, 29 contacts were not reached or declined to answer. Reliability and validity of the questionnaire will be evaluated in next section.

The questionnaire was divided into five main sections and the structure and contents are attached in Appendix 1. The first questions (Q1-Q3) collected basic background information about the respondents. This information included questions about organisation, business function and type of purchases involved with. While the data is used to evaluated whether the objective for collecting responses organisation wide was successful, it also provides possibility for clustering and comparing responses based on different characteristics.

After background questions, set of statements related to TCP were evaluated by the respondents on five-level Likert-scale (Q4). Likert scale was chosen to enable easy processing and comparability of different answers (Bryman et al. 2007: 260-261). In addition, closed questions help to perform comparison between different respondent groups. Because the closed questionnaire with predefined alternatives, reduce respondent's possibility to express personal opinions, possibility for additional comments (Q5) was reserved.

Similar closed questionnaire was also presented for respondents about procurement cost categories (Q6). In this section, respondents were asked to evaluate importance of different procurement cost categories and their importance for total procurement costs on a six-level scale. Also, a possibility for open comments was provided (Q7).

Next questions (Q8-Q13) included multiple selections statements where respondents were asked different questions related to characteristics of measurement models and demand for TCP measurement. Finally, the questionnaire was closed with three open questions (Q14-Q16) related to possible improvements that TCP could provide from respondent's point of view, possible existing TCP adoptions and open word. In general, respondents actively provided their opinions also for open questions, although all the questions were not mandatory.

To obtain more detailed information about existing procurement cost management practices and desirable future measurement practices, semi-structured interviews were performed with key stakeholders. As described earlier, the interviews were also carried to validate the results gathered from the questionnaire, and to evaluate whether the results would be applicable in a more specific context. The participants for the semi-structured interviews were selected so that specialist and decision makers from all functions within procurement process would be presented. Availability of different opinions and experiences was ensured by having interview participants from different business functions.

The evaluation of earlier procurement cost studies and TCO investigations was performed based on the materials that were received from different stakeholders, such as questionnaire respondents or procurement decision makers. The purpose of this evaluation is to obtain more thorough understanding of current situation and earlier findings related procurement cost measurement. Although these studies might be applicable for only a specific procurement scenario, they might provide important insights about procurement decisions making within organisation and possible barriers related to TCP adoption.

Finally, the analysis of existing procurement cost data will help to identify and evaluate availability and validity of existing cost information. The reason to analyse availability and validity of procurement cost data, is based on barriers and risks related to TCO adoption, identified in earlier researches and literature. Focus in this analysis was given to cost elements or categories that were identified as most important by the questionnaire and interview respondents. If the procurement cost data is already available, the target of analyses was to evaluate existing measurement practices and validity of the data. On the other hand, if cost information is not currently available, possible enhancement regarding availability will be discussed. As a limitation to the analyses, available cost data is mainly searched from organisations ERP and accounting systems, or from reporting systems that are connected to these databases and are available for employees making procurement decisions. Results of data analyses are discussed especially in section 6.3. Data quality and availability.

5.3 Evaluation of research methods and data

Data validity and reliability are important characteristics, when applicability and quality of research methods and results are evaluated. Validity can be defined as characteristic of a research, which describes the integrity of collected data and results. In other words, how accurately the results describe existing reality. For qualitative research, validity can be evaluated on two dimension, internal and external validity. (Bryman et al. 2007: 40-43).

Internal validity is mainly related causality and trustworthiness of research findings. In practice, internal validity describes whether data is credible and if conclusions about possible cause and effect relationships could be done. External validity, on the other hand, evaluates if the collected results could be extended over the research context. In other words, whether the results can be generalised to describe existing reality also in other corresponding environments, for example in other case company. (Bryman et al. 2007: 40-43).

Data reliability describes how well the study and research methods could be repeated. One part of reliability is to evaluate how research methods and data collection process has been described by the researcher, and can these same methods be followed by others. In addition, reliability includes important factors such as stability, internal reliability and inter-observer consistency. (Bryman et al. 2007: 162-164).

Stability aims to describe possible variation of results over time. If the results from specific sample can change between different research moments, stability of results should be considered. Internal reliability describes relationship between different research indicators and how respondents have perceived them. In other words, are results consistent if respondent is requested to compare multiple alternatives against each other. Finally, inter-observer consistency should be evaluated when possible subjective judgement can occur during data collection. (Bryman et al. 2007: 162-164).

When evaluating the internal validity of the empirical research, the level of validity could be considered to rather good, which means that for example the questionnaire provided data that could be utilised as part of the thesis. This was primarily because the questionnaire was only distributed to specific employee group which was working with procurement related activities. While the response rate could have been higher than 20.7%, the participation and response cover can be considered good in general. The quality of responses to open questions was also relatively good and many respondents provided real effort with their responses. The response effort can also be observed from average response time, which was slightly over 18 minutes. At the same time, required time to fill the questionnaire might have been a reason not to respond for many of the questionnaire recipients. As a result of good response data validity, no responses were excluded from the results.

On the other hand, when the responses were clustered based on the organisational groups, the responses were not valid for all the groups as the amount of responses was too small to be considered representative enough. Also, there was two questions (Q8 and Q9) in the questionnaire, for which the expected responses should have been more similar than the ones that were received. This might be because the respondents have understood the questions differently than questionnaire author. This kind of conflict between two answers also impacts research stability.

Also, the data which was collected from ERP data sources can be regarded as valid, especially because the information was rechecked from actual documentations instead of using only data records. While being the most challenging to evaluate, also the data collected from semi-structured interview can be generally considered as valid. This is because the interviewed persons were selected from relatively experienced employees and their input was only qualitative. In other words, these interviews mainly reflected their opinions related to quantitative research findings.

From external validity point of view, there is no guarantees that similar responses and outcome would be achieved if the research is performed in different environment. This is because of the nature of case study and strictly limited environment. Therefore, the level of external validity is relatively low, but shouldn't impact overall considerations of research validity when evaluated at case study context. In other words, this type of qualitative case study can't be generalised.

To evaluate research reliability, three main areas should be evaluated. When possibilities to repeat similar research are considered, the reliability is especially good for the questionnaire part. This is because the questionnaire is well documented and there should not be a lot of room for distortions or incorrect interpretation. At the same time, the semi-structured interview could not be repeated as easily because of the respondent and interviewer influence which happens during the discussion.

If the data reliability is evaluated over time, the level of reliability is not very high. For example, the respondent attitudes might change over time and possible managerial focuses and strategic initiatives might have influence on how respondents are answering to specific questions. Meanwhile, the data collected from the accounting systems and sources related to organisations earlier studies, should remain the same. On the other hand, as the research objective is to evaluate current state of phenomena, reliability over time shouldn't mean that exactly same responses would be achieved although the environment could have changed.

Regardless of being the last element to be evaluated, interobserver consistency can have impact to the research reliability. While the subjectivity of own interpretations can be rather hard to evaluate, there is some elements that could be considered. For example, subjectivity is most probably present at least for insights collected from the interviews and other discussions. For the questionnaire, the response results are relatively objective processed, but the subjective evaluation has been used when creating the questionnaire response alternatives and scales. Therefore, the impact of interobserver consistency can't be excluded when evaluating research reliability.

While identifying the impact of above factors related to research validity and reliability, the research could still be considered as valid and reliable with certain reservations. Still, having these reservations should be typical when qualitative research, related to managerial topics and are performed within limited case environment.

6 EMPIRICAL FINDINGS

The objective of this chapter is to introduce, analyse and discuss the results of empirical findings of the research. The materials to be analysed have been collected from the case organisation by using previously mentioned research methods which have included research questionnaire, theme interviews and examination cost data from organisation ERP data sources.

This chapter is divided into six sections based on the topics of interest. These sections aim to answer questions such as current awareness of TCP concept, existing cost measurement practices and earlier studies within case organisation, and perceived importance of procurement cost information within the group of respondents. To analyse possible threats related to procurement cost evaluation and measurement, existing cost data availability and validity will be discussed and illustrated with examples. To consider the future possibilities and development, two last sections will focus on opportunities and barriers related to more extensive implementation of TCP measurement practices and discuss about matters that should be considered when TCP model is developed and implemented.

6.1 Current awareness on total cost of procurement

Organisations existing awareness about TCP approach was studied with a questionnaire, where statements related to TCP was presented. In addition to directly asking about respondent's personal awareness about TCP or TCO, additional statements were set to evaluate respondent's perspective towards procurement costs, how they are created and to what extent respondent feels that his or her personal decisions impact procurement costs. Because the questionnaire was distributed within business functions which are taking part in procurement process, it was expected that respondents would be relatively aware about TCP or TCO concepts and recognise that their own decisions have impact to procurement costs. In addition, respondents were asked whether they feel that decisions related to procurement costs are done often, and if minimizing TCP should be recognised as most important objective for procurement process.

While providing the base for further evaluation, the current awareness of TCP practices also impacts the possibilities for adoption. For example, it was recognised by literature that successful adoption of TCO measurement practices might require extensive training programs for procurement decision makers. For example, if TCP concept is not currently

familiar for employees participating in procurement process, the training should be started from basic principles. On the other hand, if organisational awareness towards TCP concept is already on a high level, training activities could be targeted towards more practical factors related to measurement models and use of TCP information.

The number of responses for the statements are presented in figure 12., where the responses are grouped for each statement and height of bar describes the count of each specific answer for that statement. From the figure, it can be recognised that the concept of TCP (or TCO) is familiar to most of the respondents, and only one respondent strongly disagreed with the statement. While the good awareness of the concept in general was partly expected, it also supports the validity of the other results which are obtained from statements related to the concept.

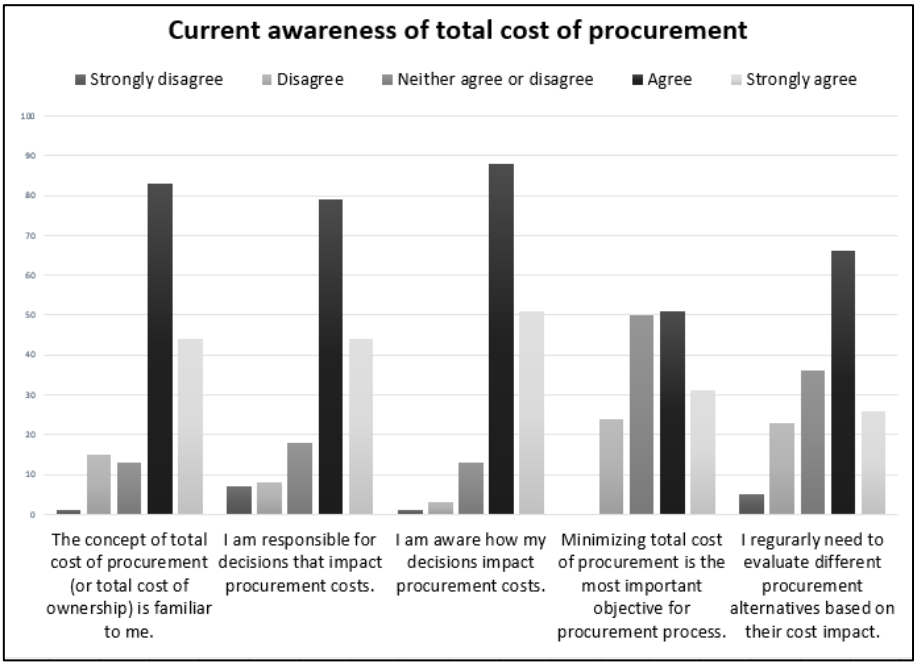


Figure 12. Responses related to current awareness of total cost of procurement

Following two statements were related to the procurement decision making. First, respondents were asked whether they are responsible for decisions that impact procurement costs. Next, it was asked if the respondent is aware how his or her decisions impact procurement costs. The deviation of responses for these two statements are similar than with the first one. Therefore, the results propose that most of the respondents at least agree with the statement that they are responsible for decisions that impact procurement costs. In addition, almost all the respondents feel that they are aware how their decisions impact towards procurement costs.

To provide more information to these statements, correlation between the answers were calculated with Pearson's correlation coefficient. This was performed, because before the questionnaire, it was expected that respondents who are responsible for decisions impacting procurement costs, would also be most aware of the cost impacts. The result of Pearson's correlation coefficient was 0,48, which indicates some positive correlation between the two responses, while the correlation is not very strong. The decreased level of correlation might have been partly caused by the fact that some respondents indicated that they are not responsible for decisions that impact procurement costs, while they understand how these decisions impact procurement costs. If the lowest responses for the second statement would be removed, the level of correlation could probably be slightly higher. In general, it can be still concluded that respondents who feel responsible for decisions impacting procurement costs, are mainly relatively aware of the impact of their decisions. This can be considered as a positive result, although cost awareness should always be increased and maintained.

Last two statements for this section were related to procurement decisions making and importance of TCP as a main objective for procurement process. Higher level of dispersion was observed with these responses, as many respondents disagreed with the statements, or at least didn't agree. Although there was more variance with the last statements, only a few respondents fully disagreed.

In addition to evaluating each statement in general, responses were also clustered based on respondent's role, business line and type of purchases involved with. While there was no major variation between different respondent groups and some groups only included few responses, some interesting results were observed especially when different categories are compared against each other. Generally highest level of agreement was received within respondents representing category management and strategic purchasing. High level of awareness was expected within these user groups, as the connection between procurement costs and decisions done by these respondents is relatively straightforward.

Although there was only a small number of respondents from inbound logistics and transportation, and quality management groups, the results can be considered interesting. While the logistics respondents indicated high level of agreement to almost every statement, respondents in quality management group displayed relatively low agreement. For example, logistics respondent provided highest level of agreement to statement that they often need to evaluate different procurement alternatives based on their cost impact. In addition, high level of agreement was received with statements related to TCP familiarity and awareness of own decisions towards procurement costs. Simultaneously, respondent

from quality management function disagreed with familiarity of TCP concept and didn't feel responsibility about decisions impacting procurement costs. Quality management respondents also felt that they are not regularly involved with decisions that would have impact towards procurement costs.

Comparisons based on business lines or type purchases didn't reveal notable differences between the categories. As one difference, it can be noticed that decision making based on procurement cost is evaluated as more regular by respondents involved with indirect purchasing, in comparison to direct purchasing or both. The detailed summaries of responses are displayed in appendix 2.

In addition to requesting respondents to evaluated closed statements, also alternative for providing additional comments were reserved. In the open questions, respondents provided extensive amount of comments related to TCP awareness and other procurement cost related statements. One of the comments that was often repeated, observed that there is no TCP or procurement cost management practices that would penetrate the whole organisation, and follow consistent process within different business lines or functions. Simultaneously, respondents stated that pressure for cost reductions exits, but focus is mainly on component price when new suppliers are selected, or cost reductions are pursued with existing sources.

Respondents also highlighted that while TCP as a concept might be familiar, visibility towards certain cost elements is poor, and therefore it is not possible to apply total costs for decision making. Also, while respondents feel that they and their organisation are aware of TCP approach, cost saving objectives don't support holistic approach to procurement cost measurement and evaluation. Additionally, technically driven decisions are considered as a limitation towards cost-based decision making.

In general, most of the respondents seemed to have positive approach towards TCP concept, and they would like to utilize total cost of procurement data more efficiently in their decisions. Good awareness and positive approach towards TCP concept should be considered as a good foundation for more comprehensive adoption of TCP practices.

One of the most commented statement was related to minimizing of TCP as the most important objective for procurement process. For this statement, the users commented that sometimes it is not possible to identify source of supply with best possible cost, because production requirements mandate that supplier must be selected as soon as possible. Therefore, short time solutions need to be implemented. Respondents also notified that

minimizing TCP could lead to sub-optimization if each activity included are considered and evaluated separately.

Securing material availability by having right materials available at right time with right quality, was also considered to be more important than minimizing TCP by some respondents. In other words, especially operative purchasing should focus more on material availability than optimisation of material flows. While the requirement for securing material availability is acceptable, TCP based measurement shouldn't be conflicting with this approach. Based on these comments, it could be interpreted that cost impact of materials not being available for production is not currently measured and available. Therefore, also respondents are not fully aware how late or missing deliveries impact procurement related costs.

6.2 Existing procurement cost measurements in case company

In general, the case organisations measurement practices for procurement process are aligned to evaluate performance based on three key performance indicators. These indicators include cost, delivery and quality. While some of the measures are based on financial figures, extensive cost-based measurement practices don't exist. In addition, costs are not recorded very accurately, and cost assignment is done only at general level.

The purpose of this section is to discuss and analyse how procurement costs are currently measured in the case organisation, and how the concept of total costs has been approached earlier. For this purpose, the section has been divided into two parts. First part is focused on the existing cost measurement practices, while the second part evaluates earlier total cost considerations and their conclusions.

6.2.1 Procurement cost measurement practices

To evaluate case organisations existing cost measurement practices, respondents were asked to describe current measurement practices within their organisations. While the responses described overall state of procurement cost measurement practices within the whole case organisation, more accurate awareness was perceived by performing theme interviews with procurement managers and experts who are operating within the focus business processes. In other words, the results gathered from the questionnaire were tested

against the views of individual procurement decisions makers to obtain more accurate understanding.

Based on the questionnaire, most of the respondent's report that there are no procurement cost measurement practices or models that would especially target to capture procurement costs from total cos t perspective. For example, respondents directly state that TCP or TCO is not measured and existing procurement cost measurement practices only focus on a limited number of direct or indirect cost elements, which are considered to be important for that specific procurement decision. Respondents also reported that existing accounting systems don't support TCP measurement as the cost data is not captured accurately enough. This means that decision makers don't have required data available at the time of decision, or the available data is not accurate enough so that it could be used.

The responses also reveal that that procurement costs are mainly followed on a component or unit level, and measurement mainly considers price and is limited to individual procurement scenario. For example, one of the respondent's report that agreed purchase order price is measured and followed accurately, but information related to transportation, quality costs or supplier level activities are not officially captured and collected. In addition, measurement is not done on continuous basis, but rather as some individual studies.

While there are no structured total cost measurement practices that would be applicable for the whole case company, some respondents identify that total cost concepts have been developed for limited procurement areas during the past years. In these scenarios, the measurement is mainly structured around evaluation templates, spreadsheets and proactive evaluation, instead of collecting and analysing cost data directly and continuously from accounting or ERP systems. In addition, some organisations have established rule-based routines to ensure that lowest cost can be achieved. For example, these routines might require that certain minimum number of quotes must be requested from potential suppliers before selecting the most suitable offer. In these scenarios, TCP is mainly evaluated based on the quotes, instead of evaluating historical cost information. In general, these practices mean that total costs are not evaluated very accurately and based on comprehensive cost data. Instead, the evaluations are a result of expected cost impacts based on limited information.

If existing procurement cost measurement practices are categorised based on the organisations represented by the respondents, some differences can be noticed. For example, exiting approaches towards total cost concept have been mainly implemented in indirect procurement and project procurement. In these organisations, purchases can often be non-

repetitive and have higher investment value. Based on the responses, increased interest toward total costs is mainly related to lifecycle costs, administrative costs and logistics costs. It can be also observed that higher interest towards TCP is given in businesses where the impact of indirect costs can vary significantly. For example, procurement costs related to poor delivery reliability or quality non-conformities can be notably higher in businesses where it is not possible to maintain safety stocks or plan time buffers to secure material availability.

Regardless of small steps and increasing interest towards TCP awareness and evaluation practices, continuous measurement and follow-up processes have not been widely established or adopted in any of the procurement organisations within the case company. This means that TCP measurement is not actively used for selection and evaluation of suppliers. Neither TCP is used for measuring internal procurement performance or to optimize procurement activities and flow of materials, information and resources.

While there is lack of organisational measurement and evaluation practices, some respondents and interview participants report that there have been efforts to evaluate total costs at individual procurement scenario level. In these cases, individual procurement decision makers have evaluated total costs separately for a specific procurement decision. In practice, this has meant that decision makers have collected available procurement cost information from different data sources and quantified indirect cost elements according to best understating. In the focus procurement process, these kind of individual cost studies have been especially typical when major procurement decisions, such as supplier selection, have been done. While these studies have supported individual procurement decisions by providing more cost data, the lack of structured TCP measurement model has caused that these evaluations are not comparable against each other, because they are made by using different sets of procurement data, based on availability and evaluators own subjective view of cost element importance.

While the procurement costs are not currently measured comprehensively from total cost perspective, the case organisation is putting lot of efforts to evaluate component price and its development. This focus has meant that case organisation has implemented many organisation wide procurement cost management programs that are mainly concentrating on achieving reductions in purchased component prices. In practice, these inter-organisational projects have mainly focused on component design and suppliers manufacturing processes because these elements are biggest direct contributors to component price element.

Based on the focus group interviews, most important tool for procurement cost evaluation is component price development tool. This tool is mainly used to support internal cost accounting processes by proactively evaluating price development of purchased components. This information is then provided to cost accounting and used to forecast value of end products within specific time horizon. While the component price follow-up is also used to evaluate procurement organisations performance at maintaining requested cost level, it doesn't support decision making in supplier selection or evaluation.

Based on the questionnaire and interviews, there has been no remarkable production cost reduction programs that would emphasize indirect cost elements, such as logistics, material handling or quality failure costs. Neither have these cost elements even been included in the scope of existing price reduction programs. On the other hand, there has been separate activities to increase supplier quality for example, but these programs have not included accurate cost measures. In a worst-case scenario, disregarding indirect cost elements in cost reduction programs, might have led to increase in TCP. This is related to misassumption that price reduction would automatically lead to cost reductions also in indirect procurement costs, although the impact might be totally opposite. In other words, if the procurement costs are not measured beyond price, success of these price reduction programs can't be factually evaluated.

Also, when procurement cost and performance measurement mainly concentrate on price, it might encourage procurement decision makers to emphasize price reductions regardless of other cost elements. This risk is especially relevant, if the personal performance of an employee is also measured against component price development or reductions. Based on the discussions with some of the procurement decision makers, it was identified that existing measurement practices and performance objectives are not aligned with achieving lowest total cost of procurement.

6.2.2 Earlier total cost studies

As mentioned already in the earlier section, individual total cost studies or TCO concepts have already been examined in the case organisation. These studies include business driven researches related to individual procurement scenarios, thesis works and TCO cost element mappings. While the studies provide goods insight to existing state of measurement practices and acknowledged challenges, they are not considering how total cost approaches could and should be adopted in a more comprehensive way. The purpose of this

section is to present some of the recently performed studies related to procurement total costs.

One of the studies has aimed to determine potential procurement cost elements in the area of indirect procurement. The objective of this model was to support procurement decision makers in identifying the most relevant cost elements that should be applied for evaluations made for the specific spend categories. By implementing the model in practice, the organisation has aimed to increase its change to capture all cost reduction opportunities, while also being able to estimate possible benefits more accurately.

In this total cost model, the cost elements have been categorised based on their applicability for purchasing materials and services. In practice, all the cost elements have been recognised to be important when materials are purchased, while some of the elements are not relevant for services. Cost element categories included in the model are presented in table 2.

While the existing TCO study provides good and extensive list of potential cost elements in indirect procurement, the information can also be utilized when TCP measurement practices for direct procurement are established and developed. The cost element applicability for TCP measurement, based on the scope of TCP, is commented in the fourth column of the table 2. As described in the key principles for total cost of procurement, TCP cost elements can be divided into three primary cost drivers related to source of supply, and into one driver which is related to performance of procurement organisation itself. The relevant sources of cost and cost drivers related to each cost element are evaluated in the fifth column of table 2.

Primary category	Cost elements	Applicability	Included in TCP scope	Source of cost / cost driver
Purchase costs	Purchase cost (price etc.)	Materials and services	**YES**	Supplier internal cost structure and process capabilities
	Payment terms	Materials and services	**YES**	Supplier internal cost structure and process capabilities
Logistics costs	Transportation costs	Materials	**YES**	Supplier geographical location
	Taxes and duties	Materials	**YES**	Supplier geographical location
	Handling costs	Materials	**YES**	Supplier performance + Internal
	Logistics failure cost	Materials	**YES**	Supplier (carrier) performance
Inventory holding	Storage and service costs	Materials	**YES**	Internal + Supplier performance
	Inventory capital costs	Materials	**YES**	Internal + Supplier performance
	Inventory risk costs	Materials	**YES**	Internal
Operations	Engineering and R&D costs	Materials	**NO**	
	Installation costs	Materials and services	**NO**	
	Operating and maintenance costs	Materials and services	**NO**	
	Downtime costs	Materials and services	**YES**	Supplier performance
	Capital equipment costs	Materials	**NO**	
	End product costs	Materials	**NO**	
	Decomissioning and phasing-out	Materials and services	**NO**	
Health, Safety, Engineering, Quality	Non-conformance costs	Materials and services	**YES**	Supplier performance
	Training and consulting costs	Materials and services	**YES**	Supplier performance
	Testing, qualification and inspection costs	Materials and services	**YES**	Supplier performance
	Warranty costs	Materials and services	**NO** (to be included in non-conformance costs)	
	Legislation costs	Materials and services	**NO** (to be included in sourcing and contracting costs)	
Purchasing process and administration	Sourcing and contracting costs	Materials and services	**YES**	Supplier performance
	Supplier management costs	Materials and services	**YES**	Internal + Supplier performance
	Administration costs	Materials and services	**YES**	Internal
	Transaction costs	Materials and services	**YES**	Supplier performance + Internal

Table 2. Procurement cost elements based on indirect procurement study and applicability to TCP measurement.

Couple of important factors needed to be evaluated when the applicability and sources of procurement cost elements for TCP were evaluated. One of the basic principles behind TCP was to consider component requirements and specifications as given inputs from earlier process steps. Therefore, cost elements related to engineering and R&D have been excluded, although similar activities and cost elements might be included in supplier management costs, training and consulting costs and testing, qualification and inspections costs. Similar considerations were done for costs related to installation, operating and maintenance, capital equipment, final product and end of lifecycle. On the other hand, downtime costs are considered from production downtime point of view, and are related to supplier delivery reliability, which would have otherwise been missing from the scope. Main driver for making these limitations was based on processes where the activities are performed. If the activity is related to procurement process itself, the cost should also be included.

For many of the procurement cost elements, it would be relatively hard to identify only specific source of cost that is having impact to overall amount. Therefore, multiple sources and drivers have been recognised for some cost elements. For example, transactions costs can be seen as a result of supplier performance and procurement organisations internal capabilities. For example, what is the maturity of collaboration tools and how well the organisations can communicate with each other. Similarly, the basic level warehousing costs can be result of internal factors, while poor supplier performance might increase the cost due to additional stocks. From cost management point of view, it is important that different cost elements can be connected to proper cost sources and drivers. In addition to listed cost sources, is also possible, that other sources are applicable for some special cases.

Another interesting study related to total cost of ownership was performed in one of the case company's business lines. Objective for that research was to improve activities related to supplier selection within one of the purchasing departments. This was performed by analysing variety of costs which are related to procurement and identifying typical cost structures related to each of the activities. The primary cost element categories that were acknowledged in the scope of the study, included sourcing and purchasing, transportation and warehousing, duties and quality.

This study supports TCP model conceptualisation by discovering some of the main activities that result to procurement costs. For example, resources required by sourcing or purchasing activities have been examined at relatively detailed level, so that it has been possible to determine typical costs for each of these activities. On the other hand, cost evaluation has been done by using standardised labour costs and average resource utilisation for each activity. Therefore, results provided by the evaluation form might differ from the ones that will be generated by the activities that were really performed. The labour utilisation-based costing was specially utilised for studying sourcing related costs and it covered activities from creating sourcing long lists to supplier visits and price negotiations.

The study also identified multiple cost objectives that were related to supplier quality and logistics. For example, quality costs were traditionally categorised into prevention, appraisal and failure costs. While the prevention and appraisal costs were mainly captured from costs of resources utilised, failure costs were studied based on country specific performance indicators that were describing the percentage of nonconformity costs against total purchasing price of purchased components. Based on the report, nonconformity costs are measured at relatively general level, which might lead to inaccuracy. For example, having same nonconformity cost ratio for all suppliers within one country, doesn't recognise that different types of purchased components can also have different quality cost structures. Therefore, nonconformity costs should be captured for each component and supplier combinations, so that quality costs can be the evaluated and analyses at both levels. Also, it would be important to reveal more detailed what are the individual cost elements that have been used when nonconformity costs were captured. For example, does the number only cover cost of purchased components or are also other elements, such as rework and additional logistics costs been included.

For the transportation costs, the study concludes that it is difficult to identify typical cost for each delivery because special requirements were often impacting the freight rate. Therefore, the study concentrated on evaluating the costs for most relevant modes of transportation, such as road transportation and sea freight. While this approach provides interesting insight logistics costs, more detailed information should be pursued. This is especially important because transportation costs can change relatively quickly as a result of fuel price changes or other factors that have direct impact to freight rates. Accuracy can also be required because transportation costs are often connected to an invoice and therefore costs is available from accounting system. For measurement purposes, the challenge is to connect transportation costs for each purchase by identifying what has been delivered and by distributing costs based on allocation rules.

The study also paid attention to duties and warehousing costs that were present in procurement process. For these costs elements, it is important to acknowledge that cost can be different for each individual material and location. For example, warehousing cost might be dependent on the weight of material, while also different warehouses have different storage rates. For duty costs, also the direction of material movements can have an impact. For example, duties from China to Europe can be less expensive than to the other direction. Due to variation within these cost elements, there is no easy possibility to allocate fixed overhead cost for each purchased component or batch. Instead, purchased materials should be categorised so that accurate duty and warehousing costs can be distributed based on specific attributes, such as country of origin or storage location.

The last example of an internal procurement total cost evaluation, is a study related to total costs of one component category. While this study only concentrated on limited amount of cost elements, such as purchasing price, transportation cost and inventory value, it is a good example of study that compared two alternative procurement alternatives from different sourcing markets. While the first supplier presented typical TPM source, the second alternative was an example of LCC source. Due to this setup, the study provides a good example of a typical decision related to supplier selection with an objective to minimize cost of procured components.

The study included three main cost objectives: component price, inventory holding cost and transportation costs. Because both supplier alternatives provided same or similar components, possible differences in each the cost of component would be a result of supplier related factors. For example, inventory holding cost was calculated based on safety stocks and cycle stocks, which were both impacted by supplier delivery reliability and replenishment lead time. Similarly, transportation cost was connected to supplier's geographical location.

From total costs perspective, the most important implication of the study is to illustrate that cost reduction achieved by price reductions are often diminished when other cost elements are taken into consideration. For example, the study showed that while the purchasing cost with LCC supply alternative was 17,5% lower than from supplier within TPM, increases in inventory holding and transportation costs reduced savings with over 6%. This example showed that over one third of possible cost benefits were lost when evaluation was extended beyond price and while consideration only included two additional cost elements. If more cost elements, such as purchasing transaction costs, duties

and quality costs would be added, possible cost reduction could be even smaller. Therefore, these elements need to be included in all supplier selection decision at least by evaluating their relevancy.

The purpose of discussing these earlier internal total cost studies was to illustrate that certain level of awareness and interest towards TCP concept already exists within the case company. At the same time, the organisation is lacking comprehensive model and systematic way of working that would be applied in whole organisation. As a result, considerable benefits could be achieved if case organisation would adopt structured way for evaluating, measuring and following total cost of procurement.

6.3 Perceived importance of procurement cost elements

As part of the questionnaire, respondents were asked to evaluate importance of specific procurement cost elements. Purpose of this question was to evaluate what the most important cost elements are from the respondent's point of view, and whether there is difference between respondent groups. The evaluation of cost element importance can be utilized when activities are introduced to TCP measurement model. In other words, while the goal for TCP would be to capture all procurement related costs, collection and model creation might need to be started from the most important ones. Information provided by the answers from this question are also utilised in next section where the data quality and availability will be evaluated for the most important cost elements. In the questionnaire, respondents were asked to evaluate importance of ten fixed procurement cost elements in a six-level scale. The highest value in questionnaire described that cost element is crucial for procurement decision making, while the lowest option indicates that cost element is not relevant for decision making. While the fixed cost elements for the questionnaire were selected based on their presence in literature and earlier studies, a possibility for open comments was also reserved. Count of responses for the fixed question part is described in figure 13., while results are also presented in Appendix 2.

Based on the questionnaire results, the most important procurement cost elements are related to poor supplier delivery performance, quality failure costs and component price. While these cost elements were perceived most important as an average, standard deviation between all the responses was also relatively low. In other words, common agreement seems to exist regarding the importance of these cost elements.

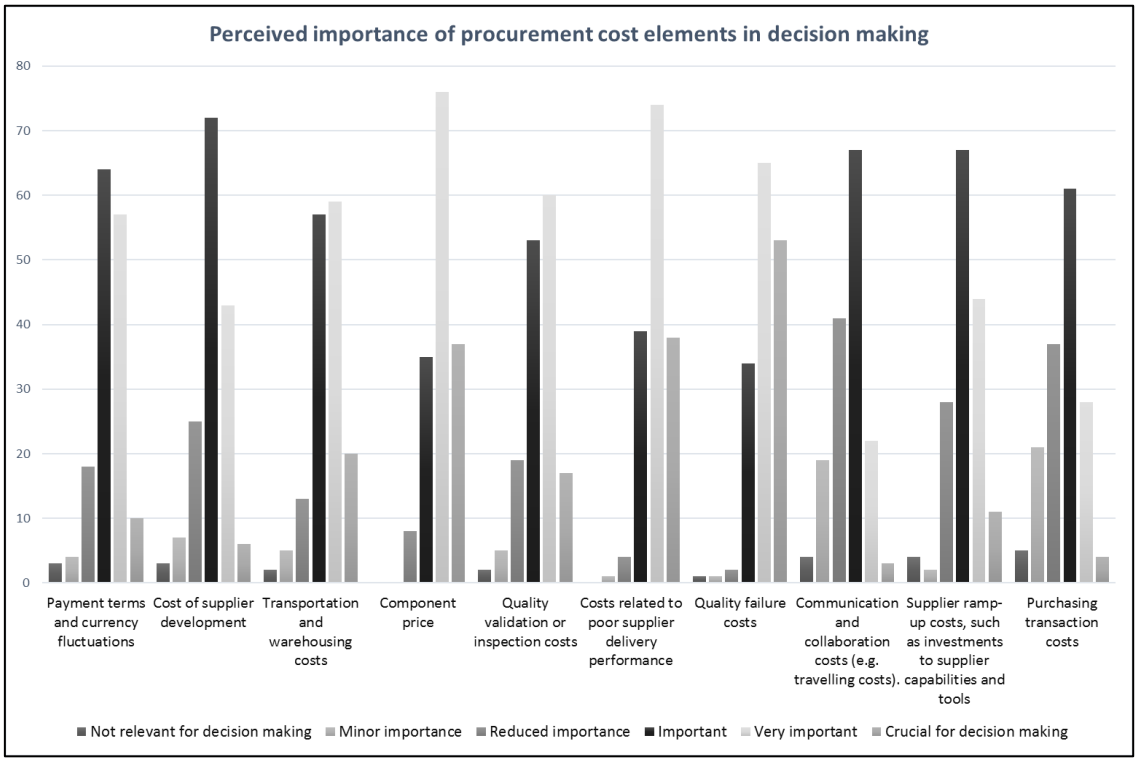


Figure 13. Perceived importance of procurement cost elements in decision making.

Based on the questionnaire, least important procurement cost elements include communication and collaboration costs and purchasing transaction costs. On average, these cost elements were perceived either as important or reduced importance. While common agreement occurred for the most important cost elements, shared agreement also existed for the least important cost elements, although the standard deviation was a bit higher.

It is interesting to notice, that while the two most important cost elements, quality failure costs and cost of poor delivery performance, can be considered as deviations to procurement or delivery process, the least important cost elements are related to normal, everyday procurement activities. In other words, cost elements that should only occur occasionally, are given higher importance in comparison to costs that are related to normal working process. Higher awareness and priority towards these process nonconformities can be caused by many things. For example, while costs related to quality failures or poor delivery performance don't occur as often, the cost impact might be substantially higher in case of occurrence and might be in interest of many stakeholders. Simultaneously, costs related to purchasing transaction, communication or collaboration, often have indirect nature and might be hard to allocate for individual suppliers or purchased materials. In addition, these costs are often created by multiple small activities that are performed on

daily basis and their cost impact might not be easy to recognise or capture, and therefore these cost elements are often considered as typical overheads.

When the responses were categorised based on different respondent groups, it was possible to make some interesting observations (Appendix 2: table 10). For example, some of the respondent groups evaluated almost every cost element lower than some other groups. This can be noticed when comparing average responses by category managers group and quality management group. While category managers on average evaluated each cost element between important and very important, respondents from quality management group evaluated below important on average. While also strategic purchasers and supplier development engineers provided relatively high averages on perceived cost element importance, also respondents in other material management group provided lower results on importance. The average perceived importance is most likely related to employee's role in procurement decision making. Those employees that are often involved in procurement decisions, and have to evaluate procurement cost data, seem to provide higher perceived importance for cost elements on average. This assumption can be validated by comparing results in this chapter and categorised responses to earlier statements considering procurement decision making.

Interesting deviations between different respondent groups occurred also when responses were categorised based on business lines (Appendix 2: table 10). Most notable deviation occurred with cost elements related to payment terms and purchasing transaction costs. In both cases, there was a one-scale difference between highest and lowest average value for business line. In other words, while payment terms were considered almost as very important by respondents in BL1, respondents in BL2 considered them less than important on average. Similarly, BL1 respondents considered purchasing transactions costs to be important, while BL2 respondents only perceived reduced importance.

It is good to acknowledge that deviation between responses from different business lines can be a result of variation in business processes. For example, while BL2 takes part in various procurement processes, from project purchases to more repetitive standard purchases, BL1 mainly processes project purchases. As a result of different focus areas, different requirements might be given to procurement process. In other words, in project purchasing environment, one single purchase might require a lot more time and effort from procurement organisation, and therefore purchasing transaction costs are seen more important. Similarly, the payment terms might have larger importance if cost of purchases

are higher and delivery times are longer. In summary, different procurement environments might cause that procurement employees have different views on perceived importance for cost elements.

To achieve more detailed view on how respondents within case organisation perceive procurement costs, possibility to provide open comments was reserved. In this section, respondents highlighted additional procurement cost elements that they regarded to be important, and provided other comments related to procurement cost measurement and evaluation. For example, many respondents considered that certain cost elements are highly dependent on maturity of procurement process, which can vary inside the case company. With more mature procurement process, it is easier to provide attention for cost elements that would normally be either harder to evaluate or otherwise considered less important. Simultaneously, with less mature procurement process, higher attention must be given to basic activities and simple decisions.

Respondents also identified that perceived importance of procurement cost elements can differ between direct or indirect purchasing and sourcing categories. In addition, many respondents highlighted that procurement costs are not only dependent on the source of supply or supplier. According to the respondents, also internal processes, such as technological support, can lead to increase or decrease in procurement costs. For example, unclear specifications and technological requirements can lead to poor supplier quality, increased lead times and unreliable delivery schedules. As a result, proper availability of internal support and resources should be secured, instead of just considering procurement cost elements.

In addition to predefined cost elements, the respondents also identified and highlighted following elements:

> *Taxes, tolls, customs duties, warranty costs, supplier customer service, vendor profit margin, discounts, rebates, delivery terms, working capital, trade compliance, internal material handling, classification costs, suppliers financial position, raw material costs, inventory turnover costs, internal process costs (purchase to pay), price stability, EOQ, scrap rates, administrative cost of supplier maintenance, product development costs (joint design and development), cost of documentations, invoice checking costs, supplier ramp-down costs, intellectual property rights.*

While some of the above-mentioned cost elements can be considered as inclusive to predefined cost elements, such as purchasing transactions costs, transportation and warehousing costs or component price, the list provides good insight to extensive range of cost elements that are present when procurement decisions are made.

For example, taxes and duties were identified by many respondents, and some even highlighted that they might become even more important due to current protective developments in global procurement and supply markets. Another cost element that wasn't included in the original list, but was highlighted by the respondents, is cost of component classifications. Classification costs were also considered as a source of procurement cost variation, because cost differences between classes can be notable. While classification costs are more related to requirements than supplier selection or evaluation, it is good to understand that smaller procurement costs can be achieved if unnecessary classification or over-classifying can be avoided.

6.4 Data availability and validity

The purpose of this chapter is to evaluate availability and validity of existing procurement cost data. This evaluation is based on data which is available for procurement decision makers directly from case organisations ERP or accounting systems. While the availability of data is evaluated on a general level, the evaluation of validity is targetted to more specific set of cost information which is already measured or collected at some level. Also the perceived importace of different cost elements has been taken into account, and therefore, evaluation focuses on component price, quality costs and transportation costs.

6.4.1 Procurement cost data availability

At the moment, the availability of procurement cost data from ERP and accounting systems seems to be rather weak. This is supported by questionnaire responses, which are providing relatively low results for statements related to availability of procurement cost data. For example, while the result for statement related to the availability of procurement cost data was slighty over an averege value of neither agreeing or disagreeing, the value is low in comparison to all statements in question 4 (appenix 2: table 11). Therefore, it can be interpreted that respondents don't have good experience about the statement. Poor agreement was also received for statement related to ease of accessing required procurement cost data. In other words, lowest agreement received from respondets was related to availability and having access to required cost information. The number of responses and distribution can be seen in figure 14.

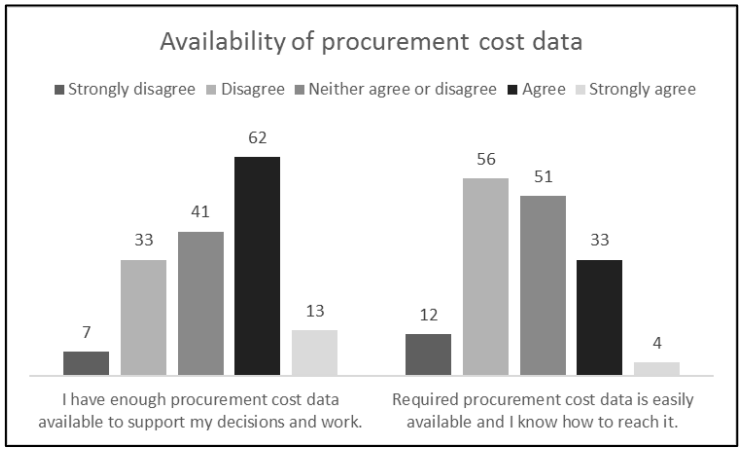


Figure 14. Availability of procurement cost data

The correlation of answers provided to previous statements was also examined, to evaluate whether there is relationship between procurement cost availabilit yand accessability. The Pearson's correlation coefficient was applied for the examination. As a result of the calculation, positive correlation of 0,62 was provided. Based on the results, the respondents who consider the there is not enough procurement cost information available, also consider that the data is not easily accessible. Similarly, respondents who consider that data is available, have easy acces to it. In other words, there is relationship between perceived availability and ease of accessability. Therfore, accessability should always be considered when procurement cost data is collected.

Need to have more procurement cost data available or earier access to it, is also reported by some of the questionnaire respondents. For example, one respondent states that data

availability and quality create the biggest gap between current situation and more comprehensive TCP adaption. Some respondents also highlight that especially transportation and inventory holding costs are not enough visible, and there is no proper way defined to allocate these costs down to material level. Similar allocation issues also exist for supplier quality costs, which are only followed and reported at supplier level, instead of breaking the costs down to component level. Additionally, some respondents feel that data is scattered into too many sources and storages, which makes it harder to utilize it.

While the data availability in general seems to be weak, some respondents still feel that data is available for normal procurement scenarios with direct purchasing, but not easily available in special occasions. Therefore, lots of resources, time and effort are needed to collect information. In these special occasions, respondent feels that lack of TCP understanding and inadequate information leads to incorrect decisions. In general, there seems to be clear understanding and unanimousness among the respondents that better availability of procurement cost data needs to be established before TCP measurement practices can be adopted.

After having a review of available procurement cost data in ERP system, questionnaire results and respondents perceptions of data availability could be challenged even more. In practice, available procurement cost information is limited to some key cost elements, such as price, classification costs and transportation costs. For these elements, cost data is available due to financial records which are created when invoices are received and paid to suppliers or carriers. At the same time, it is relatively hard to connect classification or transportation cost to individual purchase orders or purchased components, because systematic link between these items is missing. This notably reduces usability of recorded cost information.

For example, transportation invoice can’t be searched from the system with purchasing document number, although purchase order numbers are often referred in the invoice documents. Availability of transporation cost data is also reduced due to use of multiple carriers and different processes with each carrier. For example, some carriers are able to provide cost information electronically, while some cost of some local tranportations is hard to evaluate and allocate because fixed transportation fees are paid to carriers.

Similar issues related to missing connection between purchasing documents and invoices, seem to exist for classification costs. In addition, these costs are often grouped to framework orders, instead of allocating costs to actual purchasing documents. Issues

related to cost data availability are also present with supplier quality costs, where available information only covers some of the cost elements that are related to supplier quality failures, but might not even be the most relevant from TCP measurement and evaluation point of view.

Some additional information related to supplier invoiced price can also be found. For example, if scale prices have been maintained to provide quantity discounts, they should be collectable from to systems. Although this information is not currently very visible for purchaser who created the purchase order. Similarly, information related to payment terms can be extracted from the system, with some accuracy. This would allow organisation to highlight possible differences with efficiency of financial resource flow and cost of capital related to sourcing.

While only some information about cost elements is available and easy to collect from ERP and accounting systems, data related to most of the cost elements can't be found or is recorded only at very general level. This group of cost elements includes almost every cost element which is related to utilisation of resources during procurement activities. For example, resources used for supplier development are not accurately recorded to ERP system. Same applies for activities related to material handling, supplier collaboration and purchasing transactions. Having these cost elements more easily and extensively available, resources spend during procurement process would be easier to evaluate and measure. In addition, it would be possible to allocate and connect resource related costs to suppliers and components which are responsible for utilising them most.

It was also interesting to find out that while cost of poor supplier delivery reliability is perceived as one of the most important sources for TCP, it is not very accurately measured or evaluated at the moment. On the other hand, information is available for supplier delivery reliability and safety stocks. While it would be possible to evaluate how these figures impact cost of inventory, it doesn't directly cover all the cost elements related to supplier being late. For example, cost impacts to production schedule and possible downtimes are not evaluated. On credit side, cost information about late delivery penalties can be found and this information could also be calculated.

Although, the availability of procurement cost data is currently at poor level, some developments towards having more information available has already been done. According to one of the interviews, case company has started to collected more accurate cost information about joint component and manufacruting development programs with suppliers and possible investments done to supplier operations. At the moment, cost

information about some of the development activities is collected to specific accounting objects and this way the investments can be later analysed. The weakness with this new way of working, is that data is not actively allocated to suppliers or components, and then used for measurement and evaluation purposes. In addition, perfromed activities and use of resources are often recorded by personnel who doesn't have required skills and knowhow, which has led to inaccurate and unreliable data. Still, increasing availability of data can be seen as a good step towards better utilisation and cost awareness.

6.4.2 Validity of existing procurment cost data

To support supplier selection and evaluation based on total cost of procurement, the cost information collected from the ERP and accounting systems should be valid and relevant for these purposes. While the relevancy, or perceived importance, of cost elements was already discussed in the previous chapter, this section aims to evaluate validity of some key cost elements for which the information is currently available from the system. These elements are component price, transportation cost and supplier quality costs. In the context of this thesis, validity is considered as accuracy of cost information. In other words, does the available cost information provide correct data or is there some deviations within the data.

The evaluation of procurement cost data validity can be started by investigating component price, which is also the primary cost element used for procurement performance measurement processes and supplier comparison. In practice, using price is generally straightforward end comparison can be made quite easily. For example, it is possible to evaluate which of the supply alternatives offers lowest price, and whether the price in purchasing document and invoice are matching. In addition, price development is easy to measure based on historical data, as the organization currently does.

The direct use of component price for measurement and delivery purposes might became hard if there is variability between source of supplies on what is included in the price. This might be caused by different terms of delivery or agreed way of working. For example, discrepancies can occur when packing is included in the price for one supplier, while the other supplier is invoicing packing separately. In these scenarios, packing costs are often allocated to separate cost objects and procurement decision makers are not even aware of additional invoicing.

Supplier	*Component price*	*Invoiced packing costs*	*Total invoiced cost*
A	7 440 €	0 €	7 440 €
B	10 348 €	535 €	10 883 €

Figure 15. Example of hidden packing costs

Having this kind on invisible discrepancy can be especially harmful in situation where multiple procurement alternatives are evaluated based on component price. The above figure 15 illustrates one of the observed examples. In this situation, the packing costs are not easily visible for purchaser, and only one of the supply alternatives are invoicing them. Both suppliers are delivering the same component.

As illustrated by the example, comparison based on the component price between the supply alternatives would indicate that supplier A is able to deliver the same component with 28% lower price. When the evaluation would be extended beyond the price and towards actual invoiced cost, we can observe that supplier B is invoicing packing costs with over 5% of component price. This means that the cost difference between these supply alternatives would increase to almost 32% for delivering the same component.

Supplier	*Component price*	*Invoiced packing costs*	*Total invoiced cost*
A	1 296 €	24 €	1 320 €
B	1 154 €	0 €	1 154 €

Figure 16. Example of hidden additional costs: packing cost

Supplier	*Component price*	*Invoiced packing costs*	*Total invoiced cost*
A	3 229 €	237 €	3 466 €
B	4 978 €	0 €	4 978 €

Figure 17. Example of hidden additional costs: packing cost

More similar examples are presented in above figures. Also figure 16 illustrates scenario where originally more expensive supplier becomes even more expensive when the hidden packing costs are added to purchasing price. Figure 17, on the other hand, is an example of scenario where part of the cost savings achieved with lower price are lost when packing costs are added to evaluation.

Above examples were deliberately selected from multi-source scenarios, where two or more suppliers are providing the same component. In addition to these scenarios, similar hidden costs can be easily found from the system. Having different ways of processing

additional costs, such as packing, doesn't support existing practice of making comparison based on component price, especially as these hidden costs are not always recognised by the decision makers. Therefore, invoicing practices should be aligned within the whole organisation by either including certain cost elements always into component price or requesting them being invoiced separately. Having aligned way of working, would increase validity of component price information.

Similar validity issues seems to occur also for the transporatation cost follow-up. This is mainly caused by current case company policy of allocating 3% landed costs for each purchase order to cover transportation costs paid by the purchasing organisation. In other words, same 3% landed cost is added to component price, regardless of required mode of transportation, and whether the component was purchased from TPM supplier located close or LCC supplier at the other side of the globe. Similarly, existing landed cost allocation doesn't recognise differences at component characteristics. As a result, lower transportation cost is allocated for a cheap and simple metal component, which is large, heavy and expensive to transport, than for more expensive technological equipment that can be easy and cheap to ship.

While most of the procurement decision makers seem to understand problems related to existing landed cost allocation, current way of working still makes it harder to identify true costs of transportation. As a result, comparison between different supply alternatives might not done based on actual cost information, but instead assumptions of possible cost structures are used. Examples of transportation cost discrepancies are display in table 3. In the table, example purchase orders are listed with component price, existing landed cost allocation and actual transporation cost invoiced by the carrier. In addition, the region of dispatch is displayd to provide background information. All prices have been adjusted, while proportions have been maintained.

From these randomly selected example items, it can be already noticed that 3% landed cost allocation doesn't accurately describe actual transportation cost. Instead, transportation costs are varying between 0,7 and 125,5 percentages. This means that actual transporation cost can be either higher or lower than allocated landed cost.

Purchase order	Dispatch region	Component price	Allocated landed cost (3%)	Actual transportation cost	Actual transportation cost %
1	Asia	9 887,22 €	296,62 €	1 377,98 €	13,9 %
2	Asia	2 321,54 €	69,65 €	242,34 €	10,4 %
3	Asia	4 890,00 €	146,70 €	1 416,59 €	29,0 %
4	Asia	1 477,78 €	44,33 €	379,96 €	25,7 %
5	Domestic	1 222,40 €	33,89 €	8,55 €	0,7 %
6	Domestic	4,54 €	0,14 €	5,69 €	125,5 %
7	Domestic	55,56 €	1,67 €	6,63 €	11,9 %
8	Europe	1 075,80 €	32,27 €	85,02 €	7,9 %
9	Europe	2 777,24 €	83,03 €	216,91 €	7,8 %
10	Europe	9 620,23 €	288,61 €	182,23 €	1,9 %

Table 3. Examples of actual transportation cost and difference to allocated landed cost.

While more extensive, but still relatively limited background data was analysed, it was observed that certain differences in transportation costs between different dispatch regions exist. For example typical transportation cost for components purchased from Asia was almost 12% of component price. Similarly transportation costs for components from Europe were close to 5% and from domestic markets below 3% of component price. It was also noticed, that transportation costs for individual purchase orders might became high also from domestic markets if the lot-size has not been determined economically. Inability to determine EOQ's for replesnishment might be related to poor visibility towards transportation and inventory keeping costs.

While it is possible to identify that there is variation between transportation costs from different supply regions, it is not possible to accurately determine root causes for higher share of tranportation costs based on evaluation performed for this thesis. This is because higher share of transportation cost in comparison to component price can be caused either by more expensive transportation or less expensive components. Typically with components purchased from LCC sourcing markets, both reasons can be applicable. Still it is possible to conclude that transportation costs should be captured more accurately based on real costs, instead of using general allocation rules.

In addition, it was noticed from the invoices that transportation costs have relatively dynamic nature, as freigth costs are often impacted by changing fuel prices. This also

supports the need for collecting transporation costs directly from invoices, instead of using price lists. Based on the invoice, actual transportation cost could be then divided for each individual purchase based on predifined allocation rules. Unfortunately, while the carrier invoices already exist in case companies ERP system, transportation costs are hard to capture due to missing links between different documents. Possible developments should be considered to enhance transparency between different cost elements.

As a final observation to validity of transportaion costs, it has to be notified that certain inaccuracies were observed while analysing the data. For example, delivery terms for some suppliers were either incorrectly maintained in the system, or alternatively agreed delivery term was not applied during the procurement process. In other words, there was examples where data in ERP system indicated that FCA incoterms should be applied with one of the suppliers. This would mean that case company is responsible for covering transportation costs. Regardless of information provided by the system, the supplier was still performing deliveries with their own carrier and cost impacts were not transparent. In this case, validity of component price and transportation cost were affected, because it was not clear whether transportation cost was already included in the price, while landed cost allocation would still calculta 3% transportation cost. To achieve higher validity with transportation costs, higher data quality needs to be achieved with delivery terms.

In addition to component price and transportation costs, case company is currently also collecting data considering supplier quality costs. Therefore, validity of existing supplier quality cost is also evaluated. This evaluation is mainly based on discussions performed with quality and procurement experts within case company. In addition, it is evaluated whether existing supplier quality cost data collection practices are enough or should more accurate or extensive data be collected.

After review of excisting processes and ways of working, it can be observed that case company actively measures supplier quality cost, but cost elements included in the measurement are rather limited. In practice, current measurement is based on costs that can be claimed back from the suppliers, instead of costs that were actually created by the activities that were performed because of supplier quality nonconformity. This means that case company measures the amount that it should be capable of claiming back from supplier due to nonconformity. Typically this cost is limited to component price, or costs related to rework as long as those are below component price. This also means that defect with small consequenses in expensive component would be regarded as more important than defect in cheap component but with severe impacts to production process or end

product. Generally, it could even be argued whether the claimed cost can be considered as nonconformity cost as the case company will be compensated.

While the existing data collection and measurement practices mainly concentrate on the price of nonconforming materials, costs are more extensively recorded when material is repaired by the case company. Typically the recorded costs are related to rework and use of machine or labour resources to eliminate the nonconformity by repairing the component, while activities related to additional inspection, internal logistics or reverse logistics are not included. This means that multiple costs elements are still left without attention, and therefore the real cost of supplier quality failures remain hidden.

As an example of results from poor visibility towards supplier quality costs, case company is currently taking responsibility of costs that should more likely be carried by the supplier in case of nonconformities. For example, when component is purchased, case company carries the transportation cost. If nonconformity is observed, component is returned and only the component price is claimed back. If the case company now purchases replacing component from the same supplier, it will again carry the cost of transportation. As a result, case company has paid double transporation for one material, and this cost is not even recorded in the systems and made visible in measures. Similarly, many other cost elements are not recorded to the systems, which reduces the validity of quality cost information.

To support more extensive TCP measurement and supplier evaluation based on total costs, quality cost data collection should include more extensive range of cost elements and extend beyond claimable costs. To increase validity and availability of supplier quality costs, proposals for new nonconformity management policies have already presented. Unfortunately, these proposals have not been extensively adopted in practice. This might be partly related to complexity of recording policies and need for manual inputs, which might be easily condidered as an extra work.

The objective of this section was to evalauate availability and validity of procurement cost data in the case company. To summarize, availability of procurement cost information is relatively weak in the case company and measurement practices are mainly focusing to component price, while also information about some other cost elements can be found from the ERP system. Unfortunaly, validity of available cost elements is not perfect and it was possible to identify inconsistencies already by analysing a limited sample of records. To support TCP adoption, availability of procurement cost data should

be improved, while enhancing the validity of already existing cost elements. This means that proper policies should be established for data collection and cost recording processes.

6.5 Opportunities and barriers for implementing TCP measurement practices

The objective of this section is to identify and highlight some of the opportunities and barriers between current state of procurement cost measurement and more extensive adoption of TCP approach. Based on the theoretical review, typical barriers for adopting total cost approach could be divided into availability cost information, system limitations and organisational issues. For example, existing systems don't support total costs approach, not enough procurement cost data is available or employees and top management don't support total cost initiatives. Analysis for this chapter is based on the questionnaire results, interviews and strategic objectives of the case company.

To enable more comprehensive TCP adoption, need for the approach should be recognised by relevant stakeholders, such as top management and procurement decision makers. Case company's supply management mission identifies lowest total cost as one of the key objectives. In addition, total cost approach has been recognised in many discussions, development programs and strategic objectives. Also, general interest towards TCP topic supports impression that topic is relevant and current.

Based on the questionnaire, 59% of respondents considered that there is a need for TCP measurement model within their organisation, while 26% was not sure with their view (figure 18). While this provides relatively strong support for more extensive TCP adoption, also challenge how to convince remaining employees about importance and benefits of TCP approach exist. More thorough analysis could provide information whether TCP evaluation is relevant topic for respondent who answered "No". In other words, some of the "No" -respondents might not be actively making procurement decisions based on total cost information, and therefore don't identify need within their organisations.

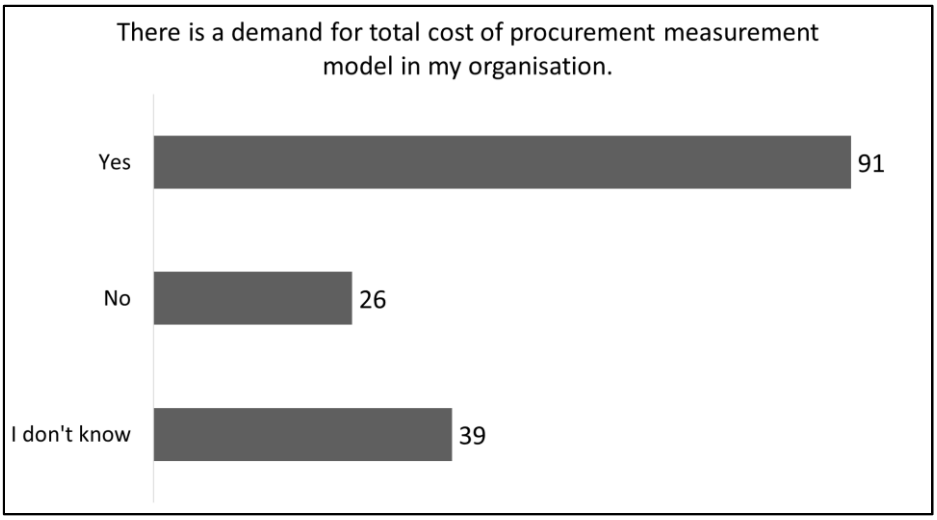


Figure 18. Identified demand for TCP measurement model

Interest and need towards comprehensive TCP model was also highlighted separately by many of the respondents. For example, one respondent highlights that TCP should be part of long term strategic action plan when procurement process is developed, while the other respondent recognises that TCP would be an important enabler for improving work performance. In general, questionnaire results and positive comments from the respondents should be considered as an opportunity for more comprehensive TCP adoption, especially when the lack of employee commitment was identified as one of the major implementation barriers by literature and earlier studies.

The earlier total cost studies also observed that employees might be hesitant if total cost information is used to evaluate their own or organisational performance. Based on the questionnaire results, large majority of respondents would consider it comfortable if total cost information is used for evaluating their own performance (figure 19). The questionnaire result was also supported by interviews and other discussions. Based on the respondent views, use of TCP would allow procurement decision makers to use more versatile methods for achieving lowest possible total cost instead of concentrating only on price reductions. Based on the additional comments, it was also highlighted that if TCP is used for performance evaluation, benefits should also be recognised by controllers who are currently more focused on component price. In other words, TCP approach should also be recognised by the internal stakeholders outside of procurement process.

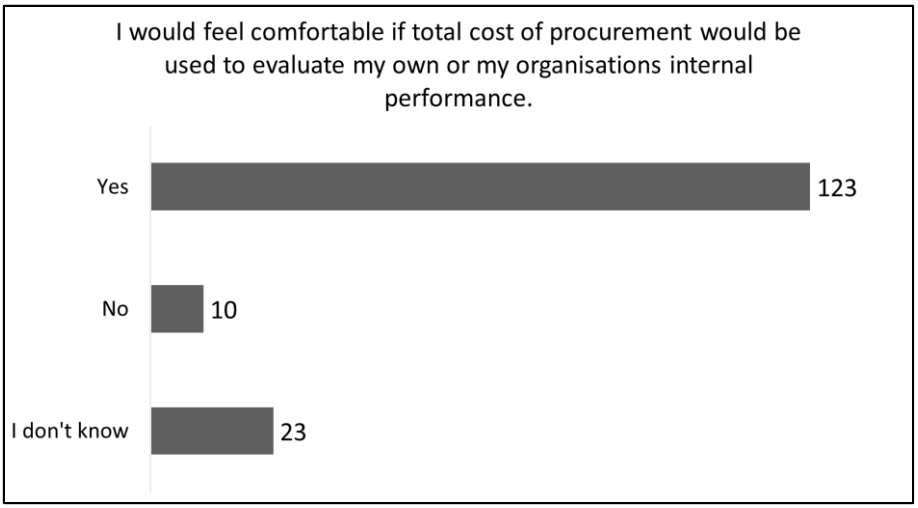


Figure 19. Use of TCP for measuring personal or organisational performance.

Based on the literature, top management support and commitment is one of the key requirements for successful TCP adoption. Therefore, it is important to ensure that procurement top management recognises the value of TCP approach and is committed to its adoption. To evaluate existing commitment, respondents were asked if they feel that their organisation supports decision making based on minimizing TCP (figure 20). In addition, respondents were asked whether more extensive reporting would be acceptable if it would enable more efficient TCP measurement.

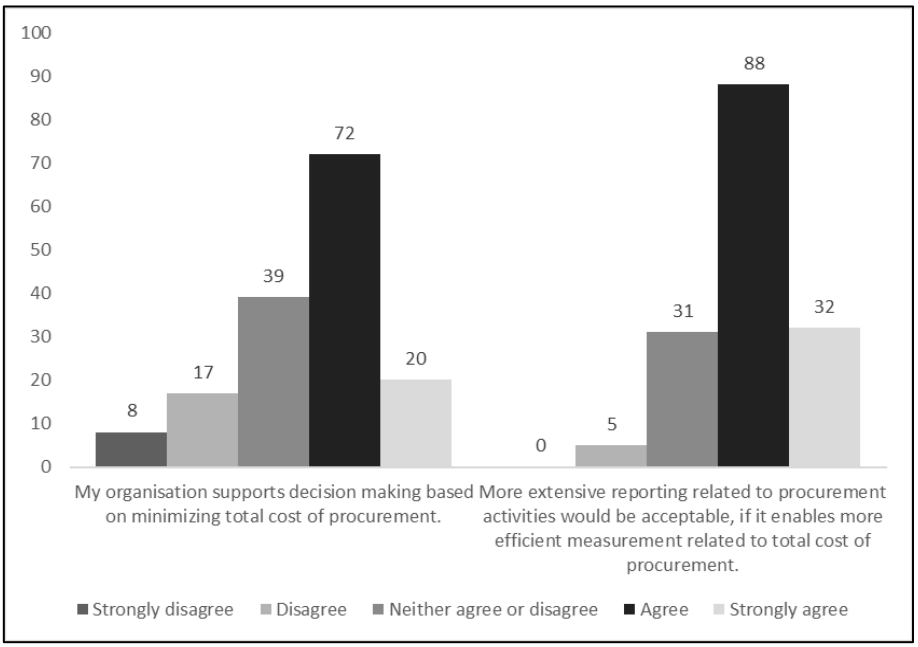


Figure 20. Organisational support for minimizing TCP and readiness towards more extensive reporting.

Based on the questionnaire results, most of the respondents either agree or strongly agree that their organisation provides support for their decisions which aim to minimize TCP. Although procurement decision makers perceive that their organisations support minimizing TCP, the results seem to be bit conflicting with existing measurement practices and price reduction programs, which don't basically recognise other cost elements than component price. On the other hand, together with case company's supply management mission statement, the questionnaire results indicate that support from top procurement management should be available for TCP adoption activities.

Readiness towards more extensive reporting requirements provided positive results for TCP adoption. In advance, it was expected that procurement decision makers would not be ready for additional reporting, as the current reporting needs are already relatively high. To indicate already existing reporting activities, some respondents noted that extra reporting should not increase overall workload and overlapping reports should be avoided. At the same time, some respondents recognised opportunities with automated data collection enabled by data robotics and business intelligence systems. Opportunities to support TCP adoption with these tools can be considered good because case company has invested lots of efforts to data robotics and self-service BI solutions. Availability of these new tools for data collection, should also be recognised as an opportunity and enabler.

While many organisational opportunities for TCP adoption exists, also barriers were recognised based on questionnaire responses, interviews and evaluation of existing procurement cost data. As described in the previous section, availability of procurement cost data, and validity of existing data create its own barrier. In practice, it will not be possible to extensively adapt and establish TCP measurement practices if the required data is not available or can't be trusted. Poor cost data quality was also recognised as one of the key barriers for TCP adoption. To enhance data availability and secure its validity, possibility to record procurement cost information should be acknowledged in all the development programs. In addition, cost impact of new processes should always be evaluated and recorded so that possible improvements and changes can be applied into TCP model.

When the cost data from the ERP system was analysed, it was observed that purchased components are not very accurately categorised, at least within the focus business process. While the missing categorisation might not impact cost data collection and reactive measurement, it might reduce the possibilities related to proactive evaluation of typical cost structures. For example, it might be hard to evaluate what is typical cost structure for

specific material, when it is purchased from certain region, if the category information data can't be easily categorised.

In addition to data related barriers, existing procurement process also creates challenge that don't support decision making based on TCP. For example, many respondents highlight that there is no sufficient time for them to source materials and select suppliers based on cost information. In practice, new component design is introduced so close to manufacturing requirements, that major focus needs to be given for securing material availability for production instead of looking optimal supplier from cost perspective. By providing more time for sourcing activities, respondents would be able to put more effort supplier selection and cost comparisons.

While this thesis has mainly focused on one of the procurement processes within the case company, it has been highlighted by the respondents that same TCP policies should be followed by all the organisations within the case company. This can be considered as a challenge for TCP model development, because there is lots of variation with performing procurement process within the case company. In other words, different variations of procurement process should be considered as a barrier if same TCP model needs to be applied for all procurement scenarios, and especially if high level of accuracy is expected.

Finally, it was also suspected in one of the interviews that existing rewarding practices might not support activities that aim to minimize TCP. Instead, rewarding systems and individual performance plans tend to concentrate on reducing component price. If the rewarding practices conflict with achieving lowest TCP, commitment from employees can't be fully expected. Therefore, conflicting objectives should be considered as a barriers and alignment is required if TCP measurement practices are focused adopted.

The purpose of this section was to introduce existing opportunities and barriers for TCP adoption. As a result, it was recognised that organisational opportunities seem to exist and there are positive expectations towards TCP adoption. On the other hand, barriers related to procurement cost data and procurement process exist. Similarly, some practices should be aligned with TCP concept, if the approach is adopted.

6.6 Considerations for TCP measurement model

The purpose of this section is to discuss about characteristics that would be important for the TCP measurement model. The background information for this section was mainly collected from interviews and questionnaire, where questions related to use of TCP model, data contents and characteristics were asked. In addition, some highlights from the theory will be repeated.

Two questions (Q8. & Q9.) related to the scope and accuracy of TCP measurement model were asked from the respondents. The objective of these questions was to provide support for adoption process by describing the expectations from end users. Figure 21 indicates that most of the respondents consider that TCP model should include only reliable and relevant data. While the ultimate objective of total cost approach is to include and collect all the cost elements related to procurement process, the result provides support that TCP model could be adopted in stages. In other words, the first implementation of TCP model could only include the most relevant cost elements, while the availability and validity of other cost elements could be simultaneously enhanced. After the required enhancements have been applied, these cost elements could be added to the model.

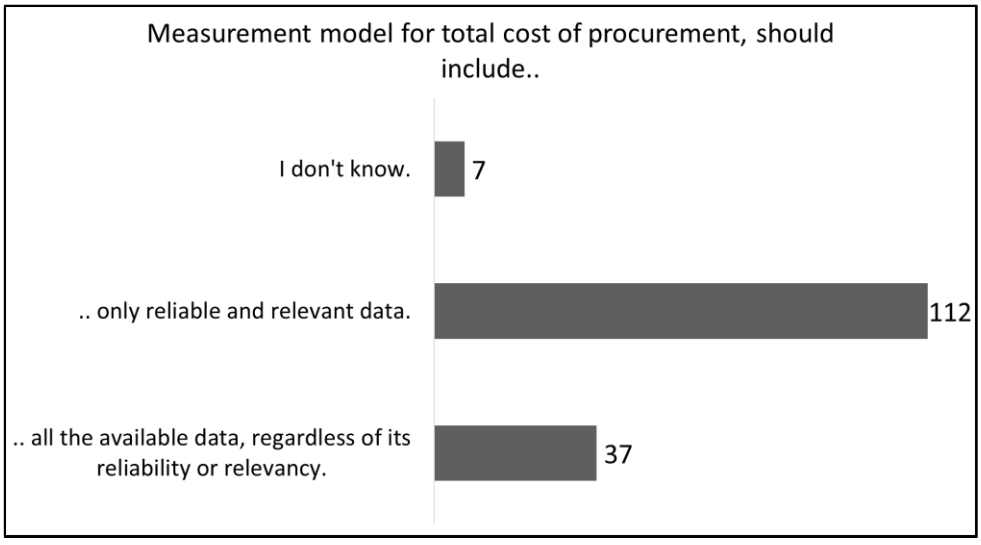


Figure 21. Reliability and relevancy of TCP measurement model data.

Corresponding question (Q9.) was also asked to evaluate applicability and accuracy of TCP measurement model. Figure 22 illustrates that most of the respondents would rather select accurate model with limited applicability, in comparison to inaccurate model that could be applied for every procurement scenario. Although the results for this statement are also relatively clear, more respondents would be ready to accept less accurate data

than unreliable and irrelevant data. In other words, small inconsistency between responses to the Q8. and Q9. could be observed. While it can be hard to accurately determine reason for the inconsistency, possible explanations could be considered. For example, it is possible that respondents didn't identify any correlation or relationship between the two statements, and therefore don't consider that relevancy, reliability and accuracy are connected to each other. Also, it is possible that respondents emphasized applicability over

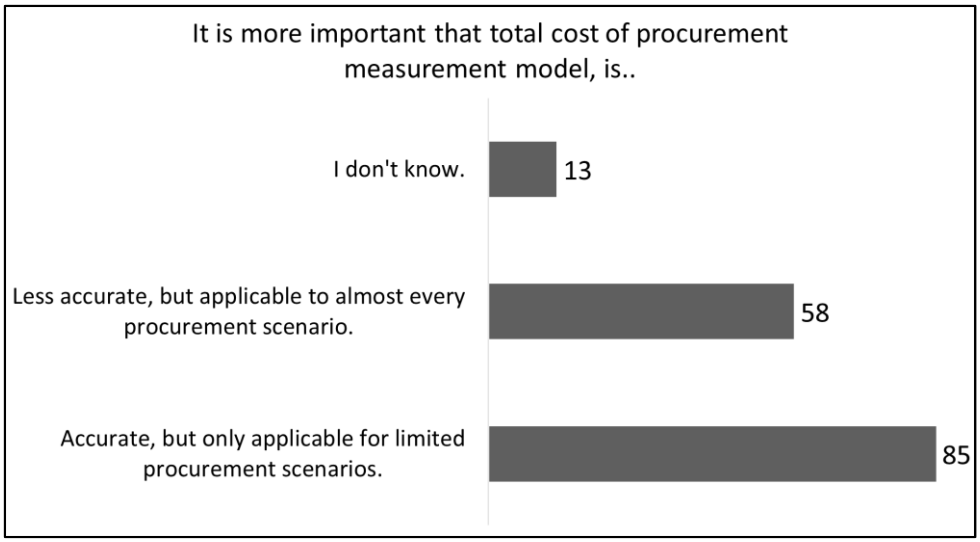


Figure 22. TCP model accuracy and applicability.

accuracy in question 9. Meaning that accuracy itself wasn't possible considered as a result of data relevancy and reliability, but rather as the amount of collected cost information. While there might not be any major issues related to these questions, it could be useful to clarify end user expectations before the actual model development.

The interviews and responses to open questions provided additional input for model development from reliability, relevancy, applicability and accuracy point of view. For example, it was considered by respondents that TCP should be evaluated in a similar way throughout the organisation and the measurement policies should be equal. Similarly, it was also emphasized that accuracy should be prioritized, and the model could include only the most relevant cost element in the beginning. Minor deviation was observed between the responses on the cost element importance and priority, though different priorities could be result of respondent's personal interests and responsibilities.

In general, the empirical findings conform to earlier studies presented in the theoretical part of the thesis. For example, earlier studies identified that accuracy is one of the key enablers for the success of TCP adoption. Additionally, earlier studies also supported the

importance of identifying the most relevant data for each procurement scenario, instead of collecting all the information that could be somehow loosely connected to the evaluation or measurement. Earlier studies also proposed that inaccuracy related to some cost elements could be absorbed by making these cost elements visible in the model, while excluding them from the actual TCP model if the data is not reliable enough.

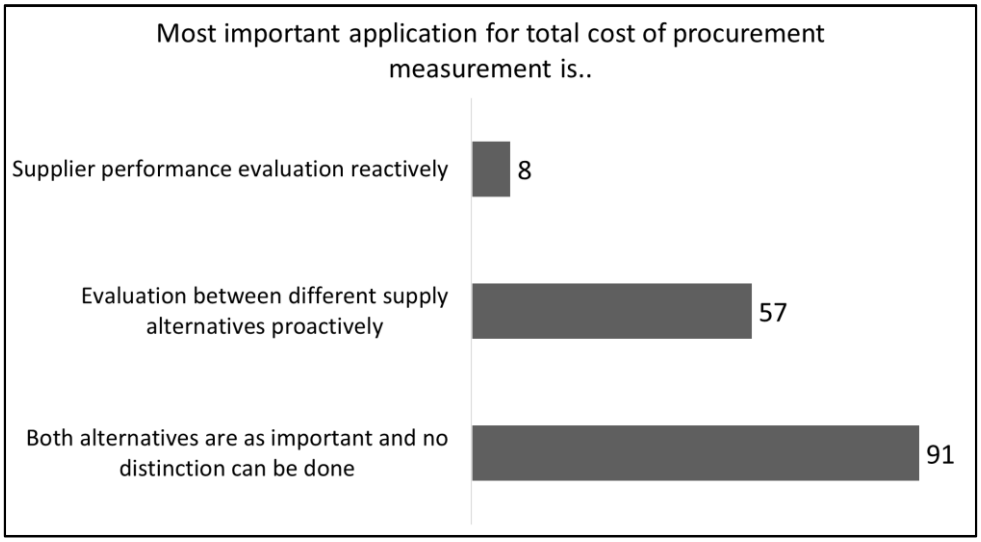


Figure 23. Primary use for TCP measurement.

Three primary objectives for TCP measurement were defined earlier in this thesis. While the TCP approach can also be used to evaluate organisations internal procurement performance and cost impact, empirical part of this thesis concentrates on supplier evaluation and supplier selection. To understand need for TCP evaluation in different procurement decisions, respondents were asked which of these two applications is considered to be more important, or if they are equally important. Based on the responses, TCP model could be either emphasized towards reactive data collection or proactive forecasting model.

Instead of having one clear preferred application, the questionnaire results indicate that data provided by TCP measurement would be used for both purposes, reactive supplier performance evaluation and proactive consideration between different supply alternatives. While most of the respondent consider both alternatives equally important, only eight persons consider reactive supplier performance evaluation to be more important than proactive decision making. While most of the respondents still recognize also the importance of reactive long-term supplier performance evaluation, the results partly indicate that organisation is putting more emphasis on supplier selection phase in comparison to long-term follow-up and evaluation.

In some extent, these results can be related to the fact that some of the respondents are working in an environment where purchases are not repetitive and supplier relationships don't extend over a long period of time. This can be typical scenario for example in indirect procurement when capital goods are purchased, and each transaction is unique. Similarly, it could be expected that respondents working with direct component procurement would appreciate for having both application available as they need to select suppliers by evaluating expected cost structures based on historical data, while also performing follow-ups on existing supplier performance. In general, the results suggest that both applications need to be considered for model development, which means that TCP measurement model should indicate cost performance of existing suppliers, while also describe typical cost structures for different kind of purchases.

Possible applications, or ways of using TCP information, were also examined by asking respondents whether supplier specific procurement cost data such be shared for each supplier if the data is already used internally for supplier measurement. Distribution of responses is presented in figure 24. Based on the questionnaire, almost two out of three respondents agree that cost information could be shared with suppliers, when the data is used for supplier measurement. In reflect to literature, the results are encouraging as the positive impact of communicating TCP information towards suppliers has been acknowledged in the previous studies. Meanwhile it is also important to understand possible risk that are especially related to supplier relationship management, when cost data is openly distributed along supply chain. In practice, this means that proper governance for utilisation and communication related to TCP models need to be defined before distributing the data.

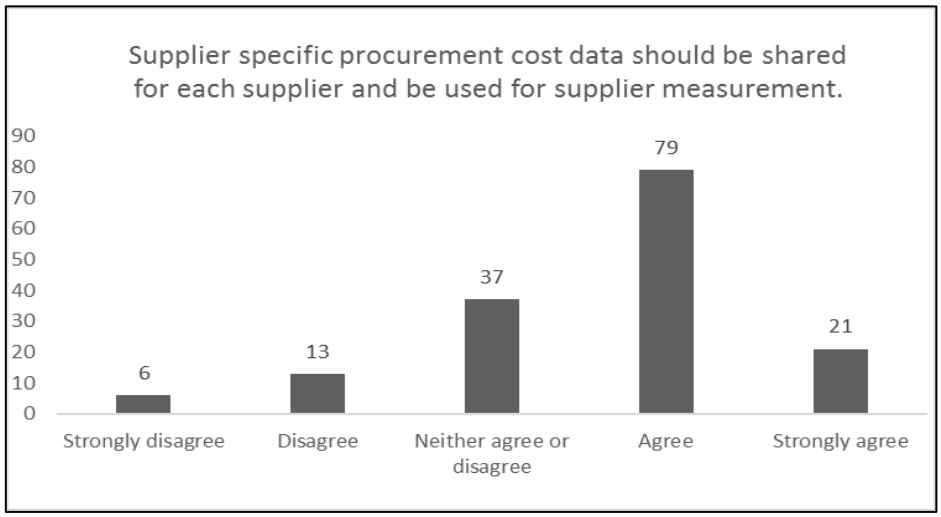


Figure 24. Sharing procurement cost data to suppliers

Additional comments related to distributing TCP information towards suppliers was also provided by the respondents. For example, one respondent highlighted that TCP information should only be distributed to that supplier who is responsible for that cost and is delivering the components. In general, this could be considered as a good practice and, supplier specific, accurate TCP data shouldn’t be distributed to the competing suppliers. On the other hand, providing suppliers with general high-level information about their competitors cost performance, could lead to performance improvement with those suppliers who are currently performing worse than average. Similarly, it could be beneficial to provide acknowledgement and encouragement for those suppliers who are currently performing well.

7 CONSIDERATIONS FOR TCP MODEL DEVELOPMENT

The objective of this chapter is to summarize introduced previously theoretical framework and empirical research sections in a way that enables case organisation to develop its procurement cost measurement and evaluation practices. This will be performed by evaluating empirical findings against theory, and by discussing how the different cost elements would be possible to combine into one TCP measurement model in a way that doesn't risk the integrity of data and validity of the results. In practice, the model considerations for TCP adoption will include following aspects: steps for model development, what cost elements should be introduced into the model and how these costs could be categorised. Finally, the chapter also aims to consider how the model itself could be built and structured, and how the TCP information can be visualised.

7.1 Model development steps

While the thesis itself doesn't cover the actual development of TCP measurement model, the necessary implementation steps will be acknowledged as part of the considerations. This is performed to ensure that the recommended model would be applicable for the actual implementation. In addition, some of the steps are important to discuss so that proper extent and structure of TCP measurement model can be secured. For the consideration, development steps recommended by Ellram (1993) and Degraeve et al. (1999b) will be utilized. It is also recommended that these models would be utilized for the actual model development and implementation as they provide clear and structured framework for the development activities.

Ellram's (1999) development model starts by identifying the need for the measurement model. Based on the results provided by the empirical research and organisations supply management objectives, the need for more extensive procurement cost measurement and evaluation model within the case organisation can be observed. This means, that incentive for TCP model development should exist.

As a next step, scope of the measurement model should be defined. Based on the framework and restrictions of this thesis, the model will include only direct materials and components which are purchased by the case organisation and used as inputs for the manufacturing process. It is also typical for these components, that material master records are maintained for these materials, and the requirements, replenishments and consumptions

are recorded in the ERP management system. This enables that basic material information from the ERP system can be utilised for model creation.

The next important step for model conceptualization is to identify relevant sources of procurement costs. For this step, stages defined by Degraeve et al. (1999b) will be utilised. This means that the most relevant activities of procurement process will be identified based on their cost impact. After that, cost drivers impacting these activities will be mapped, so that possible changes within the costs can be evaluated. Finally, each of the activities will be assigned to specific hierarchical level, which will enable allocation of costs. In addition, existing possibilities to evaluate each specific cost will be discussed. The mapping and categorisation of these procurement activities and cost elements will be performed in the next section of this chapter. In Ellram's model, these actions would be part of step 4.

After identifying relevant activities, cost drivers and hierarchies for occurrence, a structure for TCP measurement model will be proposed. This model will be based on case organisations existing business reporting infrastructure and data models. As part of the model proposal, also actions to improve data availability and validity will be proposed. These steps will be performed in section 7.3 Model infrastructure.

Remaining steps of Ellram's model are mainly related to actual implementation of the TCP measurement model and its continuous improvement. Therefore, these steps will not be covered in detail as part of next chapter, although some recommendations for proper actions might be given to ensure successful implementation. Additionally, also the third step related to TCP development team formation will be left outside of the discussion.

The steps included in the scope of this thesis are presented in below figure 25.

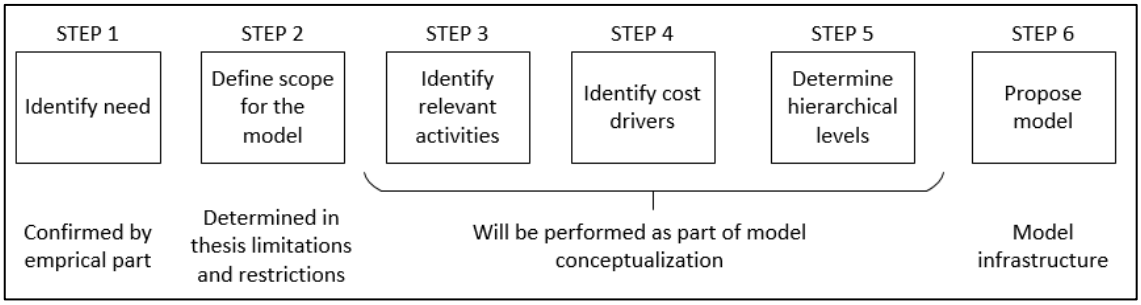


Figure 25. Steps for TCP model development.

7.2 Cost identification, categorisation and measurement possibilities

Purpose of this chapter is to illustrate how the steps three, four and five could be performed according to the proposed model development steps. The activity identification was performed according to thesis limitations and empirical research results. This means that all the activities are included in the procurement process and are considered important sources of procurement costs according to questionnaire results, interview respondents and earlier studies related to procurement costs within the case organisation. The most relevant activities for procurement cost evaluation are presented in table 4. These cost elements are also considered to be important for the TCP model development and they should be either included in the measurement model itself or visualise their existence.

To provide more accurate understanding related to possibilities and challenges related to measuring cost impact of these procurement activities and cost elements, a short discussion will be performed for each of the items. This discussion aims to evaluate how the cost can be derived from the activity based on the specific cost type and cost drives. Additionally, possible allocation rules will be discussed based on the level of hierarchy where cost occurs. For some of the activities, the evaluation will be primarily related to cost availability and related enhancements, as there is not enough accurate data to start evaluation and measurement immediately.

The first three cost elements are related to logistics function. While transportation costs, taxes and duties are direct monetary costs that should be possible to trace back to invoice, costs related to goods reception and material handling are related to utilization or resource. Therefore, different collection methods are required for these cost categories.

For transportation costs, four different scenarios can be identified within the case organisation. Supplier can either book transportation by using system integrated advanced shipping notice (ASN) or by contacting instructed carriers directly outside of any system integration. In addition, orders can be delivered by using local deliveries or by using DAP and CIP incoterms, which assign cost responsibility to supplier. Overview of cost availability and allocation rules are presented in table 5.

	Activity / cost element	Potential cost drivers	Cost specifity	Hierarchical level	Cost type
Logistics	Goods reception and handling costs	packing quality, quality of delivery documentation	supplier capabilities	batch	resource utilization (time)
	Transportation	mode of transportation, special requirements, delivery distance	supplier geocraphical location	order	monetary
	Taxes and duties	component categorisation	supplier geocraphical location	unit or order	monetary
purchasing	Incoming inspection	supplier quality performance	supplier performance	batch	resource utilization
	Nonconformity management	supplier quality performance	supplier performance and capabilties	product / supplier	resource utilization (time), transportation costs, material handling costs, material costs
	Late delivery management	delivery reliability, number of late deliveries	supplier performence	order	resource utilization (time)
	Purchase order management	communication capabilities, use of order management tools	supplier capabilities	order	resource utilization (time)
	Safety time	supplier delivery reliability, average number of late days	supplier performance	product / supplier	cost of working capital
	Level of safety stock	supplier quality performance	supplier performance	product	cost of working capital
	Packing	agreement terms, requirement for protection	supplier geocraphical location	batch	monetary
	Purchase price	complexity of product, delivery terms	supplier capabilities	unit	monetary
	Additional purchase order costs	supplier capabilities, purchase agreement	supplier capabilities	order	monetary
	Unnecessary inventory	supplier delivery reliability, warehouse location	supplier performance	product	cost of working capital
sourcing	Agreement negotiation	use of supplier relationship managment tools	supplier capabilities	product / supplier	resource utilization (time)
	Supplier development	supplier capabilities and skills, current supplier performance	supplier capabilities	supplier	resource utilization (time)
	Currency fluctuation	changes in currency valuation	supplier geocraphical location	unit	monetary
	Payment terms	payment days, discounts	supplier performance	order	monetary
	Supplier ramp-up	amount of training required, required capital investments	supplier capabilities, location	supplier	resource utilization (time), capital investments
	Supplier ramp-down	legal matters, protection of intellectual property, removal of tools and equipment owned by company	supplier capabilities, supplier geocraphical location	supplier	resource utilization (time)
	Product ramp-up	amount of training required, required capital investments	supplier capabilties, supplier geocraphical location	product / supplier	resource utilization (time)

Table 4. Relevant procurement activities and cost elements.

	Cost availability and actions	Allocation rule
ASN	available for deliveries, assignment rules need to be determined	from delivery → handling units in proportion of weights
Directly booked from carriers	costs available at invoice documents, currently not collected, collection method need to be established	from delivery → booked orders in proportion of weights
Local delivery	fixed cost, not currently assigned to individual deliveries	fixed cost allocated to each delivered order item
CIP or DAP incoterm	cost included in purchase price, should be better visualised	-

Table 5. Availability, required actions and allocation of transportation related costs.

As the transportation cost should be collected directly from invoice documents to ensure accuracy, a biggest obstacle currently is to solve how to collect costs from the invoices and record them for each order. This could be enhanced by utilizing optical character recognition (OCR) and robotic process automation (RPA) solutions that could read the invoice documents and record transportation cost in more accessible form. While this development would require some investments and work, existing experience accounting automation solutions could be utilised. In addition, availability of required metadata should be ensured so that invoices can be connected to other document types.

For the cost assignment, transportation costs need to be allocated from ASN or invoice level to each order. As one invoice or ASN can include multiple orders and transportation cost is dependent on weight and distance, allocation should be performed in proportion to weight of delivered components. When transportation cost is first recorded to each order, it can be later distributed for each unit.

Taxes and duties are mainly based on rates depended on purchase order value. These rates can fluctuate between times and therefore they should be collected at the time of occurrence. Two alternatives to collect these costs has been identified. First aims to collect costs directly from invoice documents and is based on OCR and RPA tools. Same requirements apply for this development than for transportation costs, but with higher initial investment, more accurate data collection could be achieved. The second alternative would be to define additional percentage which is added to the purchase price if taxes and duties are applicable for the purchase orders. While this solution could be established relatively easily, manual maintenance would be required for each of the possible scenario and changes.

Costs related to goods reception and material handling are a result of resource utilization, in other words, time that is required to perform the activity. The standard time to perform

these activities can be collected from manufacturing execution system (MES). To identify and record differences between supply alternatives, components and suppliers should be additionally categorised based on the complexity of goods reception and material handling process, and therefore time needed. For example, cost allocation for deliveries that are easy to receive, should be based on standard time without any additions. On the other hand, if delivery needs to be separately dismantled and work requires special tools and methods, additional time needs to be added to standard time.

Categorization is recommended to maintain ease of maintenance with the recording system. Goods reception and material handling costs should be recorded for each received batch and then allocated to units. The number of received batch can be collected from ERP or MES systems. All the process deviations, such as incorrect packing or missing documents, caused by supplier, should be recorded separately via quality notification processes or packing deviation reports. This allows organisations to record actual additional costs caused by the deviation and non-value adding tasks.

Activities related to purchasing function include incoming inspection, nonconformity management, late delivery management and purchase order management. In addition, cost elements related to safety time, safety stock, unnecessary inventory, packing, price and additional purchaser order costs are included. The wide range of different cost include direct monetary costs that can be easily collected from purchase order documents, costs related to working capital that can be calculated and resource utilisation which needs to be separately evaluated.

Purchase price, packing cost and additional purchase order costs include all monetary costs that supplier is invoicing as part of the order. While the price is currently easy to collect, measure and follow, the other cost elements are not systematically recorded and therefore it is hard to identify if these costs exist for specific purchase order. As a result, system should be enhanced so that different cost types are automatically categorised and even assigned to different ledgers. This would increase comparability of deliveries between different suppliers. OCR and RPA applications could be utilised for this work, while similar results can be achieved by determining proper EDI or e-invoicing practices.

The second group of purchasing related costs elements include utilisation or working capital. Cost elements in this group include safety time due to poor supplier delivery performance, safety stock due to supplier quality defects and unnecessary inventory caused by early deliveries. While the cost related to these elements is not currently measured, calculation rules and methods should be relatively easy to define as presented in table 6.

	Cost availability and actions	calculation
safety time	possible to calculate based on supplier delivery performence and component price	**safety time in days** = average days late * (1 - delivery accuracy %) **cost of safety time** = (safety time in days / 365) * component price * interest rate + (safety time in days * cost of storage bin)
safety stock	possible to calculate based on supplier quality performence data, master data and component price	**cost of safety stock** = safety stock inventory * component price * interest rate + cost of storage bin * 365 (if component is delivered by two or more suppliers, allocate cost in proportion of defect rates)
unnecessary inventory	possible to calculate based on supplier delivery performance data and component price	**cost of unnecessary inventory** = number of days delivered early * cost of storage bin

Table 6. Calculation of purchasing related capital costs.

Safety time should be determined based on supplier delivery accuracy and average number of days that deliveries are late. As a result, organisation can determine how many days of additional inventory is required to reduce risk of stock outs. The cost of having inventory for the days can be calculated based on component price, interest rate and cost of reserving extra storage bin for these days.

Similar calculation rules can be utilised for determining cost of safety stock. As a distinction to safety time, safety stock is held to reduce consequences related to supplier quality failures. As a difference to safety time, safety stock is maintained continuously over the time. Therefore, the cost of safety stock can be calculated based on its inventory value, interest rate and cost of reserving storage bin. If two or more suppliers are used, the cost of safety stock could be allocate based on supplier defect rates and quality performance.

For unnecessary inventory, the cost of receiving early deliveries will be recorded. This cost is a results of reserving storage bin for extra days. Cost of capital is not separately calculated as the invoice should be according to agreed delivery date. All these three cost elements should be recorded at the product level and then assigned to each unit based on volume of purchases.

The remaining purchasing related activities included mix of cost types. Purchase order management costs are solely related to utilisation of resources as part of performing purchasing function. These costs are not currently measured, but measurement practices based on resources utilization could be established relatively easily. Cost drivers for this cost element are related to supplier performance of performing delivery process efficiently and supplier competence to use most suitable tools for order management. In addition to basic cost for creating and managing purchase order, following factors can be identified to influence amount of purchase order management costs: supplier ability to confirm delivery within requested time, supplier ability to confirm requested and agreed delivery time and supplier flexibility to adjust delivery schedule if needed.

Number of deviations or transactions related to previously mentioned steps can be collected from ERP system. Time required for performing these tasks should be defined based on the actual time required when specific tool is utilised. If more efficient communication tools are applied, less time should be allocated for the task. Cost for each task is a product of required time, number of occurrences and hourly rate of employee work. For example, if supplier doesn't confirm on time and purchaser needs to send a reminder, time used for the activity could be for example 0.25 hours. Therefore, additional cost related to purchase order management would be 0.25 * hourly rate for employee work. These costs should be recorded at order level and then allocated to each unit.

Late delivery management costs include all costs that are related to possible material shortages due to late deliveries and tasks that are performed when suppliers are notified about late deliveries. Based on case organisation policy, late delivery notification should be created for each late delivery. Therefore, notification should also be the best tool for recording the cost. In other words, when component shortage causes production stoppage or special activities are required to ensure continuity of production, the cost related to each of these activities need to be accurately recorded to notification costs. As an example, these costs can be a result of lost machine capacity, production slots and human labour. In addition, the costs of creating late delivery notifications, credit note requests and receiving credit notes should also be recorded.

As many of the purchase agreements contain late delivery penalty clauses, case organisation can claim some of the late delivery costs back. On the other hand, it shouldn't be possible to record profit due to late delivery. Therefore, the amount that can be claimed should be recorded as a cost. When supplier provides credit for the whole amount, the credited amount will be reduced from late delivery costs. On the other hand, if supplier doesn't provide credit, the amount will remain as a late delivery cost. Late delivery costs should be recorded at batch level as it is possible that some part of an order is late while some is not.

Two quality related activities are included as a responsibility of purchasing function. First is the cost related to incoming inspections, while the second covers all the costs that are related to management of supplier nonconformities. Incoming inspection costs are a result of resources utilized when inspection is performed. To have more accurate data on resource utilization, time spent for the inspection should be recorded to the inspection documents. This would allow cost reporting based on required time and hourly rate of inspector. Additionally, inspection lots are created based on suppliers earlier quality performance. Therefore, components from high quality performing suppliers will be taken

into inspection less frequently and cost related to incoming inspection is less than for suppliers with poor quality performance. The cost of incoming inspection is only applicable for materials within the scope of inspection. The cost occurs at batch level and can be later allocated for each purchased unit.

Nonconformity management costs include all the costs that are related to failure of supplier quality. For each supplier nonconformity, a notification is already created, but the full range of related quality costs are not currently recorded. The most important development related to this cost element, would be to define proper policies on recording all the nonconformity related costs. These costs would include the price of nonconforming components, material handling costs, nonconformity processing costs, cost of reverse logistic, cost of rework, possible machine time due to repairs and cost of components that need to be scrapped due to dismantling. To evaluate nonconformity cost accurately, all these aspects should be considered.

Finally, sourcing is categorised as the third function which is responsible for creation of procurement related costs. These costs are mainly related to resource utilisation which is required to perform sourcing activities. In addition, costs related to payment terms and currency fluctuation are included in this category. This categorisation has been done, as these cost elements are often related to supplier contracting and execution of sourcing strategy.

To evaluate how payment terms impact overall cost of purchased component, organisation needs determine descriptive cost for capital. With component price, cost of capital and net days from payment terms, following formula could be established to evaluate impact of payment terms. Spend incorporated with impact of payment terms = price * (1-(cost of capital / calendar days in a year * net days). For example, spend of 10000 euros with 6% cost of capital and 60 net days payment terms, would result actual cost of 9901 euros. If the payment terms could be extended to 120 days, the actual cost would be reduced to 9802 euros. Similarly, possible discounts should be considered and payment terms with 60 net and 1.5% discount would result to actual cost of 9701 euros.

As the payment terms have notable impact to actual cost when compared to agreement price, the should be evaluated and compared. While this kind of follow-up is currently performed in case organisation, it would be good to highlight importance and impact of payment terms more visually, so that decision makers would understand possible benefits and compare supply alternatives also based on this information. The payment term impact

should be calculated for each unit and therefore there is no need for separate cost allocations.

Similar impact can also occur if organisation is making supply agreements with foreign currency. As reported by academics, currency fluctuation can be crucial element for the success of low-cost sourcing projects. To evaluate impact of currency fluctuations, all the costs in TCP measurement model should be translated to same currency. If component is purchased in foreign currency, exchange should be performed with realistic on-time exchange rates. These can be collected from different data sources. The actual component cost and original cost from the time of price negotiations can be compared after currency exchange has been performed. Possible differences between these costs should be recorded as a fluctuation impact, which can be either positive or negative value.

While some sourcing decision makers try to evaluate impact of currency fluctuations, there doesn't seem to be established way of working and measurement practices within the organisation. This is partly because most of the sourcing agreements are made with local currencies. At the same time, measurement practices should be relatively easy to establish as the needed information is available within the different data sources.

The costs related to supplier negotiations or RFQ process are similar than purchase order processing costs. Therefore, to maintain model simplicity and decrease possible distortions, only main variables should be evaluated for this cost element. For example, if RFQ needs to be created and processed manually, certain amount of resource cost is allocated to the activity. If supplier is capable for utilising electric tools, allocated cost should be less as the process is more efficient and require less time. The accurate time and cost allocations need to be separately defined. In addition, extra cost should be allocated if supplier responds late to RFQ or needs to be reminded. As the RFQ cost occurs typically only once for supplier and product, it will be enough to record costs at product level. Currently these costs are not actively followed and measured.

All the other sourcing related cost elements are a result of resource utilisation, possible travel and communications costs and capital expenditures. As these costs, such as supplier ramp-up costs, occur relatively rarely, it would be recommended that separate cost follow-up practices are established for each activity. Alternatively, a notification document could be created in the system, so that costs can be recorded. Regardless of the tool, it would be important to evaluate what kind of costs are created due to these activities. For example, the costs related to new supplier ramp-up and old supplier ramp-down could be compared to typical supplier development costs. In general, after data collection has been

performed for some time, organisation would be more capable to evaluate costs that are related to its supplier portfolio management.

The allocation of different cost elements to individual components should be performed based on separate evaluation of suitability for each case. For example, if supplier development costs are related to certain component category, the cost should be allocated to product level, but only for those components. On the other hand, if supplier development activities are general and impact full-scope of supplies, cost can be allocated to supplier level, and then assigned to lower levels based on the volume.

The purpose of this section was to identify and categorise relevant procurement costs. Additionally, these costs were discussed, and possible calculation and allocation possibilities were considered. While some data is already directly available from the ERP or accounting systems, and some others can be calculated based on available data, lot of information is still missing and needs must be made available before comprehensive and accurate TCP model could even be considered. While this requires resources and investments to databased and information management systems, the major contribution and commitment needs to be given by procurement managers and employees who are providing the data inputs. On the other hand, the questionnaire results were supporting that at least respondents would be ready to increase amount of reporting requested from them.

When new practices for procurement cost evaluation and collection are established, it is important to recognize what procurement decision makers are requesting from the model. Based on the questionnaire performed in case organisation, respondents request that model should only include reliable and relevant cost data, instead of gathering every cost related information regardless of its validity. Similarly, respondents consider that it is more important that TCP model provides accurate cost data for specific procurement scenarios instead of being applicable, but less accurate for all procurement scenarios. Based on these requirements, it will be proposed that a strict evaluation is performed for each cost element to validate data accuracy before the data is included in the model. If certain cost element can’t be evaluated or measured with required level of accuracy, the element should be left outside or made visible by other means.

7.3 Model structure

As the earlier examination of existing procurement cost information has revealed, lack of correct data is the most important barrier for implementing TCP measurement practices within the case organisation. While the lack of currently available information sources makes it difficult to accurately define suitable model infrastructure, some key elements could already be identified based on the recommendations from literature and questionnaire responses. This consideration aims to provide insight on factors that should be considered already before any actions are taken to enhance availability of procurement cost data. By understanding the possibilities and requirements of model infrastructure, cost information related enhancements could be aligned with desirable outcome.

Based on the empirical findings, there is a clear need to utilise TCP information in a wide range of different decision-making scenarios. This means that the measurement model should be flexible enough that users can either select or filter-out each of the cost elements based on their individual requirements. This kind structure could be achieved by aggregating each of the cost elements into separate data tables that can be connected to the model separately and without relationship to other cost elements. To make the model more visual, and to improve usability, the cost data tables could also be grouped based on different attributes such as cost hierarchy, and whether the cost is specific for supplier performance, capability or geographical location.

As the purpose of TCP model would be to evaluate procurement cost for each supply alternative, the costs should be visualised for each component and supplier combination. This would mean that combination of supplier and component would be the primary key that connects the different data tables to each other, and therefore, this key should also be available for each of the cost records that are collected from different data sources. A small exception is related to supplier level costs, that can be recorded only for the supplier and then allocated for each of the components supplied by that vendor.

While the data table could include all the transactions recorded for the cost element at certain hierarchical level, it could increase the performance of the model if the returned value would be the overall sum of costs related to that specific cost element, component and supplier. For example, price data table would return a total sum of price elements. In other words, the sum that has been paid to supplier over time for that component. This total sum could then be divided by the count of components delivered by the supplier and the result would be average price, which is then uses to evaluate TCP related to purchasing one component.

Similar aggregation and allocation can be done for cost elements like cost of supplier nonconformities, cost of incoming inspections and transportation costs. While these costs would be originally recorded at different hierarchical levels, the aggregation to total sum will enable possibility to later allocate the total cost to the individual cost level. The structure for simple example created with Microsoft Power BI including only these four cost elements is shown in figure 26. The cost figures in the model are fictional.

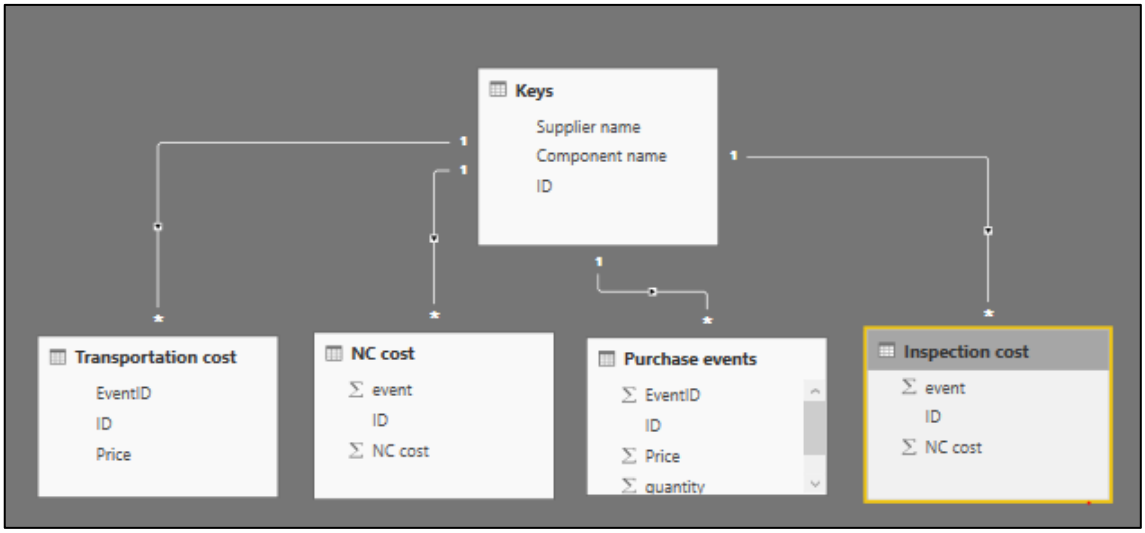


Figure 26. Example of model structure.

After the records from each data table have been first aggregated, the allocation can be done by diving the total amounts with count of purchased components. Based on these calculations, collected data can be transferred into different types of visualisations. A simple version is presented in figure 27. and it includes average price of a component, total amount of costs related to each element, total cost and total cost for an individual unit. Based on the example, it could be found out that component with lowest average price will end up with second highest total cost per material due to high amount of nonconformity costs.

Supplier name	Component name	Quantity	Average price	Total prices	Total NC costs	Total inspection costs	Total transporation costs	Total cost	Total cost per material
SupplierB	Comp3	22	498,75 €	10 970 €	120 €	40 €	330 €	11 460 €	520,91 €
SupplierB	Comp2	18	297,50 €	5 355 €	180 €		395 €	5 930 €	329,44 €
SupplierA	Comp2	38	230,00 €	8 740 €	670 €		240 €	9 650 €	253,95 €
SupplierC	Comp1	5	227,50 €	1 160 €		25 €	60 €	1 245 €	249,00 €
SupplierA	Comp1	19	201,33 €	3 826 €	2 299 €	75 €	204 €	6 404 €	337,05 €

Figure 27. Example of visualisation and comparison view.

If there would be a need to add new cost elements to the model, such as supplier development costs that occur at supplier level, the measurement model should be quite easy to extend. In the below example, supplier development costs have been recorded for suppliers A and C. These costs have been then equally allocated to all components that are delivered by the supplier. For example, cost of 1200 euros related to supplier development work for Supplier A, has been allocated to both components delivered by that supplier. Another way, would be to allocate supplier development cost based on the purchase volume. The proper allocation method should be considered based on the requirement.

Supplier name	Component name	Quantity	Average price	Total prices	Total NC costs	Total inspection costs	Total transporation costs	Component level supplier development costs	Total cost	Total cost per material
SupplierB	Comp3	22	498,75 €	10 970 €	120 €	40 €	330 €		11 460 €	520,91 €
SupplierA	Comp2	38	230,00 €	8 740 €	670 €		240 €	600,00 €	10 250 €	269,74 €
SupplierA	Comp1	19	201,33 €	3 826 €	2 299 €	75 €	204 €	600,00 €	7 004 €	368,63 €
SupplierB	Comp2	18	297,50 €	5 355 €	180 €		395 €		5 930 €	329,44 €
SupplierC	Comp1	5	227,50 €	1 160 €		25 €	60 €	950,00 €	2 195 €	439,00 €

Figure 28. Supplier level development costs incorporated into the model.

In a similar way, all the remaining cost elements can be quite easily incorporated into the model, considering the data must be first correctly measured and recorded. By having this kind of modular structure, measurement system could be easily tailored by the end users.

If some of the cost elements would be too complicated to measure in monetary way, it should be possible to include these cost elements into the model with a graphical way. For example, if special requirements are needed for material certificates, but the cost of these certificates could not be accurately measured, it should be possible to add annotation that these kind of cost elements exist for the component, but the impact is too hard to evaluate.

For reporting and measurement purposes, the case organisation is already actively utilising Microsoft self-service business reporting tool Power BI. Based on the experiences related to this tool, it can be recommended that TCP measurement model would be built by using Power BI. In addition to flexibility for model development, a wide range of different data sources can be connected to the data models. For example, it will be possible to gather data directly from ERP systems and SQL databases, and then transform and create calculations based on that data by different ways. In addition to these structural and rather heavy databases, Power BI also supports range of relatively light cloud-based databases that can be easily established. For example, database can be created by recording the data into excel worksheets and storing that data in a cloud.

Some of the benefits related to these lightweight databases would include ability to make fast paced proof of concepts and other developments by adding new data tables based on manual input and records provided by end users. After the relevancy and accuracy of added data values have been evaluated and verified, more structural and stable databases can be considered. Additionally, Microsoft is providing wide range of different user interfaces for creating and maintaining the records related to cost elements. In other words, the data records can be stored in excel worksheet or lists of records, but the actual user input can be done by using mobile applications. The importance of having efficient user interface would be critical if manual recording is often needed.

After the relevant data is available, data model has been created and proper allocation rules have been established, Power BI enable wide range of visualisation possibilities. For example, same data can be easily utilised for component level comparison, for which an example is presented in figure 29. Similar cost visualisation can also be performed for individual component by illustrating the distribution of different cost elements (figure 30). By categorising components and suppliers properly, the records could be also clustered into meaningful groups.

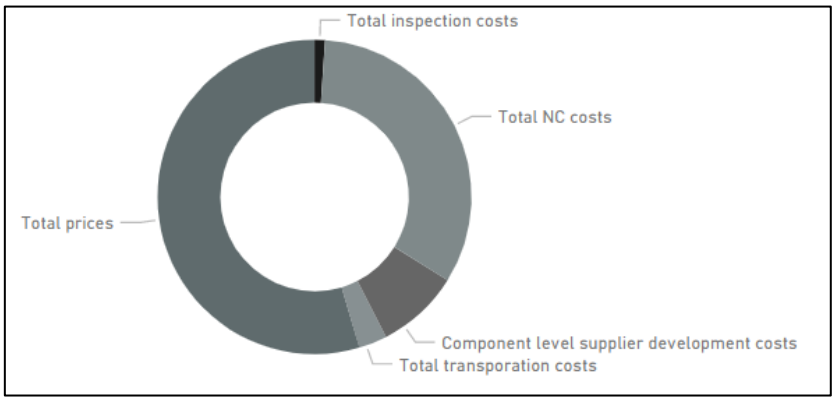


Figure 29. Cost structure for component 1 supplied by supplier A.

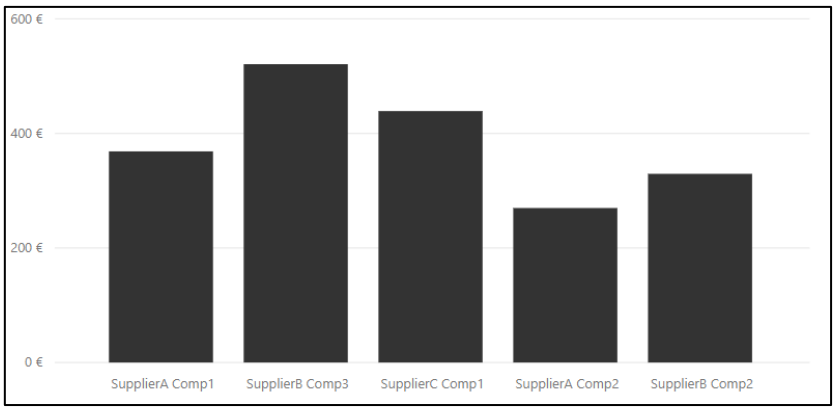


Figure 30. Total cost of procurement for each component and supplier combination.

Additionally, the model would for example allow users the measure total amount of transportation costs and then visualise how it has been distributed between components and suppliers. Example for this kind of graph is presented in figure 31.

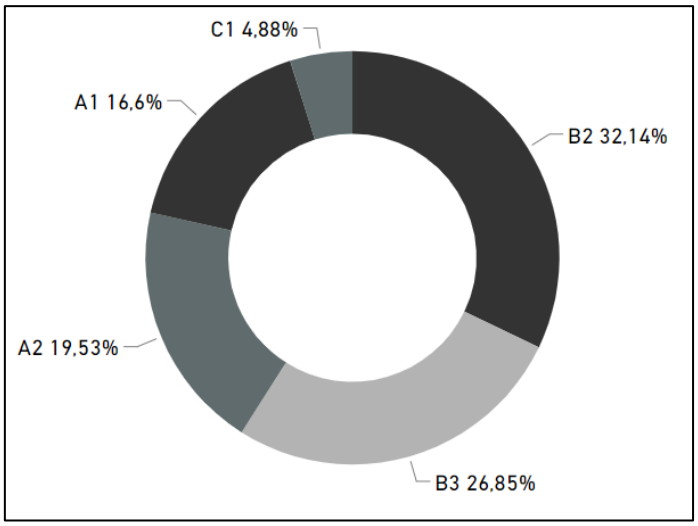


Figure 31. Example of transportation cost distribution for components and suppliers.

By being able to easily create different kind of visualisations and graphs that illustrate different aspects of TCP, the case organisation would be able to highlight full range of cost elements that are resulting from procurement process. When these elements are visible, decision makers will be more capable to make decisions based on them. This shouldn't mean that the alternative with lowest total cost of procurement should be selected, but at least the cost impact would be clear at the time of decision making.

8 CONCLUSIONS

The objective of this master's thesis was to identify how the case organization could develop and improve its practices related to measurement and evaluation of total cost of procurement within supply management framework. To reach this objective, theoretical framework related to procurement and total cost of ownership in industrial manufacturing environment were examined based on literary and academic sources. By combining these two frameworks, a concept for total cost of procurement as a limited approach to TCO was introduced during the fourth chapter.

Following the theoretical section of the thesis, an introduction to the empirical research methodologies was provided. During this chapter, also the validity and reliability of the research were evaluated according to good academic manners. Based on this evaluation, the research validity and reliability can be considered quite good, although the limited scope and focus on case organization environment reduce possibility to apply or extend research findings over time or into different environments.

After reviewing the research methodology, the actual findings of the empirical research were introduced. Major contribution for these research findings were provided by the questionnaire which was distributed to a limited respondent group within case organization. In addition, qualitative and quantitative information was collected from semi-structured interviews, ERP data sources and secondary data sources, such as earlier TCO or TCP evaluations.

Finally, the empirical part was concluded by providing considerations related to the development steps for TCP model, relevant cost elements and model structure. The purpose of these considerations was to provide ideas and suggestions for the case company, so that it would be able to start developing its own road map for the adoption and utilization of TCP measurement and evaluation practices within supply management framework.

For being able to meet the research objectives, three research questions were established:

1. How total cost of procurement can be measured in supply management framework and what measurement practices are acknowledged by literature?
2. What is the current organizational awareness related to the total cost of procurement and how organization is currently evaluating and measuring costs related to procurement process?

3. What is the organizations readiness to develop its practices related to total cost of procurement measurement and how the organization would like to use this information?

The first research question is mainly considered during the theoretical part of the thesis. According to the literary sources and academic studies, TCO is one of the many approaches that have been proposed for evaluating full extend of procurement costs. In addition to alternative concepts such as zero-based pricing, transaction cost analyses and life-cycle costing, different variations of TCO, such as total acquisition cost, have been introduce by authors. In this group, TCO stands out due to its extensive and widely considered theoretical framework which has been developed and evaluated by many authors over time.

Based on the literature, most of the TCO approaches are built upon principles of activity-based costing. While this approach requires that procurement organizations needs to identify and evaluate activities that are performed during the procurement process, it can be considered applicable especially when the procurement process itself is complex and variations in the operations exists. In other words, when procurement cost elements are traced to activities, the scope of measurement and evaluation can be adjusted based on the activity relevancy for the specific procurement scenario.

According to the literal sources, TCO can be used to support various strategic and operative decisions within procurement process. These decisions include make-or-buy considerations, supplier selection, supplier performance evaluation and internal performance evaluation for the procurement process. While the TCO information can be used to support during the decision-making phase, it will also highlight potential topics for continuous development.

While the different aspects of TCO measurement are extensively studied from theoretical point of view, lack of actual case studies related to model development and implementation were identified. Although some studies were identified from the late 1990's or early 2000's, only few examples were found from the past couple of years. Recent case studies would have been especially useful, as notable development has happened at the areas that were identified earlier as barriers for TCO adoption. For example, the capabilities of ERP and accounting systems have been developing notably during the past years. On the other hand, lack of TCO related case studies might be related to the delicate nature of the topic. Probably most of the procurement organizations don't want to publish detailed information related to their procurement strategy, cost structure and cost performance.

Regardless to the lack of recent theoretical knowledge related to implementation of TCO measurement practices within procurement framework, it was possible to develop concept for total cost of procurement. This limited scope was selected to describe more accurately the scope of interest. The approach for implementing TCP was also absorbed from TCO practices and therefore TCP is relying on the ABC principles and ABC is proposed as the suitable approach for developing TCP measurement practices.

In addition to limited case study sources, it was also noticed during the theoretical review, that the concepts and vocabulary within procurement framework can be confusing. This is because many of the functions are overlapping and it is hard to identify if there are any hierarchical relationships between these functions. Therefore, to enhance clarity during this thesis, procurement was identified as the top-level process, which includes the other functions such as sourcing, purchasing, inbound logistics and supply management. All the activities, on the other hand, are performed by these functions and can be considered as part of them. When procurement related topics are studied and developed, alignment of vocabulary and concepts can be recommended to avoid confusion and misinterpretation.

The second research question related to organizational awareness and existing practices for measurement procurement costs was evaluated during the empirical research. Based on the questionnaire results, the level of TCP awareness within respondent group is on a rather high level, although some respondents don't recognize the concept. On the other hand, highest awareness was reported within the respondent groups that can be considered most important for procurement decision making. Nevertheless, some training could be necessary to increase organizational awareness related to TCP. Similarly, most of the respondents agree to understand how their decisions impact TCP. This result can be considered encouraging as the respondent group has been selected from persons that are working within functions included in the procurement process.

When respondents' experiences related to importance of TCP was inquired, the deviation was higher within the responses when compared to earlier questions. This was related to high number of respondents who didn't either agree or disagree with the statement that minimizing TCP is the most important objective for procurement process. The higher deviation might be resulted from different daily objectives that each respondent could have. As a result, respondents might not identify how their daily objectives are impacting total costs. In general, better visibility to different procurement cost elements could illustrate how different objectives in the end impact TCP. In other words, TCP implementation itself can increase the experience of importance.

The existing procurement cost measurement practices were evaluated against the questionnaire results, comments from interviews and based on earlier procurement cost related studies within the organization. Based on the earlier studies, there has been interest towards implementing total cost of ownership measurement practices within case organizations procurement process. At the same time, these studies have been mainly focusing on cost structure of individual components or they have been oriented towards indirect purchasing. As a result, there is no evidence that these studies would have led to adoption of widescale and structured TCP measurement practices.

These findings are also supported by questionnaire results which indicate that there is a lack of established measurement practices that would extend beyond purchasing price, and therefore existing measures don't evaluate total cost related to procurement. In addition, the required procurement data is not easily enough available. At the same time case organization case organization accurately measures component price development and continuously performs different cost reduction programs. As a result, case organization seems to be relatively price oriented and emphasizes importance of price within procurement decisions. While the focus on price can't be considered as a surprise, some practices related to total cost measurement would have expected as the organization announces total cost as one of its main objectives for procurement operations.

While the current TCP related practices are not very extensive, some encouraging developments are taking place. For example, some measurement practices have been developed to follow supplier related capital expenditures more accurately. While these rather small but correct steps are taking place, it would be good to have proper governance models for TCP to ensure that information from this measurement practices can be efficiently utilized instead of creating number of scattered cost reports. Adoption of TCP practices can offer tools to implement this kind of governance.

The third and last research question was related to organizations readiness to implement TCP practices and how the organization would like to use the provided information. The organizational readiness can be evaluated from different viewpoint, such as employee readiness, availability of cost information and IT systems. The most encouraging results are related to employee readiness as the most employees seem to have rather positive attitude towards TCP measurement. For example, questionnaire respondent recognize how TCP measurement practices can improve procurement decision making and most of the respondent consider that there is a need for TCP measurement practices within their organization. Surprisingly many of the respondents would even accept more reporting

responsibilities if it would be required for having TCP model available. This might indicate that respondents consider that this reporting would assist in other decision making and reduce work.

The major barriers between current state and TCP adoption are quite clearly related to procurement cost data availability and accuracy. In other words, the data related to many procurement cost elements is either not available at all, or the available data is not accurate enough to base business decision on it. The data related issues can be divided into three categories: data is not available, data is recorded, available, but not accurate, and data is available but not utilized. To proceed with TCP adoption, it could be proposed that case organization first concentrates on developing practices to utilize existing data. At the same time, focus should be given for increasing the data accuracy. This could mean increase in data quality or change of recording granularity. After the available data is already utilized, emphasis should be change to missing cost elements. If the missing cost element is considered highly relevant, then its availability can be prioritized over the other steps.

When evaluating the IT systems and whether they support TCP adoption, the current state and forthcoming developments can be considered encouraging and more enabling than limiting. For example, organization is actively using and developing its ERP system, which provides many possibilities for recording and measuring costs. Additionally, a active development is constantly happening related to measurement and reporting practices. As major part of this development is related to self-service reporting, the organizations capability to create different measurement practices is quickly developing, while more data is constantly available. One of the suggested tools also for TCP related measurement is PowerBI, which enables organization to use and combine different data sources when creating TCP measurement model.

Finally, the respondents were also asked how the TCP information should be used. This was an important question as it provides valuable information for model development. While more respondents considered that it is more important to used TCP data for proactive supplier selection than for reactive supplier evaluation, most of the respondents considered that the model should be used for both purposes. This is a clear indication that the model should address both requirements, but there could be individual modules or tools to assist in both scenarios.

Additionally, users were asked whether they would be comfortable if TCP information is used for internal performance measurement. While issues related to internal measurement

practices were highlighted as risks and barriers for TCP adoption by literature, the questionnaire results indicated differently. While only a few respondents were against, most of them agreed that TCP can be used for measuring internal procurement. While possible risks should be recognized, this can be considered as a positive indicator of approving attitude towards TCP adoption. One of the possible reasons for this positive attitude is that respondents believe that performance and efficiency of their work can be increased when TCP practices are implemented.

The objective if this thesis was to identify how case organization could develop and improve its practices related to measurement and evaluation of total cost of procurement within supply management framework. The development opportunities related to this objective will be highlighted in the next section, which provides managerial implications for the case company decision makers.

8.1 Managerial implications

Based on the theoretical review of procurement and total cost of ownership literature and academic studies, case organisations strategy and procurement objectives, and empirical research, this section provides authors suggestions and implications for the case organisation, regarding the future development of procurement cost measurement practices. After reviewing the existing procurement cost measurement practices within case company, it is recommended that case company should extend its measurement practices to cover all the relevant cost elements. While this would enable organisation to better reach its procurement objectives, it would also increase its efficiency for making procurement related decisions and ensure that these decisions would be based on actual data instead of assumptions.

To enhance its measurement practices, total cost of procurement approach is suggested for the case organisation. While TCP is limited version of TCO, it could be embedded to more extensive TCO framework that would cover the whole component lifecycle from the designer workbench to the removal from use. On the other hand, while being limited adoption it provides focused tool that especially should meet and fulfil requirements that are placed by the procurement decision makers.

When the TCP practices are evaluated and developed, case organisation should provide notable attention to making required cost element data available and accurate. While this

might require separate project that aims to enhance data availability and accuracy in general, the TCP related requirements should be acknowledged by all the activities and developments that are already currently taking place in the case organisation. For example, if case organisation aims to perform cost reduction program, it should already beforehand identify and define how the cost impact will be recorded so that the data can be utilised for measurement purposes.

When determining the measurement practices and tools, it is recommended that case company creates modular measurement model that can be easily tailored to suit different procurement scenarios. Equally, it should be easy to extend the measurement model to cover new cost elements that haven't been identified earlier or were not available earlier. To meet this requirement, self-service reporting practices, with dedicated developers, are proposed as the first alternative.

For the measurement model itself, ABC approach is proposed. This means that organisation should identify cost relevant procurement activities and include them in the model. By doing this, the organisation also increases its own understanding about the requirements that are related to performing procurement process. It is also proposed that visualisation of data is highlighted in the development process and cost elements with high inaccuracy should be only visualised instead of including them in the figures.

As an encouraging implication, it is recommended for the case organisation that it utilises the positive attitude that organisation members currently have towards TCP measurement and its practices. While the members are aware of TCP concept and acknowledge its importance, it will be easier involve employees in development work and later implement the model in practice. Employee involvement is one of the critical success factors for TCP adoption recognised by literature.

Finally, this thesis proposes that the case company extends its procurement cost measurement practices beyond prices and establishes model for structured and continuous measurement and evaluation. The author also proposes that TCP is the suitable approach for procurement requirements. When using this approach, the next step in the development should be a proof of concept with limited amount of data. Based on the proof of concept, the organisation should evaluate whether the proposed model is meeting the requirements. The actual model development should be performed by cross-functional project team, which identifies relevant data, collects data sources, creates needed datasets and establishes measurement model. After the model has been created, it should be delivered to businesses that will be responsible for later model development and extensions.

8.2 Limitations and implications for future research

This research was performed in a case organisation environment, and therefore the results and implications are applicable only on this context and can't be extended outside of the scope without notable reservations. In addition, the approach adopted by the thesis is limited to the procurement process and activities before or after the procurement process are not considered as they are not directly influenced by procurement decision makers. Third notable limitation is that the thesis concentrates on case environment where the procurement activities are performed to acquire direct components that are used as production inputs during the manufacturing process. This means that considerations related to TCP doesn't cover procurement of indirect goods or services.

The research was also limited to evaluating case organisations possibility to develop and improve its TCP measurement practices. Therefore, the thesis doesn't include any component related cost evaluation or measurement. When performing the research, there was discussions and considerations about performing proof of concept as part of the thesis. This possibility was evaluated by the author, but the scope and work required for the proper and valid proof of concept, would extend beyond the scope of the thesis. As a result, proof of concept was recommended for the case organisation as the next step towards TCP adoption.

During the thesis, some recommendations for the future researches were identified. For example, there seems to be a lack of TCP related academic studies that would accurately illustrate how the measurement practices were adopted and implemented in an actual case company within manufacturing industry. As a result, there is also a certain lack of evidence how these models are utilised in the procurement operations and how organisations performance has improved as a result.

As an extension to this study, a research opportunity would exist to study how the adoption will be performed, or if the case organisation decides not to implement TCP practices, what are the drivers for that decision. After the implementation, it would also be possible to study if the perceived results were achieved. In a contemporary supply chain network, it would also be interesting to see how TCP practices van be extended to supplier within different tiers and how the data can be collected and shared between organizations.

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APPENDIX 1. Questionnaire

Contents of questionnaire distributed in the case organisation. Recognisable information has been changed and formatted with italics.

Total cost of procurement measurement practices in *case company*	
This questionnaire is used to collect background information for master's thesis related to total cost of procurement (TCP). The main objective of the thesis is to conceptualize TCP measurement model, which could be applied to direct material procurement process in *case organisation*. In other words, the thesis aims to identify most important targets for improvement and first steps for TCP adoption. Information collected as part of this questionnaire is used to provide awareness of current status regarding cost measurement practices as part of procurement process. While respondent names will be collected to control results, the data will otherwise be processed anonymously. For more information, please contact: Niko Leppänen / (--) (Total cost of procurement is used as a limited approach of total cost of ownership. By definition, it includes costs related to activities that are performed during the procurement process.)	
Question	**Response alternatives**
Q1. Select the most suitable organisational unit that you are representing:	*BL1*, *BL2*, *BL3*, Other (open)
Q2. Business function that you are working in:	Strategic purchasing, Category management, Operative purchasing, Supplier development engineering, Inbound logistics / transportation, Quality management, Other supply management, Other material management, Other (open)
Q3. Type of purchases you are involved with:	Direct materials, Indirect materials, Both of above options
Q4. Arguments related to the awareness and use of total cost of procurement practices and procurement cost management are listed below. Please select the most suitable alternative for each statement. 1. The concept of total cost of procurement (or total cost of ownership) is familiar to me. 2. I am responsible for decisions that impact procurement costs. 3. I am aware how my decisions impact procurement costs. 4. I have enough procurement cost data available to support my decisions and work. 5. Required procurement cost data is easily available and I know how to reach it. 6. Minimizing total cost of procurement is the most important objective for procurement process. 7. My organisation supports decision making based on minimizing total cost of procurement. 8. I regularly need to evaluate different procurement alternatives based on their cost impact.	Five-level Likert-scale for each statement: 1. Strongly disagree 2. Disagree 3. Neither agree or disagree 4. Agree 5. Strongly agree

9. Supplier specific procurement cost data should be shared for each supplier and be used for supplier measurement. 10. More extensive reporting related to procurement activities would be acceptable, if it enables more efficient measurement related to total cost of procurement.	
Q5. Please use below comment box to provide additional comments regarding previous arguments.	Open question
Q6. Some of the key sources for procurement costs are listed below. Please rate the importance of these procurement costs based on your own evaluation. 1. Payment terms and currency fluctuations 2. Cost of supplier development 3. Transportation and warehousing costs 4. Component price 5. Quality validation or inspection costs 6. Costs related to poor supplier delivery performance 7. Quality failure costs 8. Communication and collaboration costs (e.g. travelling costs). 9. Supplier ramp-up costs, such as investments to supplier capabilities and tools 10. Purchasing transaction costs	Six-scale closed comparison: 1. Not relevant for decision making 2. Minor importance 3. Reduced importance 4. Important 5. Very important 6. Crucial for decision making
Q7. Please describe other sources for procurement costs that you regard important for total cost of procurement.	Open question
Q8. Measurement model for total cost of procurement, should include... (Please select the more suitable alternative to complete the below sentence.)	.. only reliable and relevant data. .. all the available data, regardless of its reliability or relevancy. .. I don't know.
Q9. It is more important that total cost of procurement measurement model, is.. (Please select the more suitable alternative to complete the below sentence:)	.. more accurate, but only applicable for limited procurement scenarios. .. not that accurate, but applicable to almost every procurement scenario. I don't know.
Q10. Which of the below alternatives is more relevant for creation of procurement costs and differences between alternative sources of supply. (Please select more suitable alternative)	1. Geographical location of supplier 2. Individual supplier performance
Q11. Select the more important application for total cost of procurement (Please select the more suitable alternative to complete the below sentence:)	1. Evaluation between different supply alternatives proactively 2. Supplier performance evaluation reactively 3. Both alternatives are as important and no distinction can be done

Q12. I would feel comfortable if total cost of procurement would be used to evaluate my own or my organisations internal performance. (Select the most suitable alternative.)	1. Yes 2. No 3. I don't know
Q13. There is a demand for total cost of procurement measurement model in my organisation. (Select the most suitable alternative.)	1. Yes 2. No 3. I don't know
Q14. How the adaption of total cost of procurement measurement practices could lead to improved efficiency and effectiveness in procurement process?	Open question
Q15. Please describe how total cost of procurement is currently measured in your organisation. If total cost approach has not been implemented, you may also describe other cost management practices that are currently in place.	Open question
Q16. Additional comments, feedback and ideas on how to measure total cost of procurement. **(Please provide your comments in the text box below. If you would like to discuss more about the topic, please provide your contact details.)**	Open question

APPENDIX 2. Summaries of questionnaire responses

Statement	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Sum	*Average value*	*Standard deviation*
The concept of total cost of procurement (or total cost of ownership) is familiar to me.	1	15	13	83	44	**156**	***3,99***	***0,90***
I am responsible for decisions that impact procurement costs.	7	8	18	79	44	**156**	***3,93***	***1,00***
I am aware how my decisions impact procurement costs.	1	3	13	88	51	**156**	***4,19***	***0,71***
I have enough procurement cost data available to support my decisions and work.	7	33	41	62	13	**156**	***3,26***	***1,03***
Required procurement cost data is easily available and I know how to reach it.	12	56	51	33	4	**156**	***2,75***	***0,96***
Minimizing total cost of procurement is the most important objective for procurement process.	0	24	50	51	31	**156**	***3,57***	***0,97***
My organisation supports decision making based on minimizing total cost of procurement.	8	17	39	72	20	**156**	***3,51***	***1,02***
I regularly need to evaluate different procurement alternatives based on their cost impact.	5	23	36	66	26	**156**	***3,54***	***1,03***
Supplier specific procurement cost data should be shared for each supplier and be used for supplier measurement.	6	13	37	79	21	**156**	***3,62***	***0,95***
More extensive reporting related to procurement activities would be acceptable, if it enables more efficient measurement related to total cost of procurement.	0	5	31	88	32	**156**	***3,94***	***0,73***

Table 7. Number of responses for statements presented in Q4.

	The concept of total cost of procurement (or total cost of ownership) is familiar to me.	I am responsible for decisions that impact procurement costs.	I am aware how my decisions impact procurement costs.	Minimizing total cost of procurement is the most important objective for procurement process.	I regurarly need to evaluate different procurement alternatives based on their cost impact.	Count of responses
Answers grouped by type of purchases respondents are involved with						
Both of above options	3,9	3,4	4,2	3,7	3,4	**43**
Direct materials	4,0	4,2	4,2	3,5	3,5	**76**
Indirect materials or services	4,0	4,0	4,2	3,5	3,9	**37**
Total	**4,0**	**3,9**	**4,2**	**3,6**	**3,5**	**156**
Answers grouped by business functions respondents are representing						
Category management	4,5	4,8	4,8	4,0	4,1	**12**
Others	4,1	3,8	4,4	3,5	3,3	**22**
Inbound logistics / transportation	4,0	3,7	4,3	3,7	4,3	**3**
Operative purchasing	3,6	3,7	4,0	3,6	3,4	**35**
Other material management	3,3	3,6	3,4	2,9	3,1	**7**
Other supply management	4,2	3,9	4,2	3,6	3,8	**16**
Quality management	2,0	3,0	3,3	3,7	3,0	**3**
Strategic purchasing	4,2	4,4	4,4	3,5	3,9	**45**
Supplier development engineering	4,1	3,1	3,8	3,7	2,5	**13**
Total	**4,0**	**3,9**	**4,2**	**3,6**	**3,5**	**156**
Answers grouped by business lines respondents are representing						
Others	4,2	3,9	4,2	3,2	3,3	**18**
BL1	4,2	3,8	4,3	3,9	3,1	**9**
BL2	4,1	4,0	4,1	3,4	3,5	**61**
BL3	3,8	3,9	4,2	3,7	3,7	**68**
Total	**4,0**	**3,9**	**4,2**	**3,6**	**3,5**	**156**

Table 8. Categorised responses analysed for current TCP awareness.

Cost element	Not relevant for decision making	Minor importance	Reduced importance	Important	Very important	Crucial for decision making	Sum	Average value	Standard deviation
Payment terms and currency	3	4	18	64	57	10	**156**	***4,27***	***1,12***
Cost of supplier development	3	7	25	72	43	6	**156**	***4,04***	***1,13***
Transportation and warehousing	2	5	13	57	59	20	**156**	***4,45***	***1,10***
Component price	0	0	8	35	76	37	**156**	***4,91***	***0,95***
Quality validation or inspection	2	5	19	53	60	17	**156**	***4,38***	***1,17***
Costs related to poor supplier	0	1	4	39	74	38	**156**	***4,92***	***0,86***
Quality failure costs	1	1	2	34	65	53	**156**	***5,05***	***0,89***
Communication and collaboration costs (e.g.	4	19	41	67	22	3	**156**	***3,60***	***1,15***
Supplier ramp-up costs, such as investments to supplier capabilities and tools	4	2	28	67	44	11	**156**	***4,14***	***1,23***
Purchasing transaction costs	5	21	37	61	28	4	**156**	***3,63***	***1,20***

Table 9. Count of responses for perceived procurement cost element importance.

	Average of Payment terms and currency fluctuations	Average of Cost of supplier development	Average of Transportation and warehousing costs	Average of Component price	Average of Quality validation or inspection costs	Average of Costs related to poor supplier delivery performance	Average of Quality failure costs	Average of Communication and collaboration costs (e.g. travelling costs)	Average of Supplier ramp-up costs, such as investments to supplier capabilities and tools	Average of Purchasing transaction costs	Count of responses
Answers grouped by type of purchases respondents are involved with											
Both of above options	4,30	4,00	4,47	4,70	4,33	4,95	5,07	4,00	3,98	3,70	**43**
Direct materials	4,05	4,05	4,37	5,08	4,24	4,91	5,13	3,17	4,11	3,34	**76**
Indirect materials or services	4,30	3,59	4,38	4,59	4,35	4,84	4,84	3,41	3,70	3,70	**37**
Grand Total	4,18	3,93	4,40	4,86	4,29	4,90	5,04	3,46	3,97	3,53	**156**
Answers grouped by business functions respondents are representing											
Strategic purchasing	4,38	3,96	4,44	5,18	3,98	5,16	5,16	3,49	3,93	3,49	**45**
Operative purchasing	4,11	4,00	4,43	4,77	4,23	4,86	4,71	3,51	3,77	3,60	**35**
Category management	4,67	4,00	4,33	5,50	4,42	5,25	5,67	3,08	4,08	3,67	**12**
Other supply management	4,13	3,75	4,31	5,06	4,94	4,88	5,38	3,00	4,19	3,13	**16**
Quality management	2,00	4,67	3,67	4,67	3,67	4,33	3,33	3,67	5,00	3,00	**3**
Supplier development engineering	4,15	4,46	4,23	4,38	4,85	4,69	5,00	3,69	4,38	3,31	**13**
Other material management	3,71	3,43	4,86	3,71	4,86	4,43	4,86	3,57	3,14	4,00	**7**
Inbound logistics / transportation	2,67	3,67	4,67	3,67	4,00	5,00	4,67	3,33	2,67	3,67	**3**
Others	4,32	3,64	4,36	4,68	4,09	4,64	5,14	3,64	4,23	3,73	**22**
Grand Total	4,18	3,93	4,40	4,86	4,29	4,90	5,04	3,46	3,97	3,53	**156**
Answers grouped by business lines respondents are representing											
BL2	3,89	4,05	4,33	5,10	4,26	4,97	5,10	3,26	3,92	3,03	**61**
BL3	4,26	3,90	4,53	4,75	4,38	4,82	4,97	3,57	3,99	3,78	**68**
BL1	4,89	4,11	4,67	4,44	4,11	5,11	5,11	3,89	4,33	4,00	**9**
Others	4,50	3,56	4,00	4,67	4,11	4,89	5,11	3,44	3,94	4,00	**18**
Grand Total	4,18	3,93	4,40	4,86	4,29	4,90	5,04	3,46	3,97	3,53	**156**

Table 10. Categorised importance of procurement cost elements

	I have enough procurement cost data available to support my decisions and work	Required procurement cost data is easily available and I know how to reach it	My organisation supports decision making based on minimizing total cost of procurement	Supplier specific procurement cost data should be shared for each supplier and be used for supplier measurement	More extensive reporting related to procurement activities would be acceptable, if it enables more efficient measurement related to total cost of procurement	Number of responses
Answers grouped by type of purchases respondents are involved with						
Both of above options	3,4	3,0	3,6	3,4	3,9	43
Direct materials	3,2	2,5	3,3	3,7	3,9	76
Indirect materials or services	3,4	2,9	3,7	3,6	4,1	37
Total	**3,3**	**2,8**	**3,5**	**3,6**	**3,9**	**156**
Answers grouped by business functions respondents are representing						
Category management	3,2	2,4	4,1	4,1	4,2	12
Others	3,6	3,1	3,7	3,7	4,1	22
Inbound logistics / transportation	3,3	3,0	4,3	4,0	4,3	3
Operative purchasing	3,3	3,0	3,5	3,5	3,6	35
Other material management	2,4	2,3	3,0	3,6	3,9	7
Other supply management	3,3	2,4	3,6	3,6	4,3	16
Quality management	2,0	2,3	1,7	3,3	4,0	3
Strategic purchasing	3,4	2,8	3,4	3,5	3,9	45
Supplier development engineering	2,8	2,5	3,3	3,6	3,9	13
Total	**3,3**	**2,8**	**3,5**	**3,6**	**3,9**	**156**
Answers grouped by business lines respondents are representing						
Others	3,4	2,8	3,7	3,2	4,0	18
BL1	2,8	2,1	3,8	3,8	4,1	9
BL2	3,2	2,6	3,3	3,7	4,0	61
BL3	3,4	3,0	3,6	3,6	3,9	68
Total	**3,3**	**2,8**	**3,5**	**3,6**	**3,9**	**156**

Table 11. Categorised responses regarding procurement cost data and measurement.

APPENDIX 3. Topics for theme interviews