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Heidi Nenonen

CREATING VARIANT STRATEGY WITH TOTAL COST MODEL CASE: SUUNTO – MOVESENSE

1st Examiner: Professor Jukka Hallikas

2nd Examiner: Postdoctoral Researcher Mika Immonen

Supervisor: Sourcing Manager Harri Mölsä

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LIST OF ABBREVIATIONS

BOM	Bill of Materials
CODP	Customer Order Decoupling Point
COGS	Cost of Goods Sold
EBIT	Earnings before Interest and Taxes
EMS	Electronic Manufacturing Services
EOQ	Economic Order Quantity
ERP	Enterprise Resource Planning
HR	Heart Rate
LCC	Life Cycle Cost
MTO	Make to Order
MTS	Make to Stock
ODM	Original Design Manufacturer/Manufacturing
OPEX	Operating Expenditure
SCRM	Supply Chain Risk Management
SKU	Stock Keeping Unit
TCO	Total Cost of Ownership

ABSTRACT

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This thesis is a qualitative case study and it aims to create a variant strategy with total cost of ownership model. The case company is creating a new product which can be variated in different ways and seeks to analyse these variation possibilities from cost point of view. The objective is to find a TCO model that would benefit this project and also the case company’s sourcing function in their everyday decisions. Data for this study was collected with five semi-structured interviews in 2017. These interviews each had their own objectives, they concentrated on the variating possibilities of the case product and current cost calculation models used in the company.

In this case the product and the process could be variated. This thesis shows that there were a large number of variation possibilities for the product, but customer requirements and technical requirements delimited variation options to three. The production process created make or buy-dilemma and the created TCO model was used to find an answer. However, the data showed that cost elements were not decisive in this decision but risk elements were the most important factors. Interviews revealed that making would be more reasonable option to avoid high risks of losing control and information leaks.

TIIVISTELMÄ

Tekijä	Heidi Nenonen
Otsikko	Varianttistrategian luominen kokonaiskustannusmallin avulla, case: Suunto – Movesense
Valmistumisvuosi	2017
Tiedekunta	Kauppatieteellinen tiedekunta
Maisteriohjelma	Hankintojen johtaminen
Pro gradu- tutkielma	Lappenrannan teknillinen yliopisto 74 sivua, 11 taulukkoa, 8 kuvaa
Tarkastajat	Professori Jukka Hallikas Postdoctoral Researcher Mika Immonen
Hakusanat	kokonaiskustannukset, hankintakustannukset, TCO-malli, varianttistrategia, tuotevariantit, hankinnan strategia

Tämä lopputyö on kvalitatiivinen tapaustutkimus, jonka tavoitteena on luoda varianttistrategia kokonaiskustannusmallin avulla. Toimeksiantajana toimii yritys, joka on luomassa uutta tuotetta. Kyseisen tuotteen tuotantoprosessia ja ominaisuuksia on mahdollista varioida asiakkaan toiveiden mukaan ja toimeksiantaja on kiinnostunut variointikustannuksista. Tutkimuksen tavoitteena on kehittää kokonaiskustannusmalli, joka antaisi informaatiota tähän sekä kaikkiin tuleviin yrityksen projekteihin. Materiaali kerättiin puolistrukturoiduilla haastatteluilla vuonna 2017.

Tutkimuksessa kävi ilmi, että sekä asiakasvaatimukset että tekniset ominaisuudet rajoittivat tuotevarianttien määrää. Lopulta mahdollisia tuotevariantteja jäi jäljelle kolme. Kokonaiskustannuslaskelmalla pyrittiin vertailemaan tuotantoprosessin variaatoita, mutta lopulta riskit nousivat kustannuksia suuremmaksi tekijäksi. Riskit palveluiden ostamisessa osoittautuivat korkeiksi ja niitä välttääkseen yrityksen kannattaa itse tehdä tuotteiden variointi.

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In Vantaa, 26.10.2017
Heidi Nenonen

1 INTRODUCTION

The popularity of wearable technology and tracking devices have increased explosively in the past few years. Major device manufacturers are interested to have their share of the growing market but they have faced a challenge of having many product variants in their selection. (Koo & Fallon 2017) Increasing number of variants is direct cause of answering customers' needs of individual products. (Lanza et al. 2010). Customers want products that meet their individual needs but at the same time they are not willing to pay extra for features they do not need. (Alard et al. 2010) This creates a dilemma of what is the optimal number of product variants that customers' needs are fulfilled but it is still profitable for the company to produce those variants.

Often the number of variants is defined by the market and companies must adapt to these demands. Managing a large number of product variants can be very expensive and it needs to be planned carefully. Adding a new variant creates costs in several areas and cost management becomes more important. (Tynjälä & Eloranta 2007) Cost management can give great strategic advantage since external purchases have noticed to be usually 60% of the company's total amount of spent money. (Degraeve et al. 2004b). Total cost of ownership model has been praised to be a versatile analysis for purchasing especially for selecting and comparing suppliers (Ellram 1995). Chick and Handfield (36, 2015) described TCO as a model that shows how much a certain price cost to the company.

In this study TCO principles are applied to create a total cost model which can be used not only for supplier selection but also giving information for make or buy -decision and comparing product variants. Ellram (1995) has glorified the multifunctionality of TCO model and stated that it is ultimately the best tool for supplier selection. Though it may be true, Degraeve et al. (2004b) noticed that supplier selection is often done with simple, subjective and incomplete methods and TCO is not applied in many companies. This case study is based on that thought, sourcing decisions should be made in an objective way without estimating or guessing. Exact figures should be availible and sourcing professionals should have the capabilities and tools to benefit those figures.

One of sourcing activities in every company is to create strategies to guide future decisions. TCO model can help to form those strategies and that is why it is an important part of strategic costing. Strategic costing has its focus on financial and accounting perspectives but Ellram & Siferd (1998) brought up that TCO analysis combines strategic cost management concepts with fundamental approach of TCO as a holistic costing model. Even though, TCO analysis is not necessarily strategic costing, only the ones that considers both external and internal costs in the organization are considered strategic costing (Hurkens et al. 2006).

There are three levels of TCO identified: operational, tactical and strategic (Ellram & Siferd 1998). Often the model is applied to operational and tactical levels in practice, for example to manage or to measure supplier related actions. In strategic level TCO model can be a driver to redesign the supply chain and make it more efficient. (Hurkens et al. 2006) Degraeve et al. (2004b) studied the use of TCO model in strategic management and found out that the strategic level is often difficult to include.

Pareto's Law can be applied also to TCO approach, using it to find the 20% cost elements that include 80% of the costs. (Ellram 1994) Pareto's Law is known for being applicable in different kinds of situations, not all even related to business. In 1896 Pareto realized that roughly 80% of the effects are the result from the 20% of the causes. Hardy (2010) listed several studies and applications for this rule, for example how 20% of customers bring 80% of the revenue or 20% of people receive 80% of all the income. Pareto's Law has also been called as "the vital few". Ellram (1994) explained how Pareto's Law can be applied into TCO and it shows that 20% of cost elements cause 80% of the total cost.

1.1 Objectives and Framing

This thesis is a case study and there are two separate research problems defined. The first is to find a suitable total cost model that would help to create a variant strategy. The case company is planning to release a new product, but there is a clear demand for product variations. In the beginning of this thesis project it is still unclear how many variants there should be and which are they. By creating a TCO model all the different options and variation possibilities can be compared. TCO model can also give valuable information to another research problem: the make versus buy -dilemma. The research questions for this thesis are following:

RQ1: How to define the total cost of a certain component or operation?
RQ2: What is the optimal amount of product variants and which are they for Movesense?
RQ3: Which elements have the most effect on the decision if the variation should be made inhouse or bought outside?

First research question aims only to find the suitable total cost of ownership-model. Second question aims to study what is the optimal number of variants for the case product Movesense. Third research question concentrates on finding the cost elements that effect most on make or buy decision. These questions can be answered by creating a TCO model that supports the make or buy decisions.

This research concentrates to find ways to use the existing machinery and equipment as profitable as possible, but does not take production improvement into account. This means that only the current production machines and equipment are considered and solutions should be possible to execute with existing facilities.

1.2 Structure of the Master's Thesis

This master's thesis is organized as follows. There are seven chapters, first of them introducing to the thesis subject. The second chapter is the theoretical background for total cost of ownership model, defining the concept and related issues. The third chapter presents theoretical background for variant strategy and strategy forming. The fourth chapter presents the methodology used in the study and how the data was collected. Fifth chapter is about the case company and sixth chapter presents the case and its background. In the seventh chapter the chosen TCO model and variant strategy is presented and analysed. The eighth chapter includes summary and conclusions that can be made based on the data and analysis.

2 TOTAL COST OF OWNERSHIP

Global sourcing can give great alternatives to local sources for European companies but it also can be a huge challenge a from procurement perspective (Alard et al. 2010). It requires skills to evaluate possible outcomes and costs which can be sometimes hard to define (Milligan 1999).

There are many reasons why companies invest in global sourcing but one of them is definitely cost reductions (Alard et al. 2010). However, if the total cost is not calculated before the purchase, there might be some surprises and the overhead of purchasing might turn out to be more expensive than own production (Wu 2015). TCO is one way to compare suppliers and find hidden costs. TCO model is an estimate of all direct and indirect costs for certain procurement object over its life cycle. TCO model is used to help decision making, especially to supplier selection and evaluation as well to observe the supplier development. (Alard et al. 2010)

2.1 Purpose of TCO analysis

Total cost of ownership is an analysis to understand the actual cost of purchase, not only the direct costs or contract price (Degraeve et al. 2000). TCO model can be used to select, evaluate or compare suppliers (Ellram 1995), guide purchasing decisions (Milligan 1999), to compare purchasing objects. (Wu 2015), for technical optimization or dimensioning decisions or even to evaluate purchases as an individual consumer (Saccani et al. 2017). Even though, this thesis takes only into account the business-to-business perspective which TCO analysis was originally designed for.

Total cost of ownership (TCO) analysis can be used to several purposes depending on the purchasing organization’s needs. TCO is often used to evaluate supplier performance efficiency (Visani et al. 2016) based on history, current actions or future expectations. Hence TCO is part if strategic costing, it promotes strategic alliances. Also, it can be a driver for supplier improvements. (Ellram 1994) TCO analysis gives information for negotiations and can help purchasing professionals to compare different options and choose the most viable one. (Visani et al. 2016) Most often TCO is used to guide supplier selection decision (Degraeve et al. 2000) or to evaluate new technology acceptance in the chosen market and economic viability (Saccani et al. 2017).

TCO model can be used to evaluate suppliers and their efficiency through all the costs that would be created in the process of purchasing (Ellram 1994). The model considers not only direct costs of the purchase or supplier errors but also all costs that are related to managing the supplier relationship which includes variety of costs and activities inside the purchasing company such as order management, delivery arrangements and administration to name a few. (Visani et al. 2015) TCO should be considered in all sized companies, but the cost drivers can be dependent on the size of the company (Alard et al. 2010). The model is often perceived most suitable for manufacturing (Milligan 1999) but it has been applied to different fields and modified for different types of purchases as goods and services (Degraeve et al. 2004a) to commodities and complex products (Ellram & Siferd 1998; Visani et al. 2015; Wu 2015).

New Zealand Government (2013) divided TCO models into two groups by its purpose; life cycle cost (LCC) and cost breakdown structure. Life cycle costing (LCC) is often linked to TCO analysis but as a part of it, not as an alternative. Understanding of the product life cycle costs is crucial when creating a TCO model. LCC model concentrates on showing all costs during a product life cycle from planning through purchasing to disposal. (Prabhakar & Sandborn 2012) LCC is mainly focused on capital or fixed assets and does not take into account pre-transaction costs. TCO is seen as broader view which includes direct and indirect as well as internal and external costs. (Ellram 1995) Cost break down structure model can be used to analyse cost elements in one project and it is based on work breakdown structure (New Zealand Government 2013).

Trent (214-216, 2007) also identified differences in TCO models and called them total landed cost model and life cycle costing. Total landed cost model is similar to cost break down structure, it includes not only the purchase price but also all inbound supply chain costs such as logistics, taxes and custom fees. Trent added also third option: total cost performance model. Total cost performance model is according to Trent applicable to purchased products and they take in account the purchase price and so called nonconformance costs.

Ellram (1994) found two concrete categories for reasons to use TCO in procurement and these have been studied in the literature as separate streams. TCO can be used for internal or external purposes. Internally this means that TCO model is supporting sourcing decisions and giving information about supplier to the purchasing professionals. Externally used data from TCO could be shared with suppliers to drive improvements and effect on negotiations. (Visani et al. 2015)

TCO shows the clear difference between low-price and low-cost suppliers. Low-price suppliers offer low price for the product but the total cost of the purchase might rise high due to supplier unreliability or long lead times. If wanted product is not easily available, buyer is forced to keep high safety stocks to ensure availability in their own production, which has effect on the costs, too. TCO model helps to differentiate these two and find the true low-cost suppliers. Costs per product might be difficult to find and it is often not clearly calculated. (Moisello 2012)

2.2 TCO model structure

The structure of TCO is presented in Figure 1 as Christopher (2011, 29) described it. Christopher pictured TCO as an iceberg which is common way to perceive the concept. Only the purchase price is often seen and compared to other options, and everything below the surface of the water (dotted line in the figure) are often forgotten but also result of the purchase decision. The purchase price only considers the acquisition cost of the product.

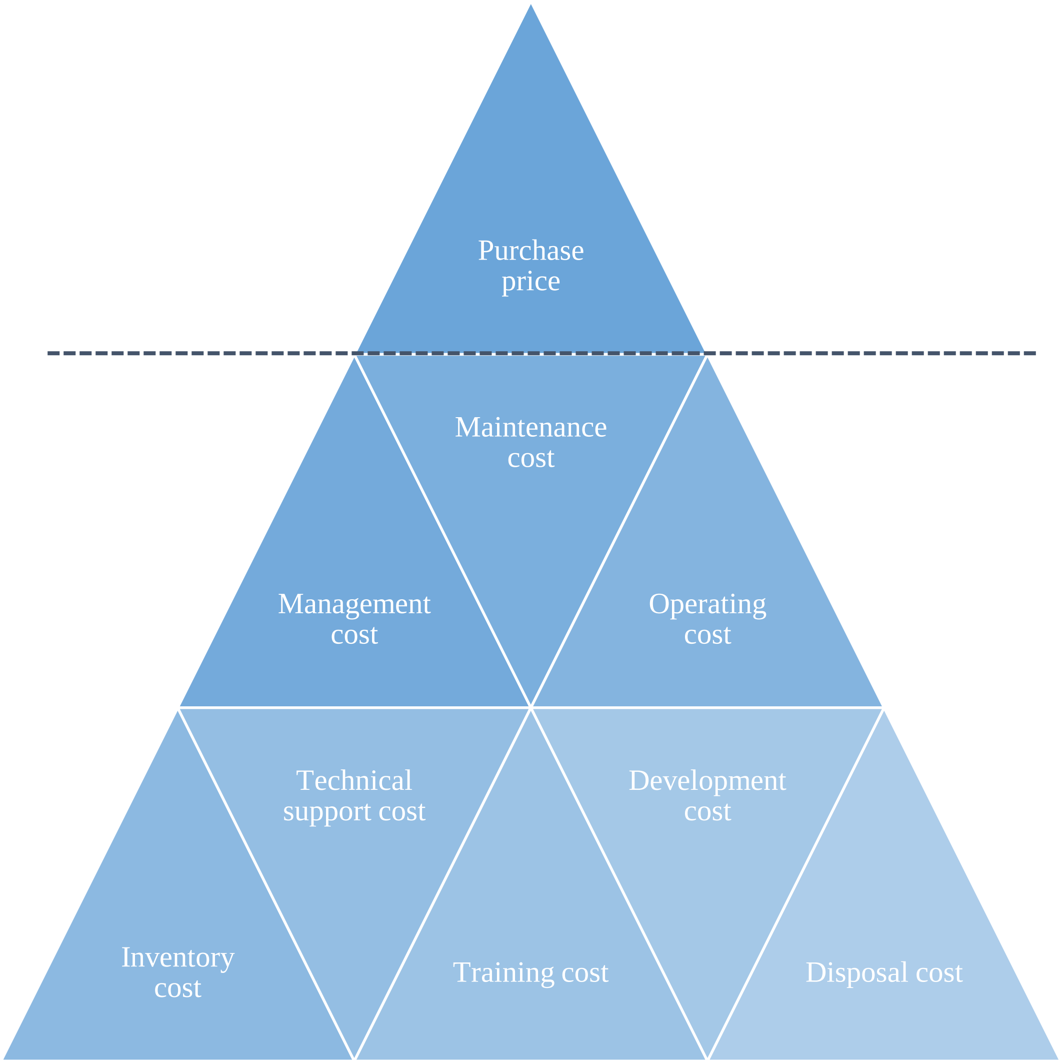

Figure 1 Total cost of ownership structure

2.3 TCO modelling approaches

The concept of total costs can be approached from different angles and several different models can be found from the literature. The chosen approach often sets the base for the whole model and they can vary greatly. (Hurkens et al. 2006) Ellram (1995) states that there are two models for determining TCO: monetary-based or value-based. Both of these can be derived from historical data or future estimates about supplier actions and prices.

Monetary-based model counts all actual costs that are considered relevant in the process. The cost elements can be individually traced back to the action or agreement that created the cost. Defining the relevant cost elements can be complicated but the results of a monetary-based model can be directly interpreted. Direct cost monetary-based model has some limitations, it does not fit for repetitive decisions or low-cost buys. (Ellram 1995)

There is also a variation about monetary-based model which is called Activity Based Costing (ABC) model. TCO is sometimes described as an application of ABC model, which uses the same concepts and tools in sourcing. ABC model is mentioned as a specific premise for TCO in literature. (Ellram & Siferd 1998; Saccani et al. 2017; Visani 2016) ABC model calculates the costs of all activities involved in the purchasing process and then allocates these costs weighing them by the effort required to use the supplier. Activities and the cost of the activities are linked to a certain purchase from certain supplier. ABC model is seen important to TCO calculations because it can identify low-cost and low-price suppliers better than traditional standard-costing and full-costing methods. Low-cost and low-price do not always go together and the price itself does not necessarily give information about the total cost. Low-price suppliers might have higher costs or high risks which can add costs greatly. (Visani 2016)

Establishing ABC model can be time consuming and the formulas needs regular reviewing and updating, but the system is easy to use once it is in place (Ellram 1995). TCO model without ABC has received critique of being too limited because the allocation of costs could not be clearly traced, but it is still rarely adopted by companies, compared to other models (Visani 2016).

Alard et al. (2010) created a general TCO tool for mechanical engineering industry which is an example of monetary-based model presented in Table 1. Their study showed that companies often see the need for TCO in evaluating supply options or suppliers and comparing them to each other. Also, it is important to the cost elements be structured into modules so that they can be used independently too. They created a tool with three modules where one module is divided into smaller sub-modules.

The first module is macroeconomic analysis module and it considers all relevant macroeconomic factors that can influence the purchasing decision, such as the price of oil or exchange rates. This might have a huge influence on the latter modules and affect strongly on the outcome. The second module is microeconomic analysis module and has been divided into five parts; contract price, strategic procurement, operative procurement, transport and logistics and the usage of the procurement object. The contract price can include several subcategories like the cost of material or production, which are common in the industrial field. Strategic procurement module consists processes and costs related to supplier evaluation and development. Operative procurement module consists all operative procurement processes for example order processing and invoicing. Transport and logistics module consists the costs related to transport and logistics, also may consist for example legal or insurance costs. Usage of material consists all costs related to material use but operating, maintenance or recycling costs are not included. The last module is a summary module used to summarize all parts. (Alard et al. 2010)

Table 1 Example of TCO tool modules (adapted from Alard et al. 2010)

	Module	Sub-modules
1	**Macroeconomic analysis module**	
2	**Microeconomic analysis module**	contract price module (purchasing price of the procurement object)
		strategic procurement module
		operative procurement module
		transport and logistics module
		usage of the procurement object module
3	**Summary module**	

Value-based model is by Ellram (1995) the most effective way to find the problems and issues. The model combines direct costs with activity data that is difficult to monetize, convert into clear costs. Value-based models can usually consider only a few major issues, often three or four, otherwise the model would be too complex and difficult to construct. Even though, value-based models usually tend to be more complex than monetary-based models, as it requires qualitative information transformation to quantitative information. Value-based models require a huge amount of fine tuning and effort to develop proper weightings to truly reflect TCO. The result of value-based model cannot be directly traced to the spent money because the result is not always transferred into currency. (Ellram 1995)

The advantages and disadvantages of monetary-based models and value-based model are explained in Table 2. The primary uses of these models are presented in Table 3 and based on Ellram's (1995) case study. It is not surprising that companies want a model that is easy to use but still complex and flexible enough to capture the critical issues. Creating the perfect TCO model is balancing between these factors and finding the most suitable approach for the situation. Companies use the value-based model for same purposes than direct cost monetary-based model, except monetary-based model is also used to reduce supplier base. (Ellram 1995)

Table 2 Comparing TCO modelling approaches by Ellram (1995)

Model	Advantages	Disadvantages
Monetary-based - direct cost	Tailor factors considered to decision	Time consuming
	Very flexible	Does not make sense for repetitive decisions
	Alter level of complexity to fit decision	Not cost beneficial for low cost buys
	Help identify critical issues	
Monetary-based - ABC	Easy to use once system is in place	Time consuming to establish the system
		Formulas need to be periodically reviewed and updated
	Excellent for repetitive decisions where costs for key factors can be determined	Inflexible to different types of decisions
		Considers a limited set of factors
Value-based model	Can incorporate issues where costs cannot be determined	Time consuming to develop: only good for important and/or repetitive decisions
	Considers the importance of factors using weighting	Much judgement in establishing weightings
	Easy to use for repetitive decisions	

Table 3 TCO approach usage by Ellram (1995)

Model	Purpose
Monetary-based - direct cost	Supplier selection Supplier base reduction Make versus buy/outsource Process improvement
Monetary-based - ABC	Supplier volume allocation Supplier base reduction Ongoing supplier evaluation Process improvement
Value-based model	Supplier selection Make versus buy/outsource Process improvement

Visani et al. (2016) had realized a problem in using TCO, many companies seem to think that it takes too much effort, so they created a TCO-based DEA, Data Envelopment Analysis. TCO-based DEA is meant to avoid the ABC process that companies have experienced to be time consuming and too complex. TCO-based DEA does not only evaluate the efficiency of the suppliers as traditional TCO analysis does, but TCO-based DEA weights the inputs and outputs with mathematical programming approach.

TCO can be unique or standard model and there are different benefits in using both of these. Unique model requires data to be prepared individually for each purchase but it is also flexible model that is suitable for different kinds of purchases. Standard model is often relatively easy to use but it only fits for situations where purchases have same kinds of issues. The key factor to determine which is more suitable is the type of purchases, the model can be developed for certain commodity or only one-time buy and hence the purpose differs greatly. (Ellram 1995)

2.4 Make versus buy

One of the most important decision in the beginning of procurement process is make or buy -decision. Make or buy -decisions are strategically critical issues, because it sets the base for not only production and procurement planning, but also the whole business. (Leenders et al. 2002, 295) It is the decision between manufacturing the needed product inside the company and purchasing it outside. Make or buy -decisions can be based into an analysis that can be part of TCO model or independent analysis. It aims to show if there could be possible savings achieved by changing current operations. (van Weele 2010, 64) The object can be either products, components or operations. Management seems to favor one option over the other and it changes all the time. In the early 2000s companies wanted flexibility and focus on the core competencies, which made buying more reasonable option. This way the supplier development can be transferred to the buyer, they have to be ready to work to get suppliers to answer their needs exactly. The key question of make or buy is that what ratio purchased objects and produced objects should have in the company. (Leenders et al. 2002, 295)

There are several reasons to make or buy and reasons depend on the object, the company and the environment it works in. There is certain flexibility if company decides to buy, if there are several potential suppliers company can select the most reliable one/ones with suitable terms and conditions. If there are no certain knowledge or technical experience inside the company, buying might be better option. Company can either gain the needed knowledge or trust a supplier and not invest into it. Buying might also add value to the end product, some suppliers have such reputation that using their components will have a positive effect on the buyer company’s brand too. Buying also enables that company is not dependent on one supplier, if there are several suppliers available. (Leenders et al. 2002, 296-297)

In some cases, making is the only option, for example the lack of reliable suppliers leads to decision to make the needed components. If company uses such technology or techniques in the production that they are not willing to share, there is no other choice than make. Making might be more flexible option, if the demand varies often and company wants to control the production. In some cases make decision can be more binding than buying, if company invests in manufacturing equipment and staff training, the decision is difficult to withdraw. (Leenders et al. 2002, 296-297)

Both buy and make decision might be driven by cost issues. Lower costs might be obtained with switching to another option, but there also might be more risks. (Leenders et al. 2002, 296-297) Risks and uncertainties cannot be avoided in any supply chain, but there are various definitions for supply chain risk in the SCRM literature. Risk can be defined as a probability of an event that will have negative consequences for the supply chain. The expectation of risk has been debated, for example the probability of supplier not meeting the quality expectations is more likely to happen than war that interrupts supplier's actions. This issue is often taken in account that the probability should be at least small and the risk for more unexpected events, such as war or a strike, is always realized. (Tang & Musa 2011)

There are numerous risks related to both making and buying options and the amount of supply risk categories is immense (Hallikas & Lintukangas 2016). Treleven and Schweikhart (1988) suggested that risks could be divided to five categories: disruption of supply, price, stock and schedule, technology and quality. Hallikas and Lintukangas (2016) added two risk categories to this: availability risks and information flow risks. Availability risk overlaps with disruption and schedule risk categories since it can be a consequence for both of them. Tang & Musa (2011) considered information flow risk as important as information flows often trigger the value adding activities. Information flow risks have been receiving less interest in the literature recently though as an issue it is only becoming more important as information technology is developed and the area changes. Information accuracy and information system security and disruption are serious information flow risks. Information outsourcing is also a risk that is becoming more common, even though it allows company to concentrate only on their core competence, it increases other risks such as control loss, vendor opportunism and disagreements. Christopher (2011, 194) also discussed about the risks in supply chain management and especially control risk. Lacking or losing control is an internal risk and related to the rules and systems that determine the company.

2.5 Barriers and benefits for TCO

One barrier for using TCO is the possibility of persons own judgement and opinions what is important and what is not. Hence the first thing to do when creating a TCO model should be determining the important issues for the company. (New Zealand Government 2013) Ellram (1995) stated that the concept of TCO has been studied and referenced in the literature but not yet fully adopted to companies at least in United States in the early 90s. Since then there has been several studies (Milligan 1999; Roodhooft 2003; Hurkens et al. 2006; Moser 2016a) about how TCO models are used in companies worldwide. The results show that companies are often are aware of TCO as a concept and its benefits but they do not use a specific model to estimate the total cost. If the analysis is executed, there is usually at least with some alterations, but even the purchasing professionals themselves indicated these calculating systems vague, inaccurate or otherwise untrustworthy. (Milligan 1999) There is a clear barrier to actually use TCO models in purchasing decisions, they are seen as time consuming and taking too much effort. In the TCO literature the concept improvement can be clearly seen from the literature but the issue with effort has still stayed highly unexplored. (Visani et al. 2015) Recent TCO model improvement studies are concentrated on improving the effectiveness of the model or creating easier access. (Degraeve et al. 2004a; Alard et al. 2010)

Swiss Federal Institute of Technology Zürich executed two studies (ETH Zürich 2008; ETH Zürich 2011) between 2006 and 2008 in Switzerland to see if there are feasible integral TCO models used in industrial companies. This analysis included 24 Swiss industrial companies and showed the same result: that no such model was fully used. There were some cases where the company used calculations or estimations for specific procurement object groups and those were always strongly limited. These studies also showed that the long-term activities in global sourcing were often not planned systematically or even calculated. Sometimes this lead to long lead times which involved loss of flexibility and high safety stocks.

The benefits and barriers of TCO approach can be seen from the results of various case studies. TCO model can be used to numerous different purposes and Ellram (1994) listed the five benefit categories of TCO analysis as follows:

- Performance Measurement
- Decision Making
- Communication
- Insight/Understanding
- Supports Continuous Improvement

As stated in several resources (Ellram 1994; Ellram & Siferd 1998; Milligan 1999; Visani 2014) TCO is an excellent model to evaluate supplier performance. TCO shows large amount of data and enables comparing several suppliers. It can also be used to show the improvement efforts that suppliers have made. TCO model can also be used to benchmark company's purchasing practices. (Ellram 1994)

One clear benefit is that information from TCO analysis can be used in many important issues not only related to purchasing but to the whole organization. This means it is a good way to get other functions involved in purchasing decisions inside the buyer company. The model provides data for different analysis, for example trend analysis, and critical data for target pricing. TCO model can be communication tool between supplier and buyer, giving information from many different areas. (Ellram 1994)

TCO model supports continuous improvement and can identify problems as well as opportunities for cost savings. If company uses TCO, they have to look at the internal issues and how they can improve conditions themselves, too. TCO model is a good driver for supplier to focus on the priorities, make efforts to improve. (Ellram 1994) Trent (215, 2007) also pointed out that TCO models are not transcendent to other cost analysing models though they are often presented in that way. As every forecasting model, TCO models have some degree of unreliability, the question only is that how much unreliability there is.

3 VARIANT STRATEGY

As stated in the earlier chapter, TCO model is very flexible and it can be applied in different situations. In general, the model is used to guide purchasing decisions (Milligan 1999) which can be related for example to the number and features of product variants. TCO model also is good for comparing purchasing objects (Wu 2015) and it can be used to compare product variants and furthermore variation costs. This chapter is presenting a literature review about product variation, its cost effects and flexibility. The terms variation and flexibility is defined and how they are applied in this particular study of creating a variant strategy.

Variant strategy can mean different things in different situations, in literature there is two common ways to define it:

1. process variation strategy which detects variation in the production process and process control (Leenders et al. 2002) or
2. product variant strategy which strives to control product variants (Lanza et al. 2010).

This study is delimited on the product variants and controlling them. Variant strategy is all about the conflict of flexibility and productivity and it is also referred as “flexibility strategy” (Lanza et al. 2010). Manufacturing flexibility has been studied in several papers (Moore 1994; Mishra et al. 2017; Wei et al. 2017) and also the costs effects of product variation (Lanza et al. 2010; Tynjälä & Eloranta 2007). Process variation strategy concentrates on process reliability and quality monitoring (Leenders et al. 2002) which are left out from this study.

Drauz and Handel (2012) recognized three different scenarios when new components are added into the product. They named these scenarios 1) partial substitution, 2) total substitution and 3) addition. In the first two scenarios, the total amount of parts does not change, one or more parts are only substituted by new parts. Even though the total number of parts stays the same in these two scenarios, in partial substitution the number or different parts is increased. One-time costs in both scenarios might occur, such as R&D or inventory costs. In partial substitution the decrease in the “old”, substituted, part quantity should also be considered. The third scenario fits best to the case situation in this research. New components are introduced additionally and not substituting any components in the previous set up. In this scenario costs are immediately higher than in scenario 1 and 2, because the total number of components and the number of different components have been changed.

3.1 Flexibility and variation

Flexibility has certain dimensions and how to measure them but these can differ a lot from company to company. The problem with flexibility is the uncertainty of demand, not only the product mix but also the volume. It is difficult to predict the future and how especially new products are received and what kind of sales there will be for certain product variation. Companies use many different kinds of tools to predict the demand, costing tool such as TCO is only one possibility. The academic literature notices that flexible production is not only something that is desired but it is becoming more and more as a requirement for industrial companies if they want to survive (Jain et al. 2013) and differentiate from other companies in the market (Lanza et al. 2010).

Jain et al. (2013) proposes that manufacturing responsiveness of a system can be increased by flexibility. The need for flexibility comes from the wish to improve operational performance and the ability of manufacturing system to cope with internal and external interferences. Managers often see flexibility in production useful but also difficult to fully apply. Jain et al. states that this is only the result of not understanding the concept completely. Needless to say that every organization understands manufacturing flexibility in its own way, which is why there is no generally accepted description of its definition. Jain et al. gathered 17 definitions from academic literature to describe manufacturing flexibility. Mainly it is seen as a capability to make adjustments or changes to the manufacturing if the environment or other factors change significantly.

Lanza et al. (2010) clarified that flexibility can be concerning different things, and the most important for manufacturing systems evaluation are volume and product flexibility. Volume flexibility means that the company is not strictly dependent on the production volume and it can be changed above or below the defined capacity. Company is still able to operate profitably at different output levels and the production volume can be changed within wide range.

Product flexibility means that the production is able to react product variety or changes in components. If company can cope with the product variety well, it can enhance manufacturing system performance. Product flexibility enables producing different product variations with the same equipment. New products are introduced in a fast pace and production must keep up with this. There is a conflict between having large variety of products and still maintaining high system performance, both are balancing with the budget and time limitations. (Lafou et al. 2016)

Lafou et al (2016) found out in their study that good communication between the product and manufacturing system designers enable higher flexibility in production. Sharing information in the early stages reduce setup time and costs significantly. This way the costs of introducing new product to the production are reduced because it is already done before the production begins.

3.2 Managing flexibility in manufacturing

Make-to-order (MTO), make-to-stock (MTS) and assemble-to-order (ATO) are manufacturing concepts that affect on the flexibility. Customer order decoupling point (CODP) has an essential role, it describes the certain stage of supply chain where the products are linked to a certain order. (Li & Womer 2012) MTS manufacturing depends on forecasts and it is suitable for products that already have stabilized in the selection and there is historical data about demand available. In MTS manufacturing products are not made for certain order and they are linked to a certain customer after the manufacturing. (Olhager 2003)

MTO manufacturing is the opposite of MTS, the products are immediately linked to a certain customer when order is received. CODP is right in the beginning of the manufacturing process, products are manufactured for certain order and there are no inventory with MTO products. (Li & Womer 2012) In ATO manufacturing there are usually modules or some parts already prepared before the order. For example if same modules are used in different configurations, they could be prepared beforehand and the CODP would be after manufacturing the modules. (Olhager 2003) In MTO manufacturing all the actions, such as purchasing and assembly, wait for the order and nothing is prepared (Li & Womer 2012).

3.3 Cost effects of product variation

Today's customers want to express their individuality and find products that meet their personal demands. For industrial companies, this means that the more products are individualized, the more flexible the production should be. High levels of flexibility can lead to lower levels of productivity because the production should be highly customized. Customized production needs usually more planning and research. The error rate is higher when more variations are considered and it needs more training for employees. It can cause also larger stock levels and slower inventory turnover. (Lanza et al. 2010) Square root law, which is developed by Maister (1976), proves that adding new product variants can be very expensive for the manufacturing company. Tynjälä and Eloranta (2007) gave a simple example of this, if one product variant that costs 100€ per day to keep in the inventory and if another variant is added it would cost 141€ per day as the inventory costs grow proportionally to the square root of the number of variants. In their study Tynjälä and Eloranta also underlined the importance of benefit versus cost analysis in the design phase. If adding a product variant does not have clear benefits compared to the costs it creates, the company will probably end up losing money in the process.

In the process of developing new products or components, research and development (R&D) or sales department are usually in a key role and other departments, such as purchasing, logistics and quality, are often included only later. This leads often to underestimating costs, only direct costs of added parts or components are considered, but for example cost effects to production are forgotten. (Drauz & Handel 2012)

Lanza et al. (2010) states that 80-90% of costs can be seen already in the early stages of the planning, but evaluating the flexibility of production can be more troubling. If product and production development overlap, as they often do in efficient production configuration, they should be consistent without adding complexity. The question is how to reduce complexity and at the same time design and operate a flexible production system. There is no manufacturing system that would be optimal design for every kind of production, which makes the question hard to answer.

Lanza et al. (2010) studied the cost effects of having a wide scale in variety of products. They admitted that there are numerous suitable models and systems to count costs which have been studied in different fields and for different purposes. Different methods can be divided in many ways, Lanza et al. used two categories: method for cost estimations and description of uncertainties. TCO model is often based on cost estimations or historical data, and it can be either qualitative or quantitative. Qualitative models usually do not provide concrete figures as the final result but those can indicate the consequences of certain decisions. This kind of method can be used for comparison of manufacturing procedures or different product variants. Quantitative models on the other hand, provide exact fixed figures based on the expected costs and it can be used for example for calculating correlation of the manufacturing procedure and material costs. In the other category, description of uncertainties, is focusing on the information that is not known or is missing. It is a probabilistic model which requires a distribution function that describes the uncertainties in an optimal way. Finding an appropriate distribution function is the key for this model, when it is defined, the characteristic parameters should be determined. Also statistical methods can be used with description of uncertainties if there are empirical information available. Even though there are several product variants, the costs do not necessarily increase.

3.4 Product variety management

Porter (1980, 7-10) defined three different strategy types: cost leadership, differentiation and focus strategy. Cost leadership strategy focuses on constantly reducing the costs of the end product. This strategy is considered successful if company manages to sell products at a lower price than its competitors. Differentiation strategy is focused on differentiating the products from competitors and the aim is to be seen as unique product. This differentiation can be achieved by design (Marimekko), logo (Iittala), technology (KONE), service (Onnibus/Paytrail) or many other factors. Focus strategy concentrates on certain specific group of customers and serving them in an optimal way. This strategy demands thorough research of the customer group activities and familiarize with their demands to offer optimised solutions. Van Weele (2010, 178-179) states that company has to make a clear decision which strategy will be used. The decision effects fully on everything the company does and enables to create a sustainable competitive advantage. These strategies can be used in product variety management.

Companies use different methods to manage with product variety including product families, component commonality and product modularization. Product families can be formed from products that have same basic components. These products are valued by component commonality and also differentiation between variants which should be balanced. Product families change over time because of the development and changes of products and the variants. Often products are developed in different directions and their similarities decrease over time which makes managing product variety more complicated. Modular products are created from modules instead of individual parts or components. Modules are formed when components and assemblies are combined into certain building blocks. These building blocks, modules, can be used in different products and different combinations. Modularity increases standardization but new variant introduction costs are lowered, if the new variant uses the same modules. New variants are created with combining those modules in a different way or customers can choose from the possible combinations. (Lafou et al. 2016)

Jiang et al. (2011) addressed the issue of component variation in inventory management with product variations. Component variation in the inventory may be the cause of design improvements, changed customer requirements or product variants. Component variation can cause inventory shortage which can further be the consequence of prioritizing some orders and moving them further in the production line. If orders are prioritized material requirement planning will be instantly disorganized and this should be taken in account in planning inventory levels. Inventory shortage can be solved in different ways, but the start is to understand what kind of effect the issue has, for example how prioritizing effects on the other orders on the line.

3.5 Forming sourcing strategies

According to Hesping & Schiele (2015) strategy development can be a multi-level activity where the same strategy is seen in every level from firm strategy to supplier strategies through different stages (Figure 2). Firm strategy means the strategy for the company's overall business. Functional strategies are designed for certain business functions and sourcing strategy would be one of them. Category strategy is one of the strategies sourcing has, such as separate defined strategies for sourcing electronics or plastics. Sourcing levers are tactics applied to specify category strategies such as extending the supply base or evaluating the price. There can also be defined a strategy for a specific supplier, often there is at least for the most used suppliers. These strategies influence on the category performance, purchasing performance and the whole business' performance. Variant strategy would be a tactical sourcing lever, it's a sourcing category strategy and a tactical choice.

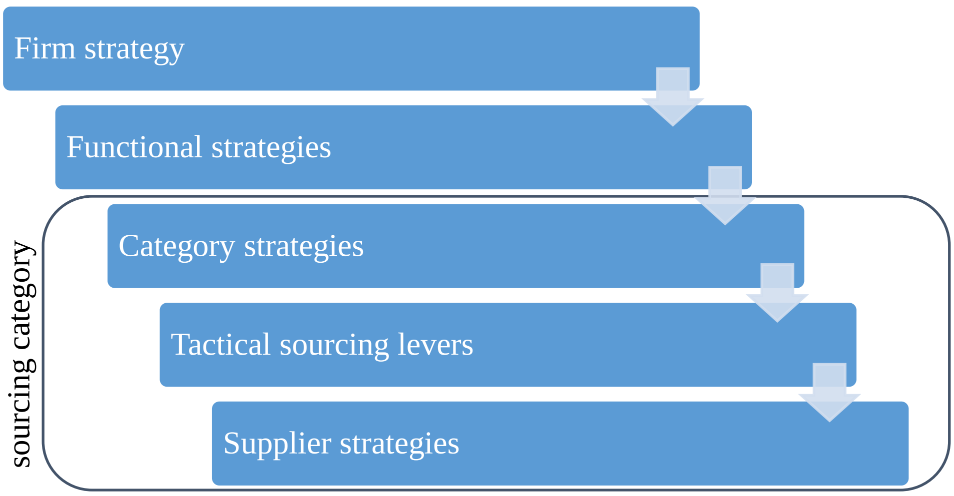

Figure 2 Multi-level approach for strategy development

4 METHODOLOGY AND DATA COLLECTION

This research is a qualitative case study. Data was gathered in 2017 by interviews, taking notes and making clarifying questions while working as team member in the case organization. Interviews were chosen as the main research method to get as much information about the situation as possible. The chosen case project was still going on at the same time as the thesis project, so a large part of the information was not yet documented hence interviewing was the best way to gather all possible information.

Interviewing is a good and flexible way to gather information and it is applicable for most situations. Semi-structured interview can be used for both qualitative and quantitative studies, and instead of specific questions, it concentrates into one theme. The method acknowledges the importance of interviewees own perceptions and interpretations and that these are created in interaction. (Hirsjärvi & Hurme 2008, 11, 47-48)

This method is called semi-structured, because the there is always something that every interview has in common for example the questions, layout of the questions or the theme. (Hirsjärvi & Hurme 2008, 48) In this study the theme was the connective aspect, the theme was the topic of this thesis, the case product and its variants.

The objectives of the interviews are presented in Table 4 in chronological order starting from the oldest one. There were five interviews, four of them in the case company and one with the supplier. In these interviews one or more case company's employees were also present in addition to the interviewer. These were semi-sturcured interviews, the objective of the interview as well as the title of this thesis were previously informed to the participants. There were no specific questions prepared for any of these meetings to give the participants possibility to bring up every thought about the topic. All participants in these meetings could ask questions, the interviewer only restricted the conversation when it was not concerning this project.

Table 4 Interviews for this study

	Objective	Interviewee
1.	Case product introduction and customer requirements of the case product	Digital Services Manager
2.	Background of the case product	Product Manager
3.	Current situation of the case product and customer requirements	Head of Consumer Experience
4.	Current cost calculation models in the case company	Business Controller
5.	Production possibilities, supplier interview	Supplier

5 CASE - SUUNTO OY

This master's thesis is made as a case study for Suunto Oy, more specifically to Suunto sourcing team. In this chapter the case company and its organization structure is briefly presented.

5.1 Current situation

Currently total cost of new projects is evaluated with an Excel-based tool called business case template. The tool uses estimated values to calculate certain key figures for example net sales, COGS and EBIT. There are certain problems with using this tool and that is why it does not give enough information to help to estimate the total cost.

The structure of the business case template is the opposite of TCO model, calculating starts from the wanted selling price and profit. This view defines how much different components and labour can cost that the wanted level of profit and selling price is met. TCO usually starts from the cost point of view, what does different components and labour cost and what would the selling price or profit be with these costs.

Business case template is scheduled in the early stages of project and project manager is responsible for it. When the product design is clear and decided, official costing is calculated. This creates a problem, the official costing might differ a lot from the original estimate and either BOM (Bill Of Materials) or the wanted selling price/profit should be altered.

Filling the template is sometimes found problematic. Even though project manager is responsible for it, they do not always know how the costs are allocated, especially with totally new products. This leads to unreliable estimations which are not based on facts or knowledge, only the manager's own interpretations which creates problems later in the project. Usually the problem is that project manager has estimated the costs too low in the beginning but the estimation is not changed though new features or more expensive components are added. The chosen TCO model is not planned to be replacing the business case template but it should benefit the earlier template and create more information to make sourcingas decisions.

Too vague cost estimates change the whole process, sometimes the tool is used in a different way. Especially if the product is new and does not resemble any other Suunto product, the cost evaluation is troublesome. In this kind of situation, the project manager can make a cost estimation which is compared later to the realized costs and the difference is reviewed critically. This way Suunto receives information about new product development. Even though it is useful and would give more information for Suunto, the process is rarely conducted this way. Reviewing the estimation takes too much time and resources compared to the benefit it would gain. Some example cases have been made and these have given good information about the process.

Suunto is aware that the tool does not always benefit project managers in a right way. The cost estimating process is not robust, project managers are not always aware of their own responsibilities in it or how to estimate costs. Financing team can help project managers with estimations but often they start to fill the template too late and there is not time to find out or calculate costs based on facts and known prices. During this thesis process there was a suggestion that project manager would consult sourcing before finalizing the estimations. Sourcing project managers have information for example about previously used components and prices which creates more accurate estimates. Using the template might become easier if there would be more people involved in the process. If there are more people involved, there is more information available and the cost evaluation becomes easier. Involving more people in the process gives a better view of all the aspects that have influence in the costs.

The sales volumes are often estimated to be higher than they actually become which also manipulates the costs in business case template. The problem is in the evaluation process and project managers' perception, they see that new products could sell more than it is possible.

Company uses Enterprise Resource Planning system, ERP, to keep track of the costs and plan the future. Labour costs can be found from there and often previous calculations are used as an example. In estimates the production costs are often set the same as with a similar product which is already in production. However, this is troubling if there is no similar product in the company's product range or if there are for example new production equipment used. In the labour cost there is only the running performance costs, not for example management costs.

In the business case template there are three sections that are especially viewing the same things as TCO model: BOM, labour cost and overhead. Overhead is a certain percent of BOM and labour costs and it covers for example inbound freights, warehousing and scrap. The business controller admitted in the interview that overhead is not the most accurate way to calculate these and for example scrap should be separately in the template. This is a common way to evaluate costs in the field, though.

Business case template does not include the cost of variants, but it has been calculated by supply chain planning team. The cost of variants has been calculated as an annual cost for a new item. The model shows a rough figure of how much it would cost to add a new item into the category and inventory. It has been calculated using a certain percentage of OPEX and inventory costs annually and dividing these with the number of active items there is in the company's ERP system.

5.2 Suunto's History

Suunto is a Finnish company and it was founded by an engineer and orienteering enthusiast Tuomas Vohloinen. He became frustrated with the dry compasses of the time with their unsteady needles and started thinking, if it would be possible to attenuate the motion of the compass needle with a suitable liquid. In addition to that he dreamed about a strong, light and simple to use compass. In 1933 Vohloinen received a patent on the manufacturing method of a liquid-filled compass and three years later in 1936 he founded Suunto Oy. Finnish army anticipated wartime and ordered tens of thousands field compasses from

Suunto. Other important products of the wartime were the bearing compass and the clinometer intended for measuring angles.

After the war deliveries to the army decreased but individual orienteers and trekkers have found Suunto's product and started buying them. The field compass became renowned for its reliability, and also export started up gradually. In 1950 Suunto had ten employees. Much have changed after that, in 2017 Suunto has over 400 employees over the world but Suunto still keeps its headquarters and manufacturing facilities in Finland in Vantaa. Most of Suunto's products are still designed and hand crafted in this flagship factory. In 2016 Suunto reached the age 80 years and the president of Finland Sauli Niinistö honored the company with his visit.

5.3 Suunto Sourcing

Amer Sports has been developing the Movesense technology and sense-making platform with Suunto. Suunto is owned by Amer Sports and they share some resources, for example sourcing. Suunto's Sourcing team consists eleven members in Finland and four members in Hong Kong/Shenzhen. The team is divided by their responsibilities into four smaller teams: strategic sourcing, sourcing development, sourcing project management and sourcing managers (Figure 3).

In 2016 Amer Sports arranged their organization in a new way which also affected to Suunto Sourcing team. Since in the beginning of the year 2017 Suunto Sourcing has been reorganized and divided into two: Strategic and Operational Sourcing. This change gave some team members new responsibilities, Suunto Sourcing team is now called Suunto Operative Sourcing, in addition four team members are also part of Strategic Sourcing, Connected Devices and Digital Services.

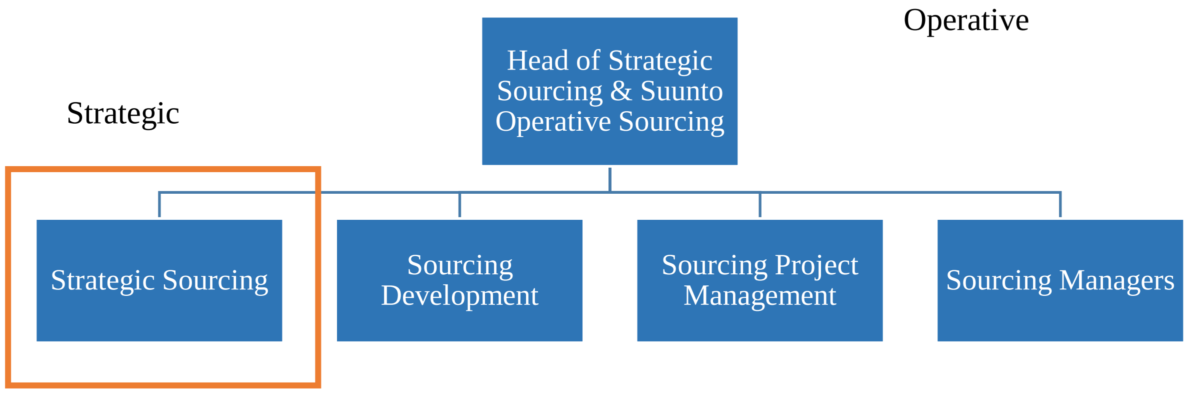

Figure 3 Suunto Sourcing team structure

In Figure 4 is presented how Supply Chain Management is organized in Suunto. Operational Sourcing can be found from the right side of the figure.

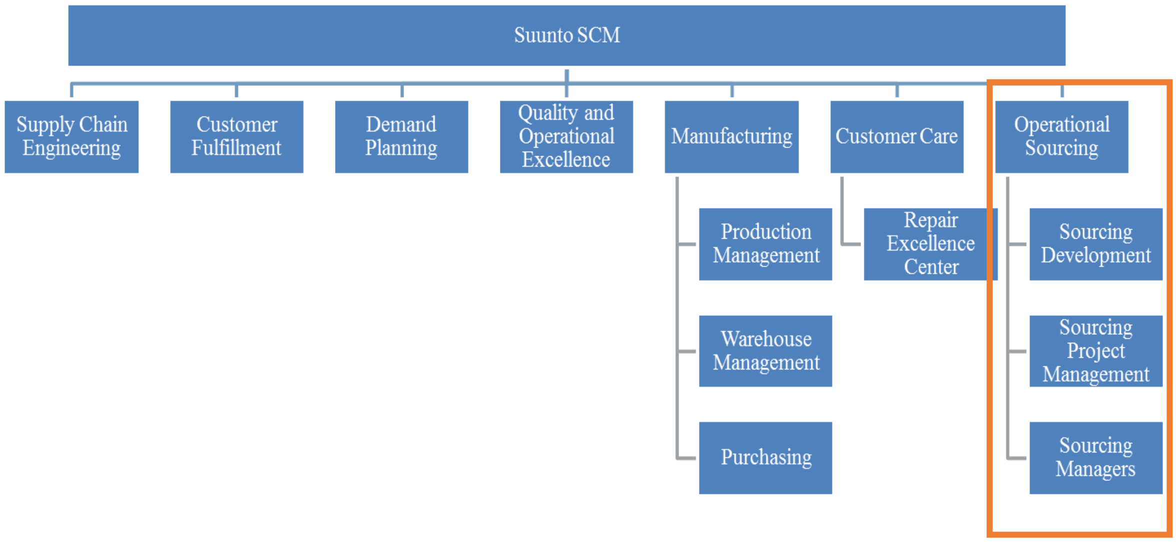

Figure 4 Suunto SCM structure

The sourcing actions and new solutions are carefully planned in Suunto but individual purchasing decisions are sometimes made from only one professional's point of view. The company desires to have certain guidelines or calculation model which would give more factual data to make versus buy decisions.

6 MOVESENSE

In the past few years sensor technology has taken giant leaps and people are paying more attention to their lifestyle. Most customers want to use a smart watches or activity trackers customers demand more accurate information about their behaviour. Physical movements can be detected most accurately if sensors are attached into the moving object, whether it is a person or sports equipment.

Movesense is a product that can be used to sense and measure any kinds of movement. It is based on an open development environment and its users can build their own gears and applications. Figure 5 shows what the final product looks like, the front is pictured on the left, back on right. (Movesense 2017)

Figure 5 Movesense outlook

Suunto wanted to renew their heart rate belt and started developing their current heart rate monitor. In the previous product there was heart rate (HR) sensor and accelerometer, though only the HR sensor was used with Suunto's software. The same product was also sold for customers who use it with their own software, some of them use the accelerometer to measure activity. In the process of developing a new heart rate monitor rose the idea of multifunctional product, which could be used in different sports activities and Movesense was created. It is important to find a viable option for the previous HR belt product, which could be sold with the same price, because Suunto is planning to discontinue manufacturing the older HR product. Manufacturing both products would not be profitable. Products are the same size and attaching pins (if needed) similar. The idea of Movesense is that it could be applied to any kind of sports and the variants would be targeted for certain activities. The product can be part of wearable technology, for example heart rate belt or clothes, but it can also be attached into sports equipment such as tennis racket or skis and the user can get more accurate and more useful information about their activities.

Movesense is designed to provide more information about sports activities. It can be used in addition to Suunto’s sports watch or in activities where the watch does not give enough information. The use of sports watches are somewhat limited due to their location, it has to be in user’s wrist or hand. This means that the sports activity has to be something that can be measured by the movements and angle of user’s hand. Also, Suunto is aware that all potential customers do not want to use a watch or it cannot even be used in every activity.

This Movesense-project is a collaboration of Suunto and Amer Sports, variants will be sold by Amer Sports. Suunto will only sell one variant, the one that has heart rate sensor and it will substitute the current heart rate belt. All the product variants will be manufactured by Suunto’s supplier Supplier. The current understating of the situation is that first only two variants will be manufactured, HR belt 2 and TuttiFrutti.

6.1 Product variation possibilities

In this study, the variation is only concentrated on PCB, Printed Circuit Board, different sensors in it and the outlook of the product. There has been also debate if the connection pins should be in this product, but this study does not consider that as an option. In Figure 6 is presented a block diagram of the heart rate belt, grey blocks are required components and blue blocks optional. In this study the focus is on the sensors, the variation between six components and which of them are used. These are accelerometer, gyroscope, magnetometer, temperature sensor, pressure sensor and heart rate sensor. This figure is presenting a set up suggestion as the product was planned to be replacing current HR belt product.

Accelerometer is used for to detect the acceleration vector of motion in Cartesian xyz-coordinate system. The sensor consumes less energy than other sensors and that is why it is often used in wearable devices that are used to track movement. Accelerometer is also not distracted from lightning or the environment it is used at. Gyroscope sensor supplements accelerometer, it detects the position of the object. Gyroscope cannot be used without accelerometer which means in the final product there is either accelerometer alone or accelerometer-gyroscope combination. Magnetometer is an internal compass, it measures the magnetic forces of the Earth. Temperature sensor senses air temperature with +-0,5 degrees of Celsius accuracy from -40°C to +120°C. Pressure sensor is used especially in diving or mountain climbing to sense the air pressure. The pressure sensor has to be accurate because it gives user important information when the pressure is too high or low.

Authenticator master detects where the device is connected and this way the right settings are used without user interaction, for example if the device is connected to certain sports equipment, the device recognizes the counter parts. Authenticator master needs authenticator slave to work, authenticator slave is also called connectors. There are two kinds of connectors, smart and basic model. Basic model only provides the connection to other products, smart connection enables the digital ID that sensor can read and so perform a context-specific application. Connection pins are included in the product in this study and these two models are not considered optional. The price difference is insignificant to Suunto and the authenticator master demands the smart connection pins. Load switch, analog switch or different sized memory components could be included into the product but these are not considered as variation options in this study.

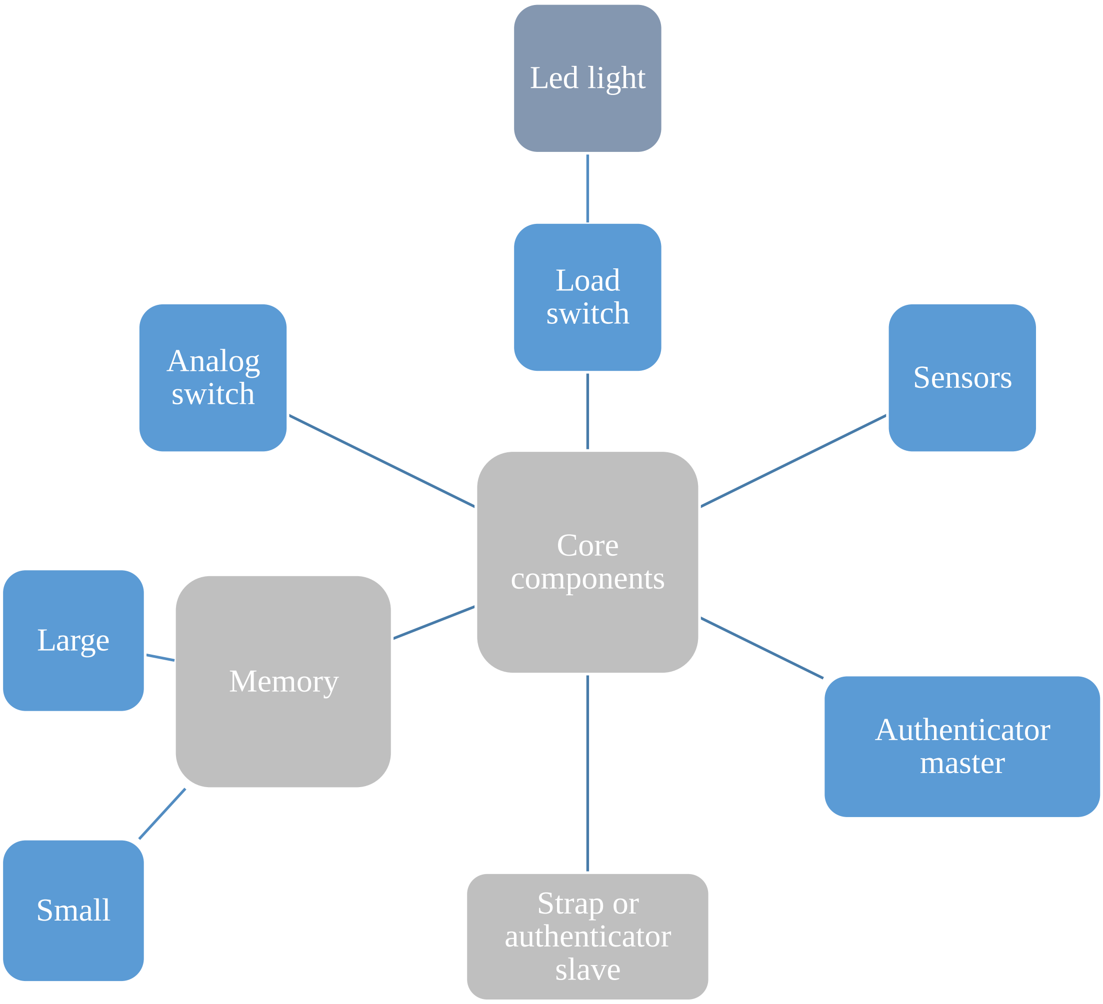

Figure 6 Block diagram of Movesense

6.2 Customer requirements

Suunto is planning to produce 3-5 variants or Movesense, one of them will include only the heart rate sensor, another one will include all seven sensors. Two interviews were concentrated on customer requirements and what Suunto has already discovered that customers want. Movesense has been introduced in three different exhibitions and it has received positive acceptance. In these exhibitions Suunto was not only trying to find potential customers but also looking for test users for beta version of the product and developers for the software. All interested companies and innovators could apply for a test user or software developer if they had some idea how they would use the product. Users can develop their own app for the product, Suunto only provides a simple software which is customizable for customer's needs. Suunto selected about 100 applicants for the test user program and they received the products in March 2017. While writing this thesis the test user program is still going on.

In the exhibitions where Movesense was presented to customers it became clear that customers want one device that can be used for several purposes, different kind of sports activities. On the other hand, customers are not willing to pay extra for features that will not be necessary to them, which shows the problem of planning product variants. Variants should be versatile but also the selling price must still be reasonable. This sets some boundaries for the components and especially the more expensive components are included only if it is necessary for the purpose.

Customers have been interested about the size and how small it can be. The product is designed to be small round device with two connection pins on the back. Figure 7 the dimensions of the product as planned, but it could possibly be even smaller. If the contact pins are left out, the product would be slightly smaller, a bit bigger than the battery used in it.

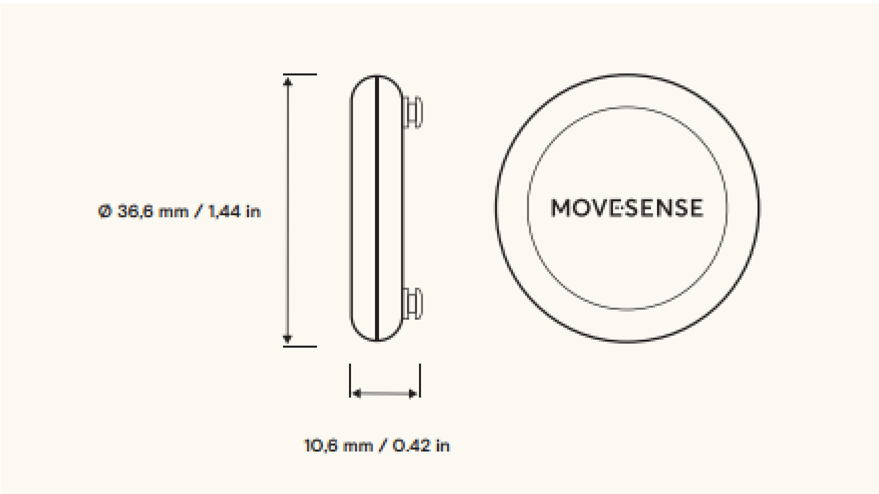

Figure 7 Movesense dimensions

The product has a battery which can be changed but not recharged. Some customers have been interested if there would be rechargeable version. Recharging might be needed if the device itself is expected to calculate certain factors which would use the battery fast. However, this creates several problems in the set up. The device is waterproof so that it can be used in all kinds of sports and weather conditions. This is definitely one feature that Suunto wants to keep in the device, all their other products are waterproof too. Also, the device might be close to skin or connected to a sports equipment and then it is exposed to weather conditions and sweat. If the device was not made waterproof, it could not be applied into all kinds of sports, water and snow sports would be definitely eliminated immediately. Waterproof charging option would need a new design and different components (for example battery). It would obviously rise the costs of the product; new components would be added into it and the charger itself.

Pressure sensor is one of the most expensive features in the product. Preliminary view is that customers who would use pressure sensor would also need accelerometer, gyroscope and magnetometer. Pressure sensor would be used in situations where movement is also important, but it has not risen much interest from customers. Temperature sensor would be useful in same kinds of situations, though it should be as accurate as possible. If there is more than +-1 degree of Celsius difference to the actual temperature, customers do not see this feature useful and it should not be considered in the device.

Some customers have asked about GPS-sensor, but Suunto does not see this important, because their watches have this feature. Customers can use watch and Movesense together to get more data about their sports performance. Authenticating is seen as an interesting feature which broads the applicability of Movesense.

The label can be a Movesense-label as in Figure 5, a company’s own label as in Figure 10. There has also been discussion about leaving the label totally out if customer asks for it, but at least at this point it is not considered as a possibility.

6.3 Production responsibilities and possibilities

There are several possibilities to arrange the production and these possibilities are described in this chapter. Suunto has agreed that at least PCBA and possible PCB variations will be done at Supplier, Suunto does not have the possibility to do this themselves. Figure 8 and Figure 9 describe the variation process from different angles. Figure 8 is a simplified process description where the production process is described step by step. Figure 9 shows how the variation possibilities grow in the process.

Figure 8 shows the five steps of the production process. The PCBA configuration options will be agreed with Suunto but the supplier is fully responsible for the production. Software, testing, labelling and packaging can be either suppliers or Suunto’s responsibility, they both have the capabilities to do these. This means that all of these steps can be performed by the supplier or the devices would be delivered to Suunto before installing software. In the first scenario, supplier would handle the distribution to the customer which is seen problematic. There is a previous experience with the same supplier in a similar situation where communication issues caused several problems.

Production can be arranged in several ways between Suunto and Supplier but there are some restrictions. PCBA is already agreed to be done by Supplier, software and testing are linked to each other in the process, testing will be done with the same equipment as the software installation. This means that the products can be delivered from Supplier to Suunto after PCBA, testing or labelling. If packaging is done by Supplier, the products will be delivered straight to the customer. To keep the process simple, Suunto has decided that labelling and packaging will be done in the same place, hence there are two options to do it.

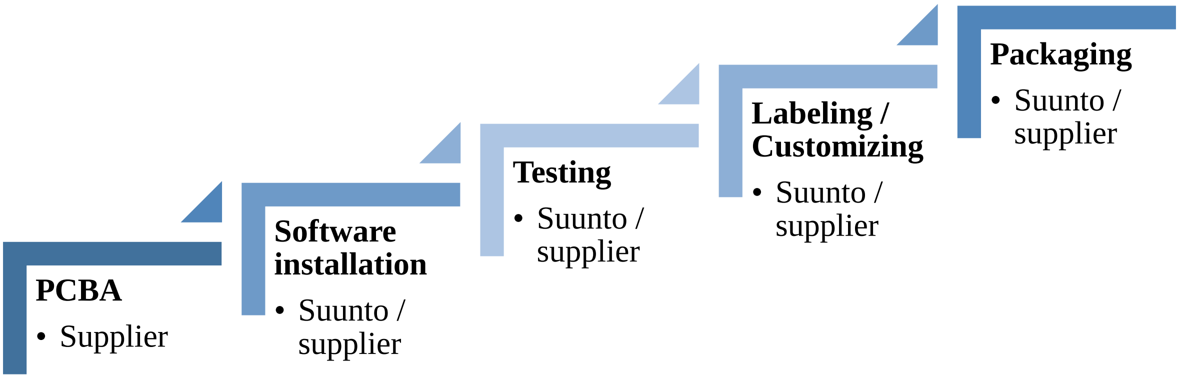

Figure 8 Simplified production process

Figure 9 describes the variation possibilities and how they grow exponentially with every decision. This does not show the reality, because the true demand is not yet known and the real customization needs can be different than in the figure. To make the figure clearer and easier to understand, only first letters of are used. S is for software, L for labeling and customizing and P for packaging. Testing is always the same, it is not depending on the variation or components. In this figure PCBA variation 1 could be HR belt as there are few different software and label variations. Suunto will manufacture and sell the same product with different software for customers too and they want their label into the device. PCBA variation 2 would be then Movesense TuttiFrutti variant. The software will always be different, because the software defines the bluetooth connection and the name which the device is found. This means that the software might be otherwise same, only the name is different.

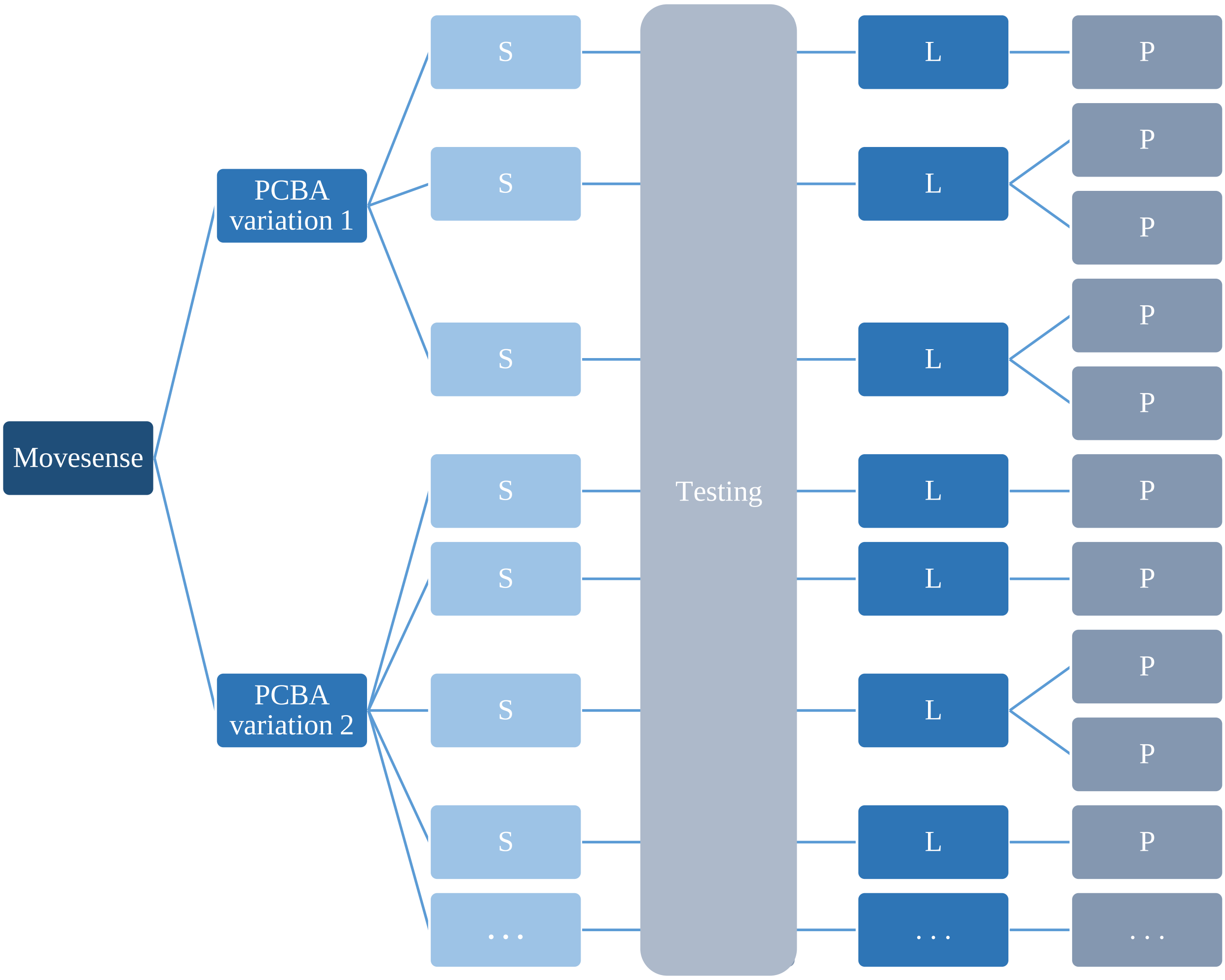

Figure 9 Example of the variation process

Supplier and Suunto has already agreed that supplier is responsible for PCBA, possibly also testing, labelling and packaging, Suunto provides the software. Besides the PCBA variations described in the Figure 6, the hardware is always the same. There is no variation in the case of the product (in Figure 5), it is always black plastic case with metal connection pins. The product will have this outlook, except the labelling, after the PCBA variation.

There would be maximum 5 new components in the production, depending on the chosen variation, and Supplier does not see this as a problem. From their point of view the biggest problems would be in the variations of the labelling and packaging, because the variation possibilities can be almost endless. Suunto has decided to limit the package options into two possibilities, single or bulk package. The single package is a standard model for all customers but the prints on it can be varied as much as the label. If the customer does not want the products individually packed, they will be delivered in a bulk package all together. Even though Suunto has limited package options, the packaging actions can be arranged in several different ways. If customer wants, there can also be additional equipment with the device in the single package, such as belt, support or wrist band for attaching the device to the user or sports equipment. Also, there might be a printed cardboard which has for example customer's logo or information about the device. This expands the packaging options, in some cases the same customer might even want both bulk and single packaging, this is presented in Figure 9.

Suunto and supplier have selected certain risk components, they are those components that have long lead times. The longest lead times being up to 25 weeks estimating demand and production planning should be weeks ahead. Fortunately, all the components of Movesense can be also used in either HR belt or in other Suunto products. If Movesense does not have quite as much demand as planned, ordered components can be used for other products so surplus inventory is not a problem.

Suunto has proposed that at least in the beginning supplier would manufacture the TuttiFrutti-variant of Movesense without software, label and package and deliver the products to Suunto for further variation. This way Suunto could do these actions after they receive an order. If the order amount is small, maximum 25 pieces, Suunto has equipment to do labelling in-house. The labelling would be done individually for every product which takes time. If order amount is more than that, Suunto will purchase labels from a supplier and the labels are glued into the product in Suunto's factory, which takes approximately 1/10 of the time that making the labelling would take.

Suunto uses MTS manufacturing for its other products but with Movesense this manufacturing model cannot be implemented since software, testing, labelling and packaging can be done only after Suunto has received an order. Suunto has decided to use MTS manufacturing with the PCBA production, Suunto orders the products from supplier based on estimations. The products are variated for certain orders so the rest of the variation would follow MTO manufacturing.

The smaller the production batch is, the larger the costs are for individual product. Changing time between different variations is considered as “waste” in production, as wasted time, so the costs are calculated that way. The production set up costs are divided for every product individually. For example production set up time between different variations for Movesense is estimated to be about 15 minutes, possibly even a little less.

The biggest problems for Suunto would probably be the software. Software is made by Suunto but Supplier can be responsible for installing it. Different product variations will have different software and the installer (either Suunto or Supplier) is responsible for choosing the right one from all the variations. The software includes certain features depending on what kind of sensors the product has. Supplier uses Suunto’s SAP codes in the installation process, it has been a clear way to separate different variations and define Bluetooth name for the product. Different variations always need an individual SAP code because the code defines certain aspects in the software installation process. Individual codes create costs and all customers are not likely to return and buy the product again. This creates a lot codes that are only used once and after that they are useless. These inactive codes would congest SAP and eventually there would be numerous codes that have been only used once. This problem can be solved only by arranging the software installation in some other way than dependent on the SAP codes. In the production planning should be considered that installing software and testing is passive time for the operator as the actions do not need manual input. The operator can use the waiting time for something else for example to prepare next product or components for the process.

There has been discussion in Suunto about how to arrange testing and there are three options; to test all products, only take a random sample for testing or not to test at all. Every option has their own benefits and disadvantages. Testing every product individually eliminates the chance of faulty items getting into market. However, testing uses quite a lot resources and time which together creates more costs.

Sample testing only considers randomly selected products, for example a certain percent of the production batch. Sample testing is faster than testing every product individually but it creates the possibility that errors are not detected. If products are not tested at all, the possibility grows even higher, there is great chance that at least some of the manufactured products are not working as they should. There also might be some errors in production that could be corrected if they were noticed in time.

These last two options create a high risk of faulty products getting into market and effecting on customers. There is a control risk Suunto is not able to control the products that are sold and there might be several products that do not fulfil Suunto's quality requirements. Suunto and Supplier do not want to take that risk and all products will be tested. Installing software and testing are linked so either way, testing is already arranged in the production process. (Supplier 2017)

There will also be several programmes for testing, depending on what kind of features the product has and what is supposed to be tested. Supplier cannot yet define the changing time from one program to another because there is only one testing program at the moment. The changing time is difficult to define beforehand, it can be from seconds up to few minutes. In this thesis the changing time is decided to leave out of the calculations because of this uncertainty.

Labeling and packaging can also be done at Suunto's premises or bought outside the company. The products can be labelled with customer's own logo as seen in Figure 10. Kaunila is a reference for Movesense and they offer a product for dog owners to track their pet's activity. Also, the label can be Movesense's own logo as seen in Figure 5.

Figure 10 Example of customized product

Sales package is bought from another supplier and the final packaging is done by Suunto. The labels and packages are sourced from different suppliers and both of their lead times can be up to 4 weeks. This has the most effect on the lead time to the customer, configurations can be done earlier, software installation and testing takes the least amount of time in the production process. Suunto has not defined an exact lead time for customers, at least in the beginning it will be defined case by case, but it could be something between 6 and 8 weeks in most cases. Suunto has not yet decided the actual size and shape of the package, but there are few options of previous HR belt packaging. Since the package is not yet clearly defined, it will be sourced with a target cost and there will be defined a target time for packaging.

Suunto and Supplier have together decided that faulty items are not repaired, they are only replaced with new product. Repairing is not seen as profitable action and it would cause more costs than cut them. If there will be repairing option, it will be offered by a third party and Suunto would give technical advices at the most.

6.4 Pricing

The BOM price or the result of TCO model should not be mixed up with the selling price. The selling price will be defined after total cost is known and variants selected. TCO model does not calculate profit margin for the product, it should be done individually, but it is clear that all of these variants would have the same profit margin. Actual selling price was not calculated in this study at all, but the total cost calculations indicated the difference between different variants which was analysed.

7 FINDINGS AND ANALYSIS

In this chapter, the chosen cost model is presented and the relation to the theory is analysed. With the information from the total cost calculations, the variants for Movesense were chosen. These variants and reasons for choosing them are also described in this chapter.

7.1 Description of the chosen cost model

In the development of this model TCO principles were used to create adequate supplier selection model. The chosen cost model has been made to be used in all sourcing decisions but mainly to calculate the total cost of Movesense variants. Suunto was also interested to find the elements that effect the make or buy -decision and if they are related to costing. Interviews showed that life cycle costing was not relevant for this model and that is why LCC part is not considered in this model. The cost model is presented in Table 5.

Many of the functions on this chosen cost model are based on the BOM price per unit which is usually known or the supplier can define it. The model is divided in five sections horizontally: calculation data, production costs, variation costs, logistics and service. Vertically there is two columns for the same product to compare Suunto’s own production and supplier production, hence giving information for the make-or-buy decision. Horizontally the first section is the base for all the other calculations. Production volume should be the same when comparing Suunto and supplier, but there can also be several columns to compare the effect of the volume. Some figures, such as supplier profit are change with volume changes but this varies between suppliers and products so much that it cannot be defined into the model. There is a certain price per hour for labour and this is used in the calculations also.

Table 5 The chosen total cost model

		Supplier	Suunto production
	BOM		
	Volume		
	Labour price / h		
Production costs		**€ -**	**€ -**
	investments		
	production (labor)		
	fixed costs		
		low	low
	quality/risk	€ -	€ -
	supplier profit		
	licenses / royalty fees		
Variation costs		**€ -**	**€ -**
	software		
	installing software		
	testing		
	label		
	labelling		
	package		
	packaging		
	variation		
Logistics		**€ -**	**€ -**
	delivery (to suunto)		
	customs		
		low	low
	reliability/risk	€ -	€ -
	partner profit		
	warehousing		
TOTAL		€ -	€ -
Difference		0,00	

Production costs compare costs that are created in production; investments, labour, fixed costs, supplier profit, licenses or royalty fees. Some of these costs are earlier defined in

Suunto such as labour price in Suunto's own premises, and this earlier defined value can be used in here. Fixed costs are depending on the production volume, so estimated fixed costs are divided on the volume amount. Supplier profit is defined case by case and usually is depending on the volume, too. With some products, for example ODM products, there can be royalty and license fees that are defined case by case. Quality and risk is evaluated as low, medium or high and there is defined a certain ratio for each option, BOM and production costs are multiplied by this. If the risk is defined "low", the ratio is zero. This could be the case for example if the supplier is already known and previously used with minimal or no problems. The ratio for "medium" is 2.5% (0.025). This option is for example with supplier that is fairly new and there is not yet much history, but there have not been huge problems, or it could be previously known supplier which has had some problems but nothing major. The ratio for "high" is 5%, (0.05). This option is used for example with supplier that have a huge risk to fail or there is no guarantee or previous experiences about the supplier's quality or activities.

Variation costs are important to specify especially if there is going to be several variations, as usually there has been. In this case all the variation steps are listed in the same order as they appear in the production process. There is also considered the possibility that variation itself might cause some costs with rearrangement and organization. If there is for example a lot variation with components or several different packaging options, there might be problems with organizing and keeping track with all the variations. All the variation items, such as software, label and package, is separately of the actions, installing, labelling and packaging.

Logistics include delivery to Suunto, delivery to the customer is left out from the model because in most cases it would be the same with both options. Suunto uses a partner to handle the logistical tasks so the model takes in account that there will be also some kind of profit for the partner. The reliability of the logistical partner is also evaluated with the same way as in the production section, low, medium and high. If user chooses low, there is not effect on costs, but if "medium" is chosen, logistic costs are multiplied by 0.025, 2.5% and with "high" by 0.05, 5%.

The last section in the model is service which includes the customer service after customer has received the product. Suunto has its’ own customer service in the same facilities as the production and some products might have more need for this service than others. Small and relatively cheap items such as Movesense, will not have repairing option, because faulty items are replaced with a new one, but there might be other kind of customer service, for example giving instructions for the customers about how to use the product. After these five sections there is summary, the total cost per one item, and the difference between Suunto’s and supplier’s costs.

In this Movesense-case, total cost model was used to compare different variations as well as Suunto’s and supplier’s production costs. In the future this model can give information about the costs that can help to make decisions for coming purchases. For Movesense there was already selected a supplier, but the model also supports using different suppliers and comparing them to each other for example in the beginning of sourcing process before making the sourcing decision.

The model was created to be used especially in Movesense-case but it can be applied to other sourcing projects, too. Suunto wanted a simple model that is easy to use and the needed information is available to all users. The more costs have to be estimated, the clearer it is that there is not enough information available for calculating the total cost. The chosen model exploits information that is easy to access and update. This model can be used for make-or-buy decisions and to compare different variation options with same supplier. If it is used to compare variations there can be new columns added for this.

LCC model was considered as an alternative to TCO model or if it should be taken in account in developing the model. However, during the interviews it became clear that only total cost model is the right choice for this project. Even though TCO is originally created for other purposes, there are many similarities than in a basic total cost analysis. Principles of TCO have been used to form this chosen model granting that TCO is generally used for purchasing hardware or software. This model is mainly used for comparing manufacturing material suppliers or supplier production to Suunto’s production. Both models might be affected by the user’s own perceptions and what is important to include. They have some similarities in their structure and purpose, both aim to show hidden costs and the total cost of the purchase. TCO model is often described as an iceberg which also describes total cost model. In the interviews at Suunto stated that too often only purchase price and delivery cost are compared to other options. Inventory costs can be also found from this model, as well as the technical support costs. Training costs are important also in this model and they are included in investment costs. The labour cost could be considered as operation cost in this case.

7.2 Chosen variants of Movesense

There were 83 possible variants with the PCB and from these seven variants were chosen for further calculations. Customer requirements limited the options more than production requirements because all the 83 variants could have been produced. The chosen seven variants are presented in Table 6. These options could include authenticator master, except for the first option it would not be useful. The first option includes only the heart rate sensor, so it could be only attached to belt so that it can sense the heart rate. Option 2 has all the possible sensors which was clear option for Suunto to create. Options from 3 to 7 are based on customer requirements and what Suunto has discovered would be useful in different activities. Pressure sensor or temperature sensor would only be part of the configuration if there is also accelerator, gyroscope and magnetometer as customers saw it most useful with those sensors.

In Table 6 there is also calculated total cost for these seven options. The actual prices are confidential information and could not be shared outside the company, so the original figures have been modified. Even though, the ratio between the figures has stayed the same so they can be analysed. All the total cost figures have been calculated with same production parameters, make versus buy -decisions related to production arrangements are analysed in chapter 7.3.

Table 6 Variant options

Options	Sensors						Total cost (€)
	Heart rate	Accelerometer	Gyroscope	Magnetometer	Temperature sensor	Pressure sensor	
1	x						10,42
2	x	x	x	x	x	x	13,43
3		x	x	x	x	x	13,03
4		x	x	x		x	12,80
5		x	x	x	x		11,20
6		x	x	x			10,96
7		x		x			10,64

Suunto has presented an option that there would be three different PCB assemblies at least in the beginning. Two of these are marked with green colour in the table, options 1 and 2. Option 1 would be replacing the current HR belt product, the one with accelerometer. Option 2 would be Movesense, a so called Tuttifrutti variant, which has all the possible sensors. Options 3 to 7 will not all be produced, one or two from these can be optional if there seems to be enough demand for it. Product variants can be created by variating the software, Suunto would provide from three to five software variants which will use some or all installed sensors. These variants will be also variated for every customer with customized label and package as presented earlier in Figure 10.

Out of these seven options two were previously selected to production, all sensors including variant and heart rate measuring variant. Customer interest studies and interviews showed that there could be other variants too, but they should be clearly separated from the Tuttifrutti variant. Customers want to see what they pay for and what are they missing if they choose the variant with lower cost.

Options 3-7 all include magnetometer and accelerometer, most of them also have gyroscope which shows that these sensors are essential for measuring sports activities. As it can be seen from the table 6, pressure sensor is expensive. For example, options 4 and 6 both have gyroscope, accelerometer and magnetometer, but 4 also has pressure sensor. If the costs of these variants are compared, the difference is 1,84. This is the biggest difference between two variants that have almost the same sensors among these seven variants. In several interviews in this study the pressure sensor was in discussion, especially when talking about customer requirements. Pressure sensor is seen as an expensive component which is not beneficial to many kinds of sports and that is why it is often not included in other Suunto products. Hence it could be left out from the other variants too as the Tuttifrutti includes it anyway. Leaving the pressure sensor out would not exclude many potential customers, according to the customer requirements studies those customers who need the pressure sensor would be interested all other features that Tuttifrutti has. Providing that the pressure sensor will not be in other variants, options are 5-7 still possible. Interviews revealed that Suunto does not want to manufacture three variants that are this similar, which means that only one of these could be reasonable option and the total number of variants is limited to three.

Interviews showed that Suunto wants the chosen variant to be clearly separated from the first two. The costs of this variant should be closer to the HR variant's costs than Tuttifrutti since the latter has all the functionalities. Customer requirements studies showed that customers would be interested in variants if they had clear differences and the variation could be clearly seen with the functionality. If there was a variant that would have only one sensor more or less than other variants, customers would not be interested in both variations. If options 5, 6 and 7 are compared, option 7 is the weakest and least applicable for different activities, though it costs less than the other two. Gyroscope is an inexpensive sensor and it can be used for many kinds of sports activities, which advocates including it to the third variant. This would exclude option 7 being the possible variant.

Options 5 and 6 are very similar in every way, they do not have much difference in costs or in functionality. The only difference in the configuration of these two is that option 5 includes temperature sensor. They are both strong options for the third variant, but in the second interview which dealt with customer requirements it became clear that in this case the temperature sensor would be left out. It is not seen such an important feature for a sports measuring device as for example gyroscope and customers have not showed so much interest towards it that would advocate including it. This means that the best option for the third variant is option 6.

As said earlier, the outlook of Movesense can be variated for every customer if needed. Suunto's products are usually not variated individually for every customer. As seen in Table 7, other Suunto products have usually more product variants in the production. There are often three to five colour variants and possibly one or two components variating the outlook. All variants are produced for two different markets which doubles the number of variants. In the table letters from A to E present different colour variants, letters F-H other variation and letters X-Y different markets. Planning production, variation and logistics is very different for product such as Movesense which is highly customized. This means that the variant strategy created in this study cannot be applied to Suunto's other products.

Table 7 Example of product variants with one Suunto product

	Colour	Other	Market
Variant 1	A	F	X
Variant 2	A	G	X
Variant 3	A	H	X
Variant 4	A	F	Y
Variant 5	A	G	Y
Variant 6	A	H	Y
Variant 7	B	F	X
Variant 8	B	G	X
Variant 9	B	F	Y
Variant 10	B	G	Y
Variant 11	C	F	X
Variant 12	C	F	Y
Variant 13	D	G	X
Variant 14	D	G	Y
Variant 15	E	H	X
Variant 16	E	H	Y

7.3 Make versus buy -decisions with Movesense

The TCO model was made also to ease the make versus buy decisions and the model compares Suunto production to Supplier production. In the model there were three scenarios which are presented in Figure 11, gray arrows are representing Supplier and blue arrows represent Suunto. In the first option Supplier is responsible for all the production. In the second option Supplier is responsible about the PCBA, software installation and testing and the products are delivered to Suunto for labeling and packaging. In the third option Supplier is responsible only about the PCBA and the products are delivered to Suunto for further variation. All of these options are possible to arrange and the process can be changed later when the demand is somewhat stabilized and predictable. The costs are almost the same with the second and the third option, because Supplier tests products anyway, even though Suunto would install the software and test the product again. The third option has some advantages at least when the production is just beginning. This option allows Suunto to place orders in advantage before there is customer or an order to fill. Suunto can create inventory with the chosen PCBA variations. With this "buffer" inventory Suunto can answer faster to the customer's needs considering Movesense. Products can be faster variated for a specific order when there is no waiting time for the product itself. Later when the demand is stabilized the first or the second option might be more reasonable because Suunto does not has to be as much involved in them as with the third one.

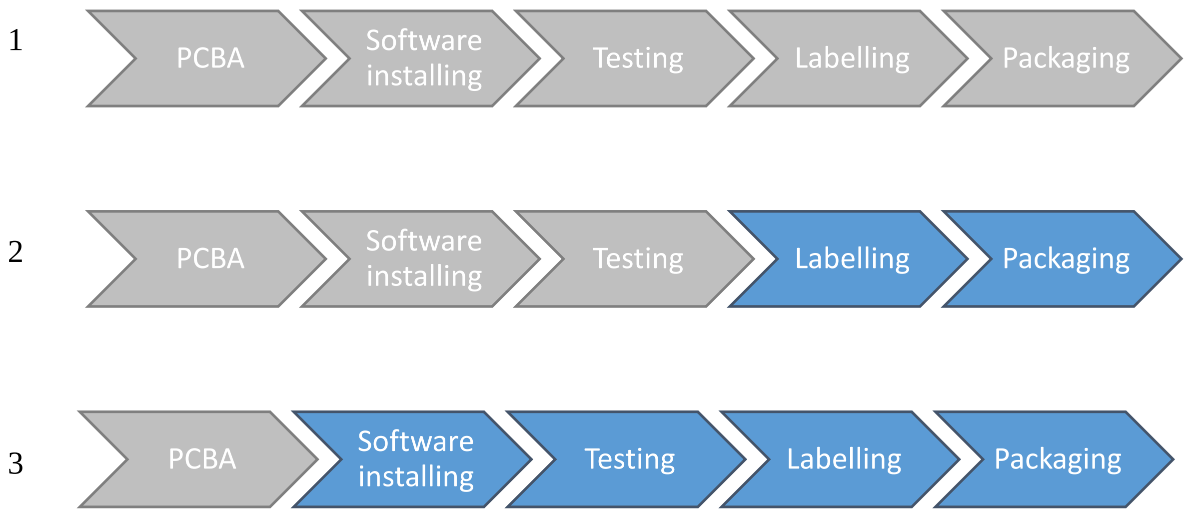

Figure 11 Variating options Suunto and supplier with three variants

7.4 Risks to be considered with Movesense

Risks cannot fully be avoided in supply chain but they can be managed in a different way. The most concerning risk from Suunto's point of view is the information flow risk. Suunto is prepared for the scenario that some actions will be done in both Suunto and Supplier if the products are delivered to Suunto for variation. As stated earlier, in every case Supplier will test products for assuring the right quality. Suunto wants to test the product after variation too, which means the same device would be tested twice during the process. To avoid performing some steps twice in the process, Suunto needs to share information about the customer with the supplier. Suunto gives high value to this kind of information and is not willing to share it easily, although the supplier is trusted and previously known. Repeating some actions in the process obviously creates more costs, but Suunto thinks it is more valuable to keep some information inside the company.

Information sharing has several risks which Suunto has evaluated to be higher than it is willing to take. There is a risk in information sharing that Suunto will lose control over the production and the supply chain management is damaged. If supplier knows the customer, they can be in a direct contact and Suunto be left out of conversations. Situation might encourage for supplier opportunism and cause disagreements between Suunto and the supplier. In the interview with Supplier came up an earlier case where the communication between Suunto, Supplier and the customer was not working properly and there were some misunderstandings. Supplier has discussed some issues directly with the customer but Suunto did not know about this which caused confusion and extra work to clear all issues. Neither Suunto nor Supplier wants this to happen again, the case took unnecessary amount of time and resources to clear the misunderstandings.

Defining value for the critical information is difficult, the value is usually known only if the risk comes to reality. Suunto wants to share information about the customer as much as it is necessary for supplier to know. It is inevitable that some information has to be shared with Supplier for the manufacturing purposes but Suunto can secure the most critical part. First

Suunto should define which information is too critical to be shared but not critical for the manufacturing process to succeed. Even though risks do not exactly show in the TCO calculations, it will definitely influence on the make or buy -decision. To include the risk to the model, there is the supplier risk/quality evaluation part which adds a certain percentage of costs to the total. TCO model does not usually take risks in account but Suunto wanted risk evaluation to be part of it. Suunto also wanted that the evaluation would be simple and not take much time, but the simplicity means that the risk analysis is not very thorough and errors might occur. The risk evaluation in this model is highly subjective and can be only about the person’s own perception. Even though this is the case, Suunto wanted to keep the risk evaluation part in the model. Suunto has high trust on its own employees and their professional know-how, so that they would do as objective decision as possible.

7.5 Variant strategy for Movesense

There will be three variants of Movesense but Suunto has decided to start production with only one, Tuttifrutti which has all the possible sensors. When the production has begun and there is some data of customer behaviour considering Movesense, then other variants are added into production, first the HR variant that will replace the current HR belt Suunto has in their selection. This new HR belt will also replace other products that Suunto offers for their customers and partners which means it needs some preparations. The new HR belt will have different price and components than the current one so customers and partners will want to get to know the product more and see the differences. This HR version of Movesense will eventually have somewhat stable demand and the production can be planned by historical data that is already received of the current HR belt. The third variant is expected to have similar demand as Movesense Tuttifrutti variant, though the functions of it will be more limited. Those customers who do not need all the functions Tuttifrutti has but are interested to get more information than just the heart rate, will probably be the key customer group.

Product variation, except variation in PCBA, should be done at Suunto. The risks of having information leak or losing control of the process is too high and not easy to manage. The same supplier is used also to other projects and Suunto does not share customer information in those projects either. The supplier relationships are wanted to keep consistent and acting differently in different projects might have effect on the roles and ways of doing things. This way the relationship stays balanced and it is clear for both parties what are the roles of supplier and buyer.

Lead times for customer are defined case by case. When the production is running and there is data available of real customer cases, Suunto is able to define lead times for customer orders. Suunto is constantly having discussions with current suppliers to cut the lead times or sourcing suppliers that would offer shorter lead times in the beginning. It is possible that the lead times to customer will be from 6 to 8 weeks due to the long lead times of labels and packages.

Suunto is aware that the problem with SAP codes is still active even though the software installation and testing is transferred to Suunto. Even though the problem has not vanished, there is no risk for critical information leaking outside the company, Suunto does not have to hide the customer in their own production. Suunto is certain that there is a way to arrange the software installation and testing without creating a new SAP code. The benefit of variation being done inhouse, Suunto can test different manufacturing options without having to settle just for one option supplier is offering. In the device or the packaging there will be noted that Suunto handles the manufacturing of the device, even though it is not sold by Suunto but Amer Sports. The resourcing is still not solved, how much resources Suunto is ready to use for this compared to Suunto’s own products. Resource allocation will affect on the service level of production considering this product.

8 CONCLUSIONS

This chapter presents the conclusions made about the gathered data and how the problems are solved. The main problem was to define a total cost of ownership model for Suunto and with the cost information make decisions about what kind of variations of Movesense there could be and where the variation happens.

8.1 Benefits of cost calculation for Movesense

Total cost model was created primarily to answer sourcing team's needs and to help sourcing decisions. Based on the literature review and interviews in the case company there has been formed following answers to the research questions.

RQ1: How to define the total cost of a certain component or operation?

Christopher (2011, 29) presented that only a small part of the total cost is usually visible and many cost items are often forgotten. TCO model is created to reveal those forgotten or hidden costs and create more comparable cost figures. The chosen model includes all possible cost items that may occur in the sourcing and purchasing processes. The chosen model is monetary based and calculates the total cost but does not include all the product life cycle costs. During the interviews in Suunto it became clear that LCC or TCO models would not answer the need of a cost evaluation model, those models are not designed for purchasing components for manufacturing purposes, but the principles of TCO could be used in this model too. As the literature review shows, TCO models can be categorized in different ways. One excellent categorization was given by New Zealand Government (2013), they divided TCO models into two groups by its purpose; LCC and cost breakdown structure. This model is clearly cost breakdown structure as the life cycle assessment is not included in it.

In this case there were critical make or buy -decisions which can be answered with a cost analysis model. TCO is not usually used for make or buy -decisions, it is more focused on understanding costs of owning a certain object for example manufacturing equipment.

However, van Weele (2010, 64) stated that make or buy -decision can also be based on TCO model and that is why it was chosen for this case.

Suunto also wanted that the total cost model could be applicable for different situations, it should give information for both make-or-buy decision and be able to compare variants. This chosen model has both features, there are 3 sections that can be used for comparing variants and different sections for Suunto’s and supplier’s production.

In the future Suunto should make certain decisions concerning about the costs, especially about Movesense. The production is in Suunto’s premises but Amer Sports is distributing the product. The factory is owned by which means that there has to be some kind of agreement of how the costs are divided. Another question is the customer service, product care. Using Suunto’s customer service would be sensible because being the manufacturer they have information that could be critical in the maintenance process. The responsibilities between Amer Sports and Suunto will be clarified in the coming years but in this thesis Suunto’s figures are used where it is possible. Also, resource allocation will be a question, Suunto will still have its own production also. Hence it is yet to decide how much of Suunto’s resources will be used for manufacturing Movesense.

Total cost of Movesense is constructed by several different factors. As the product is manufactured by Suunto’s supplier and only the variation can be done at Suunto, there is a certain price for the product. In the total cost model this price is used as a base and other cost items are added to it. The other cost items are production cost, variation costs, logistics and service. Production costs are the costs of manufacturing but in this case, it only variates with production amount, because the manufacturing is done at supplier’s factory. Variation costs include variation possibilities and variation actions, software, label and packaging. Testing is also in this category even though it does not variate, because it is bound to software installation in the process. All variation steps can be done either by Suunto or the suppliers. Logistics include cost related to delivery and warehousing. Service cost is not used for Movesense but it could be the customer service for example repairing and maintenance costs that are done at Suunto’s customer care.

The model was created to give more information for make versus buy -situations and find elements that affect the most on the decision. In this case the labour cost has probably the most effect on the decision, it has a large effect on the total cost. Production volume is also an important factor in the decision, because it affects on different parts of the model. The production cost is dependent on the production volume, with larger volume fixed costs are lower per one unit than with smaller volume.

8.2 Forming variant strategy

The aim for this research was to find out what is the optimal number of Movesense variants and which are they.

RQ2: What is the optimal number of product variants and which are they for Movesense?

Tynjälä and Eloranta (2007) stated that adding a new product variant can be very expensive and suggested cost-benefit analysis. Suunto had evaluated the benefits of variants and recognized the costs they would make. That is why Suunto suggested there would be maximum 5 variants and this study aimed to find the optimal amount.

This project includes different kinds of product variation. First of all, the product can have different configurations with seven sensors that create different functionalities for the product. Manufacturing different configurations would be outsourced to a supplier. Secondly, the product can be individualized for every customer with software, label and packaging. This individualization could be done by either supplier or Suunto itself and this study was made to get more information for that decision.

The study begun by listing all possible configuration variations with two or more sensors. and there were 86 variations. After that the number was limited to seven by customer requirements and technical data that was received from the interviews with Suunto's employees. The interviews also clarified that two of these seven variants were already

planned to have in production. One of these two was the first idea of Movesense, a product that called “Tuttifrutti” which would have all seven sensors and could be used for any kind of sports. Another one was going to replace a current Suunto product and it would only include the heart rate sensor. Addition to these Suunto wanted to find at least one variant for those customers who are looking for more than plain heart rate monitor but less than Tuttifrutti. These customers do not need such versatile product or they are not willing to pay for all the functionalities, especially if they see some functions less useful for themselves. Suunto wanted to find one or several variants that would be suitable for this customer segment. There were still five options left that could answer both customer and technical requirements. These five options had many similarities and it was clear that all of them could not be added into the production. With follow-up interviews and historical data of user experiences related to these sensors the options were narrowed down to one. The conclusion is that there are three variants for Movesense which are presented in
Table 8.

Table 8 Movesense variants

Options	Sensors					
	Heart rate	Accelerometer	Gyroscope	Magnetometer	Temperature sensor	Pressure sensor
1	x					
2	x	x	x	x	x	x
3		x	x	x		

Since the number and configurations of Movesense variants were clear, creating the production and sourcing strategy could begin. The third research question was following

RQ3: Which elements have the most effect on make versus buy -decision?

The production of different configurations would be outsourced to a supplier but variation steps; installing software, labelling and packaging, could be done in either suppliers or

Suunto’s factory. Total cost calculations showed that the difference between production options was not substantial although supplier’s costs were a tad higher due to their higher labour cost. However, in the interviews it became clear that the most important element influencing the make versus buy -decision were risks. Variating the products outside Suunto would require sharing critical information which created high risk of losing control and information leaks. Revealing these major risks lead to the conclusion that the variation should be done entirely inhouse.

8.3 Limitations and further research

The study is purely quantitative and the results cannot be quantified. The research gap was found in cost model applications, TCO has been used for comparing supplier in larger scale purchases but not for this kind of dilemmas. Even though Suunto wanted to use TCO principles as a base to creating total cost calculation tool. During this study there were detected several similarities between TCO and total cost model, they have similar purpose and structure. Nevertheless, TCO model is developed for different kinds of purchases and it might not be the most suitable model for analysing variants and total cost. The benefits of using TCO were seen mostly in supplier evaluation and comparison where it is most often used, too. The presented solution can only be applied into a similar situation, for this company the model gives the wanted information but for another company it might leave out something important. Further studies could focus on testing the model in other situations and develop this model to more generalized direction.

Another area of interest for further research could be the analysis of other products and their variating process. As stated earlier that Movesense is somewhat different product with this kind of variation process, which is why this study was made. Even though, the variating costs of other products might be interesting for Suunto and it could give information that is yet unrevealed, such as the cost of adding a new variant.

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