Supplier performance

An advice on the improvement of supplier performance

MSc Thesis Management studies

Ruud Coppens

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WAGENINGEN UR
For quality of life

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"If you cannot measure it, you cannot manage it" (Garvin, 1993)

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Glossary of terms

Customer Order Decoupling Point	"Identifies the point in the material flow where the product is linked to a specific customer" (Olhager, 2012).
Factor(s)	Circomstance(s) that affect the performances of suppliers.
Knock-out metric (s)	A performance metric on which a minimum socre has to be achieved.
Performance indicator(s)	General indicators that focus on critical outcomes of performances.
Performance metric(s)	Operational measures that organizations use to manage their processes (Sarkis and Talluri, 2002).
Supply chain management	"Supply Chain Management is the strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole" (Mentzer et al., 2001).
Procurement management	The process of planning, implementing, evaluating, and controlling strategic and operating purchasing decisions for directing all activities of the purchasing function toward opportunities consistent with the firm's capabilities to achieve its long-term goals. (Carr and Smeltzer, 1997).
Performance attribute	A performance attribute is a group of metrics used to express a strategy. An attribute itself cannot be measured; it is used to set strategic direction (Council, 2010).
Supplier performance measurement	"The process of measuring, analyzing, and managing supplier performance for the purposes of reducing costs, mitigating risk, and driving continuous improvement" (Minahan and Vigoroso, 2002).
Supplier Evaluation	"A set of systematic records, kept to evaluate suppliers' actual performance on a continual basis" (Cavinato and Kauffman, 2000).
Supplier Selection	The stage in which the buying organization selects the most suitable supplier.

Abstract

In this study a research is performed on the factors that have an influence on the performances of suppliers. The aim of this study was to create insight in the performance of the suppliers and come up with an advice on the improvement of supplier performance.

An extensive literature study is executed to create insight in the factors that influence the performance of suppliers. By conducting a literature study on different subjects, like: supply chain management, procurement management, buyer-supplier relationship and supplier performance, insight is created in the aspects that influence the performance of suppliers. The outcome of the literature study suggests supplier selection and evaluation can create insight in the performances of suppliers and potentially increase them. During the empirical part of this study, interviews are conducted to establish performance metrics to select and evaluate suppliers in order to create insight in their performances.

The results of this case study show that the product type, supplier characteristics and the relationship with the supplier determine the procurement strategy that should be applied by the buying organization. Different procurement strategies emphasize different performance metrics, which are defined by discussion with internal stakeholders and suppliers.

Suppliers stated to perform worst on the metrics regarding quick ratio and research and development. Additionally, suppliers stated to perform best on the metrics technical capability and management and organization. Assessment of the suppliers showed that the performance of the suppliers on delivery performance are considerably lower as stated on forehand by the suppliers themselves.

Key words: *Supplier(s), Supplier(s) performance, Performance(s) metric(s), Performance attribute(s), Performance indicator(s),Supplier performance metric(s), Supplier selection, Supplier evaluation, Product type, Supplier characteristic(s), Supplier relation(s), Procurement strategy.*

Preface

In the past six months I have been conducting this Master thesis in the field of supplier performance. This thesis is part of my Master in: Management, Economics and Consumer studies which I pursued in the last two years. The thesis is performed at the chair group Management studies of Wageningen University and the organization Vencomatic.

Vencomatic, is an internationally operating organization with a product portfolio containing a full range of products for the modern poultry farm. This organization provided a subject for my master thesis about supplier performanceses. The research focused on the performances of the suppliers of Vencomatic and how to imporve them. By conducting interviews with internal stakeholders as well as with suppliers, insight was created in the focus of the suppliers and Vencomatic regarding these performances.

During this research I have had valuable guidance and support of several persons. I am very thankful for the opportunity the chair group of Wageningen University and Vencomatic provided me, to enrich my knowledge within this field of study. Foremost, I would like to thank my commisioner H. Jacobs and suppervisors Prof. Dr. J. Trienekens and Prof. Dr. P. van Beek, Em., for their supervision and solid advice during the research process.

Additionally, I would like to thank my parents and girlfriend in motivating, supporting and helping me whenever necessary.

Finally, I would like to thank all the stakeholders who provided me with valuable information during the interviews.

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Management summary

As a consequence of globalization, organizations need to deliver an increasingly high level of performance. The performances on which the organization is not able to deliver in line with the requirements of the client, should be outsourced. In line with this development and the trend of focussing on the core activities, the level of procured products at organizations increased. As a consequence, dependency on suppliers enlarged. This puts the focus on supplier performances since the results of the organization are directly depending on it.

This study is conducted on behalf of Vencomatic, a supplier of equipment related to poultry farms. In this study a number of performance metrics were developed to improve the performances of the suppliers of Vencomatic. The performance metrics were determined in order to select new suppliers and to evaluate current suppliers on their performances. The latter purpose is also carried out within this study.

Literature showed the performances of a supplier, measured by the buying organization, are directly related to the procurement strategy that is applied by this organization. Determination of the procurement strategy that should be applied by the buying organization is based on a number of factors that influence this procurement strategy. These factors are in the form of: supplier characteristics, product type and relationship.

Three different elements of supplier characteristics can be defined. Culture (1) determines the values which are handled within an organization. The technology (2) determines if the supplier is capable of meeting the technical requirements of the buying organization. Both the culture and the technology influence the relationship (3) the buying organization has with the supplier.

The product type influences the procurement strategy applied by the buying organization since different products put emphasis on different performances of the suppliers. Four different types of items are differentiated in this study, in line with the Kraljic matrix. The non-critical items (1) emphasize product standarization and therefore price is an important aspect. Leverage items (2) require optimum order volumes and allow the buying organization to exploit buying power. Bottleneck items (3) are crucial for the buying organization since the supply chain risk of these products is high. Because of this essence for the buying organization, backup plans need to be conducted. Strategic items (4) demand accurate forecast and long-term relationships, since these items are valuable and hard to procure.

Furthermore, the relationship between the buying organization and the supplier is of influence on the procurement strategy that will be applied by the buying organization. This relationship is determined by the level of trust the buying organization has towards the supplier. The level of trust the buying organization has, directly influences commitment of the supplier towards the buying organization.

Besides analyzing literature, research has been performed on performance metrics used for creating insight in the performances of suppliers. The performance metrics of the SCOR-model and the selection criteria defined by Dickson were best applicable in the case of Vencomatic. Though, literature stated that no list is directly applicable and each organization should decide upon this list themselves. In line with this statement, a number of interviews are organized. These intervieuws are held with employees of Vencomatic, internal stakeholders, comparable organizations and suppliers to ensure all these different parties agreed upon the formulated performance metrics.

Additionally, different suppliers are assessed on the performance metrics to create insight in the performances of the suppliers of Vencomatic. The results of these assessments showed the performances of the suppliers regarding quick ratio and the level of investments in research and development did not cope with the demands of Vencomatic. Although these performances did not cope with the requirements of Vencomatic, it is very hard for Vencomatic to influence these performances. This is due to the fact that the financial health and the level of investment in research and development done by a supplier cannot directly be affected by a buying organization. Consulting internal information on the delivery performance of the supplier showed that the suppliers stated higher performances than they actually delivered.

To improve the performances of the suppliers of Vencomatic, a number of recommendations are formulated. These recommendations are based on the interviews held with the different stakeholders, comparable organizations and employees and suppliers of Vencomatic.

In total six recommendations are formulated. First, the procurement strategy has to be defined to create clarity on the requirements regarding the supplier. Next, supplier selection should be applied to come up with the supplier that is best able to meet the requirements of Vencomatic. By assessing potential suppliers, insight in the performances is increased and therefore the newly selected suppliers will be better able to meet the demands from Vencomatic. Subsequently, communication towards the supplier has to be clear in order to ensure the supplier knows what the demands of Vencomatic are. By clear and frequent communication, shortcomings can be observed timely and actions can be undertaken. Fourth, supplier performance measurement should be applied to create insight in whether the supplier is capable of meeting the requirements of Vencomatic. Furthermore, if the suppliers do not meet the agreed performances, it should be clear which actions can be undertaken and by whom. These consequences should be clear for the employees of Vencomatic as well as for its suppliers. Last, cooperation with suppliers should be more structured and the procurement strategy applied should be taken into account.

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1. Introduction

In this chapter an introduction is given on the topic of this study. Furthermore, the problem analysis is proposed including research objective and research questions. A description of the case is provided to create insight in the context of the study.

1.1. Problem analysis

The word 'logistics' was already used by the ancient Greeks and referred to the officers who were in charge of the financial, supply and distribution belongings. Since the 1960s, business logistics is a scientific discipline. Nowadays the word logistics refers to the aspect of providing cost and time effective services including transport, warehousing, inventory, packaging and administrative activities (Islam *et al.*, 2013). According to Langley *et al.*, in Islam *et al.*, (2013), "logistics management is the most widely used term and encompasses logistics not only in the private business sector but also in the public/government and non-profit sector".

Lambert *et al.*, state that supply chain management is often referred to as the management of multiple relationships (Svensson, 2003). Additionally Forrester (1958), addresses how the success of an organization depends on how information, material, money, manpower and capital equipment interlock on each other. This causes a higher complexity in management decisions regarding the structure of operations, locating the activities and processes, the power of the different supply chain members and the collaboration between the supply chain members (Halldorsson *et al.*, 2007). Therefore organizations seek to develop partnerships and more efficient information links with partners, which span the traditional boundaries of organizations. The physical distribution of products becomes more dependent on these information links (Power, 2005). In order to crate in-depth insight into this topic, it is important to first define one general accepted definition on supply chain management. The difficulty with supply chain literature is that there is confusing and overlapping terminology and meanings. According to Burgess *et al.*, (2006) and Naslund and Williamson (2010), the definition of the supply chain management is unclear. Therefore, Mentzer *et al., (2001)* (Park *et al*., 2013; Burgess *et al.*, 2006) stated a widely used definition:

"Supply Chain Management is the strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole".

It is essential to ensure the alignment the supply chain partner activities with the strategy of the buying organization. Additionally, the activities should be harmonised with the structure, processes, culture, incentives and people (Abell, 1999) of the buying organization.

An important part of the supply chain partners are the suppliers. Improvements in the supplier performance can create significant benefits. It has been shown that a positive relationship between buyer and supplier increases the supplier logistical performance (Morris and Carter, 2005).

To manage the relationship with the supplier it is important to have insight in the performance of the supplier. Creating insight in the performance of the suppliers is done by supplier performance measurement. Referring to the opening statement "If you cannot measure it, you cannot manage it", it is suggested that you need to be able to measure performance in order to be able to increase the performances. Research on the practice how to measure the performance of the suppliers is rather rare (Schmitz and Platts, 2004). This is strange because, according to Muralidharan *et al.*, (2002), the costs

of the purchased goods and services account for substantial costs of the goods sold by the organization.

There are different ways to manage the supplier performance. Assessing the potential suppliers during the selection on a number of criteria should ensure the supplier is able to cope with the standards applied by the buying organization. This assessment can be seen as the management of the performances of potential suppliers. A prerequisite for effective supplier selection is the determination of appropriate performance metrics. Traditionally in academic research: price, quality and delivery reliability are the most important criteria on which suppliers are assessed (Dickson as stated in Wu, 2010). Depending on the circumstances, factors like technical capability, flexibility and willingness to work in a collaborative manner can be additional supplier selection criteria (Kannan and Tan, 2006). Considering supplier selection is a multi-criteria decision problem containing quantitative and qualitative criteria, there is a need for developing a systematic supplier selection method of identifying and prioritizing relevant criteria.

Applying supplier selection by making use of performance metrics, enables the buying organization to gain in the long term on product quality, performance, and availability (Fawcett and Fawcett; Manson and Morgan as stated in Vonderembse and Tracey, 1999). By good management of the relationships, the organization can create synergy regarding: product quality, performance and availability (Kannan and Tan, 2006).

Additionally, the evaluation of the suppliers' performance is an important aspect. Evaluation enables managers to focus on priority areas. By the data of evaluation, decisions can be made to enhance performance, create better relationships by isolating problem areas, provide information to the senior management and the organizations that perform better than average can be rewarded to stimulate them even further (Wu, 2010). Evaluating the performances is an important part of supplier relationship management, to ensure regular interaction between buyer and supplier. This regular interaction increases the level of trust, respect and improves the performances of the relationship (Schmitz and Platts, 2004).

1.2. Case description

This study is conducted on behalf of Vencomatic. Vencomatic is part of the Venco group and based in Eersel, the south of the Netherlands. Vencomatic carries a product portfolio containing the interior of poultry stables including breeder and broiler housing. Most of the goods used by Vencomatic are not produced by Vencomatic but are purchased at suppliers. Therefore, Vencomatic makes use of a large number of suppliers which are located for 75% to 80% in the Netherlands and Belgium. In line with the stagnating growth of the organization the last years, Vencomatic is now increasingly looking for suppliers – both on national and international level – who can deliver the same quality products for a lower price. A number of suppliers of Vencomatic are already located in foreign countries like: Germany, Italy, England, but also countries like Israel, India, Indonesia and South Africa which nowadays deliver around 10% of input products. In addition, the main supplier of Vencomatic is located in Belgium and delivers around 7% of the input products. The percentage of input products is based on the percentage of the total purchasing amount in Euro's. The total amount purchased by Vencomatic in 2013 is around 61 million euro's.

To ensure the suppliers of Vencomatic are able to cope with the standards of Vencomatic, insight in the performances of the suppliers needs to be created. This insight will be created by formulating performance metrics and assessing suppliers to these metrics. The aim of this study is to formulate performance metrics to assess the suppliers on, create insight in the performances of the suppliers of Vencomatic and to come up with recommendations to improve the performances of the suppliers.

1.3. Research objective

The research objective of this study is to give recommendations to Vencomatic to further improve the performances of its suppliers. These recommendations will be formulated by making use of performance metrics which are used to analyse the performances of the suppliers of Vencomatic. This study will focus on the formulation of the performance metrics used to assess suppliers on. By assessing a limited, but representative amount of suppliers to the formulated performance metrics, useful results and conclusions can be formulated.

1.4. Research question

Vencomatic wants to increase the performance of its suppliers. To increase the efficiency of the suppliers this study is conducted. First a literature study is conducted to gain insight in which factors influence the supplier performance. Vonderembse and Tracey (1999), state that supplier selection has an influence on financial, qualitative, technological, delivery and flexibility (Krause *et al.*, 2000) performances of the supplier. Considering these quantitative and qualitative aspects, supplier performance is a multi-dimensional problem. The factors, derived from the different inputs, are formulated into performance metrics on which suppliers are assessed. By assessing the suppliers, insight is created in whether the suppliers perform in line with the standards applied by Vencomatic. By assessing the suppliers, suggestions can be done to improve performances. Finally, recommendations will be given, which outline how to improve the performances of the suppliers of Vencomatic.

Main research question:

In what way can Vencomatic improve the performance of its suppliers?

Sub-research questions:

- *Which factors do have an influence on the performance of the suppliers?*
- *What performance metrics can be applied to assess the performances of the suppliers?*
- *How do the suppliers perform considering the performance metrics?*
- *How can the performances of the suppliers be improved?*
- *Which recommendations can be made to improve the performances of the suppliers of Vencomatic?*

2. Supply Chain Management

Supply chain management is constantly changing corresponding to the change in competitiveness of (international) companies. Many organizations have broken down the intra- and inter firm barriers to reduce uncertainty and enhance control of the supply chain (Gunasekaran et al., 2004). By cooperation with suppliers, organizations are looking to improve services, technical innovation and product design. This development is caused by, for example, increasing globalisation and reduced barriers of international trade (Gunasekaran et al., 2004, Mentzer et al., 2001).

These developments have encouraged the discussion of supply chain management in literature for many years (Burgess *et al.,* 2006), it has become a comprehensive concept. Increased interest in supply chain management is caused by organizations who find themselves more frequently heavily dependent on an effective supply chain (Naslund and Williamson, 2010) to be able to compete in the global market economy. Lambert *et al.,* in Svensson (2003) states that supply chain management is often referred to as the management of multiple relationships. Additionally, Forrester (1958) addresses how the success of an organization depends on how information, material, money, manpower and capital equipment interlock with each other. Herewith higher complexity is caused in management decisions regarding the structure of operations, locating the activities and processes, the power of and the collaboration between supply chain members (Halldorsson *et al.,* 2007). Therefore organizations seek to develop partnerships and more efficient information links which span the traditional boundaries of organizations. The physical distribution of goods becomes more dependent on these information links (Power, 2005). In line with this, performances can no longer be determined by decisions and actions of a single organization but rather needs to be determined upon the supply chain as a whole (Naslund and Williamson, 2010).

Considering the breadth of the concept, it is important to have one general accepted definition on supply chain management. The difficulty in finding such a definition is that within supply chain literature confusing and overlapping terminology and meanings come across. According to Burgess *et al.*, (2006) and Naslund and Williamson (2010), the definition of supply chain management is unclear. In response Mentzer *et al.*, (2001) stated a widely used definition (Park *et al*., 2013; Burgess *et al.,* 2006):

"Supply Chain Management is the strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole".

The definition refers to the traditional business functions, which can be described as the core business of the organization. As stated by Van Weele (2005), the activities in which an organization cannot offer a world class achievement should be outsourced. In line with the generic strategies of Porter (Johnson *et al.*, 2012) an organization needs to focus on a few core activities (Prahalad and Hamel, 2008). Porter developed a model (value chain) which creates insight in all activities of an organization, including the core activities as well as supporting activities. The value chain (Figure 1) of Porter assists organizations to concentrate on the core activities, by creating insight in the inter-organizational links and relationships needed to create the physical product.

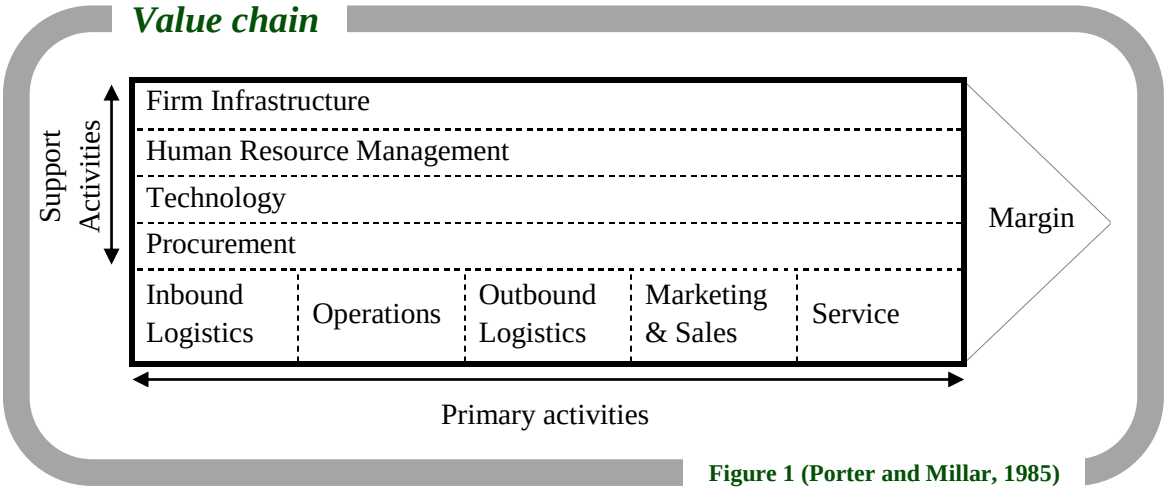

Figure 1 (Porter and Millar, 1985)

The activities performed by an organization can be divided in primary and support activities (Figure 1). The primary activities are involved with the physical creation of the products, while support activities provide input and infrastructure for the primary activities to take place (Porter and Millar, 1985).

The primary activities are all linked and need to be coordinated for efficient performance of the organization (Porter and Millar, 1985). Additionally, producing products includes procurement of goods, different forms of technology, human resource management and infrastructure (support activities). A firms' infrastructure refers to the general management, needed for all the products.

The general management within an organization contains four levels of decision-making are distinguished: strategic, corporate, business and operational. Formulating how a competitive advantage will be created is part of the corporate strategy of an organization. At this level, decisions are made regarding diversity on goods and services and the allocation of the sources of the organization (Johnson *et al.*, 2012). The decisions made at the corporate level directly influence the individual business of the organization. These individual businesses are often defined by different brands owned by an organization. Decisions made at the business level deal with issues regarding innovation and brand specific strategies. Although these decisions are made at a different level, it is essential these strategies align to the overall corporate strategy. Finally the operational level is defined. The operational level is about the day-to-day business and is dealing with translating the corporate and business -level strategies as effectively as possible into physical products (Johnson *et al.*, 2012).

According to Porter and Millar (1985), a business is profitable if the value created exceeds the costs of performing the value activities. The organization needs to be differentiating in performing activities regarding the costs or at the kind of services provided, to create a competitive advantage (Porter and Millar, 1985).

Because the accomplishment of the competitive advantage is depending on the relationship with the suppliers (Naslund and Williamson, 2010), coordination of the relations with suppliers is essential. Therefore the activities of the supply-chain partners need to be well aligned with the strategy and the organizational structure, processes, culture and people (Abell, 1999). To achieve a good alignment between strategies it is essential that the characteristics of the supplier meet the requirements of the buying organization.

2.1. Supplier characteristics

According to Sarkis and Talluri (2002), the characteristics of an organization can be categorized in three different groups: culture, technology and relationship. The characteristics of the suppliers influence the values within an organization and therewith the way of doing business.

2.1.1. Culture

The organizational culture involves all the employees of the organization and is established during and by the history of the organization. The culture within an organization is influenced by artifacts, values and assumptions according to Schein in Hatch (1993). Artifacts are visible and physical results of actions that come forward out of norms and values. Values are the social principles that are considered to have a fundamental importance. Assumptions stand for the confidence in reality and human nature. According to Schein in Hatch (1993), these different levels of culture all interact with each other and together form the culture within an organization. The basis of this culture is defined by the founder of the organization and one's personal beliefs and values who transfers these to the new employees of the organization (Hatch, 1993).

2.1.2. Technology

The capabilities of the suppliers become increasingly important, since the requirements to the suppliers increase. Suppliers are increasingly involved more early in the process to assist during the design and technical development of products. By this trend the technical capabilities of the suppliers become gradually more important and need to cope with the demand of the buying organization (Choi and Hartley, 1996).

2.1.3. Relationship

Since organizations are increasingly relying on their suppliers, the relationship with the supplier becomes increasingly important. According to Choi and Hartley (1996), a strong relationship with the supplier can be one of the strongest barriers for competitors to enter a new market (Christopher in Choi and Hartley, 1996). Additionally the type of buyer-supplier relationship has an influence on the motivation of the supplier to deliver on time (Paulraj and Chen, 2007). The relationship between a buyer and supplier organization has a significant influence on the performances of the supplier as well as on the amount of business that is done with a supplier.

2.2. Customer Order Decoupling Point

Since different markets have different requirements, organizations have different options on dealing with the market demands. Depending on the market in which the organization is operating, the organization can produce the products to stock or by order. Additionally, the organization can engineer the products customer specific. The way of how the organization deals with the demand depends on the market demand and the resources of the organization. By ascertaining the manufacturing strategy, handled by the organization, the Customer Order Decoupling Point (CODP) can be determined.

According to Berry and Hill in Olhager and Selldin (2007), the make-to-stock strategy should be handled with products that are highly standardized and have a high volume. The make-to-order strategy should be applied to customer specific products that have a low volume (Berry and Hill in Olhager, 2012). Engineer-to-order should be applied when both standardized and customer specific products are produced (Olhager and Selldin, 2007).

The location of the COPD has a direct influence on the requirements of a buying organization towards the performances of its suppliers. If the products are make-to-stock, the organization is able to make a forecast and the suppliers know further up-front when delivery is required. When the product is make-to-order, the lead time is shorter which requires the supplier to deliver in a shorter period of time.

By deciding on the manufacturing strategies, firms are essentially looking for a way to manage their inside flow of materials in the most effective way. Key to such coordination is the flow of materials coming into the organization (Mentzer *et al.*, 2001). According to Mentzer *et al.*, (2001), customers are expecting products consistently delivered faster, on time and without damage. To meet these increasing customer demands organizations can make use of procurement management.

3. Procurement management

Since organizations have to deal with globalisation and start focussing on their core competences, procurement management has become increasingly important (Van Weele, 2005). As an effect to that, purchasing models have been developed. The traditional purchasing model was based on an efficient material flow and focused on the required quantity at the right time for the best price. Since in 1979 the five forces model was published, the procurement activities of an organization began to receive scientific recognition (Ellram and Carr, 1994).

In line with the value chain (Figure 1), procurement has started to play a more important role in the strategy of an organization (Ellram and Carr, 1994). As stated by Porter (2000), the strongest competitive force determines the profitability of an organization. Additionally, Porter (2000) stated: powerful suppliers are able to keep more value for themselves by charging higher prices. Since different suppliers, have different levels of bargaining power, as a consequence of their characteristics, the type of products they deliver and the type of relationship they have with the buying organization, different procurement strategies can be handled (Porter, 2000). Since not all the products and buyer-supplier relationships can be handled in the same way (Gelderman and Van Weele, 2003), Lilliecreutz and Ydreskog as stated in Gelderman (2003) stated some sort of classification is needed to effectively apply procurement strategies. This classification can be provided by the use of purchasing portfolio models, since purchasing portfolio models seek to develop different purchasing strategies (Gelderman and Van Weele, 2003).

The article published by Kraljic (1983), pointed out the essence of purchasing portfolio models. To underpin the essence, Carr and Smeltzer (1997) stated that by acknowledging the strategic interest of procurement by the top management, the procurement strategy can contribute to achieving competitive advantage (Ellram and Carr, 1994).

This competitive advantage can be achieved by the selection and evaluation of suppliers, which can support the organizations long-term strategy. Additionally, profitability can be increased by decreasing the costs of procured goods, involvement of suppliers in product development, supporting the production process and forecasting the availability and costs of materials needed in the future (Ellram and Carr, 1994). Saving possibilities on procurement have led to increased investments in the procurement management area (Cousins and Spekman, 2003).

Purchasing portfolio models can be applied in various situations at different levels within the organization. By making use of a right balance between complex and simple variables, the full potential of portfolio models can be utilized (Olsen and Ellram, 1997b). By applying the purchasing portfolio model a graphic presentation can be created on the current and desired position of the organization (Olsen and Ellram, 1997b). Furthermore, portfolio models can be used to allocate valuable resources to an optimal combination, which will maximize long-term returns (Olsen and Ellram, 1997b; Turnbull, 1990).

According to Dubois and Pedersen (Dubois and Pedersen, 2002), the fundamental assumptions for purchasing portfolio models are power-dependence assumptions, although these relationships are seldom discussed in purchasing portfolio models. Because of these fundamental assumptions, it is crucial that the power and dependence positions of buyers and suppliers in the different strategies are defined (Svensson, 2002 Caniels and Gelderman, 2005). The dependence position of an organization is expressed by the interdependency aspects. A known definition of this aspect is: "the relative power of an organization over another is the result of the net dependence of one on the other" (Svensson, 2002, based on Pfeffer). The content of the fundamental assumptions and the effect of the interdependency on the buyer-supplier relation will be further discussed in chapter four.

3.1. Procurement portfolio models

Different procurement portfolio models have been developed. A number of portfolio models will be discussed.

The ABC analysis was developed for the allocation of inventories. The 'significant items' (A) and the 'trivial items' (C) have to be identified. The significant items are a few products which generate the most turnover. The trivial items form the largest group although generate the least amount of turnover. As stated by Flores and Whybark (1987) there was very little guidance on how to improve the managerial performance. General recommendations are given like manage 'A' items very closely and spend less time on 'C' items. Considering the critique of Flores and Whybark (1987) and the fact that this approach only considers financial aspects, ignoring the quality (Gelderman and Van Weele, 2005), performance risk and other components, makes that this analysis is not further discussed during this study.

Kraljic (1983) developed another approach, in which an organization has to classify their procured goods into different quadrants. According to Kraljic, a procurement strategy depends on two aspects: profit impact and supply risk. The importance of purchasing is based on the volume procured and the percentage of the total procurement costs. The supply risk is based on the number of suppliers available and the substitution availabilities.

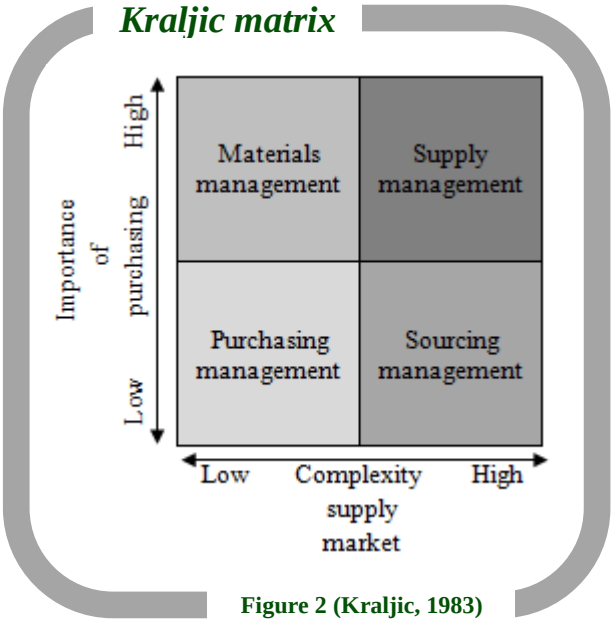

Figure 2 (Kraljic, 1983)

The goal of the Kraljic model is matching internal and external resources, by using internal and external dimensions (Dubois and Pedersen, 2002). The Kraljic matrix consists of four phases.

In the first phase the organization sorts the procured goods into four categories: strategic, bottleneck, leverage and non-critical items. This sorting is based on the current position the goods have. During the second phase of the Kraljic matrix the bargaining power of the suppliers is compared to the power of the buyer (Kraljic, 1983). In the third phase the procured goods are strategically positioned in the quadrants the buying organization prefers the goods. These quadrants consist of the four procurement strategies shown in Figure 2. The different procurement strategies are defined as:

- Purchasing management contains non-critical items and requires product standardisation, efficient processing and optimizing inventory. Referring to the interdependency, purchasing management is a form of interdependence asymmetry, since there is no sharing of strategic and vital information. Therefore, the level of trust and commitment of the supplier of these items is low.
- Material management includes leverage items and allow the buying organization to exploit the full purchasing power by product substitution, optimizing order volume and supplier selection.
- Sourcing management concerns bottleneck products that are crucial. There has to be control of suppliers and inventories and a backup plan has to be conducted.
- Supply management encloses strategic items. Strategic items demand accurate forecasting and detailed market research. Additionally, development of long-term relationships and risk analysis has to take place (Kraljic, 1983; Olsen and Ellram, 1997b). Regarding the interdependency, supply management is referring to total interdependence, since strategic and vital information is shared with the supplier. By doing this, the level of trust and commitment increases (Kumar *et al.,* 1995).

By placing the items in the preferred quadrant, opportunities and vulnerabilities can be identified.

In the fourth phase of the Kraljic matrix an action plan is determined on how to deal with these opportunities and vulnerabilities. Strategic decisions are made regarding volume, price, supplier, material substitution and inventory policy (Kraljic, 1983).

In line with the statement of Kumar *et al., (*1995) an organization should procure goods on which purchasing management is being applied, as well as products on which supply management is applied.

A different approach towards procurement management is developed by Olsen and Ellram (1997b). Their approach contains three phases for analyzing the procured goods. In the first phase the procured goods are classified on two dimensions: difficulty of the procurement situation and the strategic importance of the procurement (Olsen and Ellram, 1997b). In the second phase a distinction is made based on the current relationship with the supplier and the attractiveness of the supplier. In which quadrant the suppliers are located depends on the financial performance, technological and strategic factors. During the third phase there is determined if the procured goods are located (second phase) in the quadrant in which they are classified (first phase). In this phase an action plan will be formulated on how to relocate the products to the right quadrant.

In the second phase, Olsen and Ellram assess the suppliers on the relative attractiveness of the supplier and the strength of the buyer-supplier relationship. This phase is comparable with the second phase of the Kraljic approach. Although it is comparable, the approach of Olsen and Ellram has identified approximately fifty factors that can have an influence on the management of the supplier relationship. Taking into account these supplementary aspects, creates additional measurements and therefore implementation problems (Gelderman, 2003).

The third phase of Olsen and Ellram's approach is also comparable, although the Kraljic approach defines a fourth phase, which is included in the third phase at the Olsen and Ellram approach.

It can be questioned why there is much similarity between these approaches. As stated by Svensson (2002), the Olsen and Ellram approach is derived from the Kraljic approach. However, the Olsen and Ellram approach is using a relationship perspective while the Kraljic matrix uses a power perspective approach to make recommendations on the procurement strategy (Gelderman, 2003). Gelderman and Van Weele (2003) state that a number of procurement portfolio models are developed by other scholars based on the Kraljic matrix.

3.2. Critiques

There are also some critiques regarding the procurement portfolio models. Dubois and Pedersen (2002) state that the aspect of interdependencies between relationships is seldom discussed. The research on buyer-supplier relationships is focusing on a single relationship or one type of relationship; not on how to manage the entire supplier portfolio (Olsen and Ellram, 1997a). Since most organizations are involved in different relationships and relationships can influence each other, this is an important critique to take into consideration.

Nellore and Söderquist (2000) state that portfolio models do not take into account the link between engineering, the actual product and the supplier during the process of product development. Because of this missing link there is a potential risk that the resulting strategies of the portfolio models are contradictory, because of sub optimization. Additional criticism of Nellore and Söderquist (2000) is regarding the variables used to measure the different dimensions. They state that the variables used are estimations of parameters by approximations, e.g. market share should be a good approximation of the competitive position. According to the Competitive Strategy of Porter, this is often not true (Nellore and Söderquist, 2000). Therefore, Nellore and Söderquist (2000) argue the relation between the category in which the supplier is located and in which category the buying organization preferably locates the supplier, is more important than the initial classification of the different components.

Olsen and Ellram (1997b) state that determination of the weights regarding the variables is one of the most important parts of the implementation process. Considering this, it is also one of the most subjective aspects (Narasimhan *et al.*, 2001), though the subjectivity has the advantage of incorporating the experience and knowledge of the procurement staff.

3.3. Procurement strategies

Gelderman and Van Weele (2003) pointed out that procurement professionals make a clear distinction of procurement strategies within each quadrant of the Kraljic matrix. In line with this comment, different procurement strategies are developed within each quadrant of the Kraljic matrix (Table 1).

Quadrant in Kraljic matrix	***Procurement strategy***	***Description***
Strategic items Strategic relationships should contribute to competitive advantage.	Buyer dominated segment	Product has a high supply risk and high value. There is an asymmetric interdependency. The buyer is able to switch between suppliers.
	Hold supplier dominated segment	Product has a high supply risk and high value. There is an asymmetric interdependency. The main power is at the supplier, due to patents, monopoly or high switching costs.
	Hold balanced relationship	Product has a high supply risk and high value. There is a symmetric interdependency that contributes to competitive advantage.
Bottleneck items Buyer is always looking to reduce supply risk.	Accept dominance supplier	Product has a high supply risk and low value. There is an asymmetric interdependency. The main power is at the supplier, because the buyer has no alternative supplier.

	Reduce dependency supplier	Product has a high supply risk and low value. There is an asymmetric interdependency. The main power is at the supplier. Buyer can look for another supplier or broaden product specifics.
Leverage items Buyer is always looking for reducing costs.	Exploit buying power	Product has a low supply risk and high value. There is an asymmetric interdependency. The main power is at the buyer, so exploiting buying power is possible.
	Strategic partnership	Product has a low supply risk and high value. There is an asymmetric interdependency. Buyer can look for strategic partnership.
Non-critical items Buyer is always looking to increase buying power.	Combining orders	Product has a low supply risk and low value. There is an asymmetric interdependency. The main power is at the buyer, combining orders to increase buying power is possible.
	Individual orders	Product has a low supply risk and low value. There is an asymmetric interdependency. The main power is at the buyer and therefore the buyer can look for reducing procurement costs.

Table 1: Different Procurement strategies (based on Caniels and Gelderman, 2005)

As stated in Table 1, two different strategic directions can be differentiated: hold the same position in the Kraljic matrix or move to another position in the matrix (Figure 2). According to the study of Gelderman and Van Weele (2003), there are different reasons for an organization to hold the current position: the organization is convinced of the product being in the preferred position in the Kraljic matrix, or the organization just does not have another option. Reason for an organization to pursue other positions in the matrix is that the items are not in the preferred position in the Kraljic matrix.

3.4. Procurement portfolio model choice

As stated, different procurement portfolio models have been developed, though all of these portfolio models are based on or derived from the Kraljic matrix. The proposed procurement strategies and the dimensions used to classify procured goods are very similar to those proposed by the Kraljic matrix. Gelderman and Van Weele (2003; 2005) state the Kraljic matrix "has become the standard in the field of purchasing portfolio models". Additionally, the Olsen and Ellram approach lacks substantial empirical support and is focusing on a relation perspective. This relation perspective is also, albeit indirectly, covered in the Kraljic matrix. The Kraljic matrix is widely used since the late nineties (Gelderman, 2003). Since the Kraljic matrix has become the standard in purchasing portfolio models and empirical evidence is present, the Kraljic matrix will be used for the analysis performed during this study.

4. Buyer-supplier relationships

As stated in the conclusion of chapter three, the buyer-supplier relationship is an important aspect of the procurement strategy. Even though the Kraljic matrix does cover this relationship indirectly for the different strategies mentioned for different types of products, it is not outlined specifically. In this part, the buyer-supplier relation is explained more deeply, to create insight in this aspect.

The buyer-supplier relationship can be interdependent asymmetric as well as interdependent symmetric. The relationship which is interdependent asymmetric refers to the difference between the buying organizations dependence on the supplier and the supplier dependence on the buying organization. Additionally, the interdependent symmetric relationship is characterized by two organizations being equally dependent on each other (Kumar *et al.,* 1995).

The level of interdependency between two organizations is often determined by the replacebility of the buying organizations suppliers by one another (Brown, Lusch and Muchling as stated in Kumar *et al.*, 1995). According to Kumar *et al.,* (1995), relationships with greater interdependence symmetry embrace a higher level of trust, strong commitment and -as a consequence- less conflicts. Trust and commitment are essential elements of a relationship to ensure the success of the relationship (Kumar *et al.*, 1995; Morgan and Hunt, 1994), since it encourages partners to perceive the relationship, go for the long-term benefits instead of the short-term benefits and the believe that partners will not act opportunistically (Morgan and Hunt, 1994). Morgan and Hunt, (1994) have developed the Key Media Variable (KMV) model that focuses on relational sharing of trust and commitment.

4.1. Trust

Trust can be defined as the "willingness to rely on the supplier of who the organization is doing business with and has confidence in" (Moorman, Deshpandé and Zaltman in Morgan and Hunt, 1994). There are a number of aspects which have an influence on trust. The following aspects have a positive impact on the trust between the buying organization and the supplier (Morgan and Hunt, 1994):

- *Shared value*: The point to which the buying organization and the supplier have the same attitude towards important behaviour, goals and policies.
- *Communication*: "Formal and informal sharing of meaningful information between an organization and the supplier" (Anderson and Narus 1990, p 44 in Morgan and Hunt, 1994).

Additionally, there is an aspect that has a negative influence on the level of trust between the buying organization and the supplier (Morgan and Hunt, 1994):

- *Opportunistic behaviour:* The violation of promises or agreements between the organization and the supplier (Archrol and Stern in Morgan and Hunt, 1994).

4.2. Commitment

Commitment can be defined as: believe that a continuing relationship between the buying organization and the supplier is of the importance that maximum efforts will be embedded in maintaining the relationship. The following aspects have a positive aspect on commitment between the supplier and the buying organization (Morgan and Hunt, 1994):

- *Relationship termination costs*: The costs that have to be made by the buying organization to switch to another supplier.
- *Relationship benefits*: The added value the relationship between the buying organization and the supplier offers for the buying organization.

- *Shared value*: The point to which the buying organization and the supplier have the same attitude towards important behaviour, goals and policies.

Additionally, there is an aspect that has a negative influence on the level of commitment between the buying organization and the supplier (Morgan and Hunt, 1994):

- *Tendency to leave*: The propensity to leave is the tendency the supplier has to end the relationship in the near future.

Furthermore, trust between the buying organization and the supplier has a positive influence on the commitment the supplier has towards the buying organization. Trust and commitment lead directly to cooperative behaviour which is favourable for relationships (Morgan and Hunt, 1994).

4.3. Relationship strategy

It has to be considered that not all the procured goods have the same relevance to the buying organization. Some products are essential for the end product and some products are not crucial at all. There has to be kept in mind that close relationships cannot and should not be established with all partners since a close relationship includes the sharing of strategic and vital information and long term dedication of both parties (Naslund and Williamson, 2010). To create an overview of the relationships that should be achieved in the different quadrants of the Kraljic matrix (Figure 2) an overview is created in Figure 3.

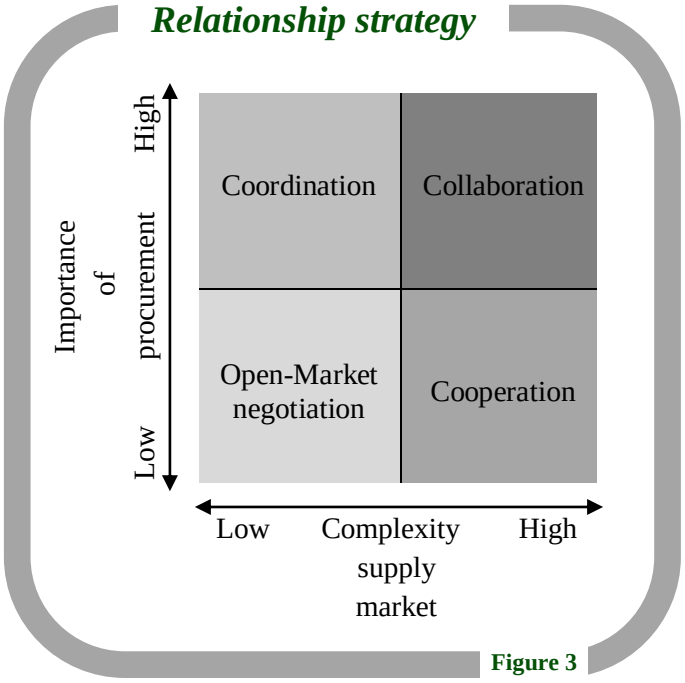

Figure 3

The strategy valuable for the procured good depends on the importance of the procurement and the complexity of the market in which the goods are procured. The complexity of the supply market in which the good is procured is determined by production and development process of the good. The importance of the procurement is determined by the interest the good has for the buying organization. These two factors determine the relationship the buying organization should develop with the supplier according to Spekman *et al.*, (1998).

With collaboration the level of trust and commitment are crucial to create the right strategy for the right type of product and can be seen as an interdependent symmetric relationship. On the other

hand, in an interdependent asymmetric relationship, trust and commitment are likely to be less present, because these aspects are less important for the functioning of this relationship (open-market negotiation). In line with the open-market negotiation, the buying organization is less motivated to avoid conflicts because the buying organization can inflict more damage to the supplier. These asymmetric relationships are less likely to function well and are less stable (Stern and Reve's as stated in Kumar *et al.*, 1995).

Since an organization procures different types of products, the required relationships with suppliers differ and therefore also the interdependency between the buying organization and suppliers. Additionally, the buying organization and the supplier should be aware of the needs of the other party and alignment in the goals and expectations should be achieved (Spekman *et al.*, 1998).

5. Supplier performance

Many organizations concentrate themselves on their core activities (Van Weele, 2005), which makes that they increasingly rely on their suppliers capabilities (Krause and Ellram, 1997). As a consequence, the performances of the suppliers have a direct impact on the performances of the organization. To ensure the performances of the supplier positively affect the results of the organization, a supplier needs to be selected of which the goals are aligned with the goals of the organization.

5.1. Supplier selection

The aspect of supplier selection has gained interest since the 1960s. The performance metrics used for supplier selection in that time where mostly based on quantitative metrics. Interest grew on using qualitative metrics for supplier selection (Tahriri *et al.,* 2008). Nowadays, mostly a combination of both quantitative and qualitative metrics has been used. Because of this combination, supplier selection has evolved to a multiple criteria decision-making problem. As a consequence of this development, a suitable method has to be selected, which is capable of dealing with both qualitative and quantitative problems (Tahriri *et al.,* 2008).

In 2001, De Boer *et al.,* published a review on the different techniques used for supplier selection. Within the review, a division is made on different selection methods, based on the complexity and importance of the procurement decision: new procurement actions, modified rebuy actions (leverage items), straight rebuy action (non-critical items) and straight rebuy (strategic and bottleneck items). This division is based on the Kraljic matrix (Figure 2). In this study a division between different methods is based on the different stages in the supplier selection process. The phases defined are: Problem definition, Criteria definition, Pre-qualification of the suppliers and the Final choice (De Boer *et al.,* 2001).

5.1.1. Problem definition phase

In this phase the decision-maker needs to determine the need and the alternatives that are available. The need for a supplier is based on the demand of an organization: why one or more suppliers are necessary (De Boer *et al.,* 2001). Referring to the problem definition phase, Vokurka *et al.,* (1996) state that the sourcing demand can come from different departments in the organization. Since this phase is not very complex and no publications have been found about the problem definition phase (De Boer *et al.,* 2001), this phase is not further discussed in this study.

5.1.2. Criteria definition phase

Only a few methods have been published on the definition of the criteria regarding supplier selection:

- Mandal and Deshmukh (1994) propose the use of Interpretive Structural Modelling (ISM), to gain insight in the necessity and significance of each indicator. A division is made on dependent and independent criteria, which is based on the relation the different criteria have with each other.
- Vokurka *et al.,* (1996) suggests using an expert system to generate the selection criteria. This system is developed by means of a senior purchasing manager, so other non-expert users can obtain the system for suggestions.

Although the methods are limited, there are some publications regarding criteria to assess suppliers. Dickson presented 23 criteria, which are a valid benchmark (Weber *et al.,* 1991; Deshmukh and Chaudhari, 2011) on the importance of supplier selection criteria. These criteria have been reviewed by: Weber *et al.*,(1991); Deshmukh and Chaudhari (2011); Cheraghi *et al.*, (2011) and JE and Thiruchelvam (2011). Appendix 1 gives an overview of these criteria. The ranking of the criteria named in the overview as well as in each review are all based on the number of times the criteria are mentioned in scientific articles. The differences between the rankings are the scientific journals that are used and the time the articles are published. Dickson based the rating of the criteria on a questionnaire among 170 purchasing agents and managers, who are member of the National Association of Purchasing Managers. The rating of the review from Weber *et al.,* (1991) is based on the review of 74 scientific papers published between 1966 and 1991 on supplier selection. The articles are published in 21 different journals of which 33 articles were published in *Journal of Purchasing and Materials Management.* The review of Cheraghi *et al.,* (2011) is based on the 74 articles used in the review from Weber *et al.,* (1991) including additional articles, in total 113. The articles are published between 1990 and 2001. In this review 23% of the articles used were published in *Journal of Purchasing and Materials Management*, additionally 10% of the articles used were published in *International Journal of Physical Distribution and Logistics Management.* The review of Deshmukh and Chaudhari (2011) is based on 49 scientific articles, published between 1992 and 2007. The articles used for the review are found by using the key words "vendor selection", "supplier selection" and "SCM" (Deshmukh and Chaudhari, 2011). The review of JE and Thiruchelvam (2011) is based on relevant articles published between 2001 and 2010, including the review of Weber *et al.,* (1991) and the review of Cheraghi *et al.,* (2011).

When there is taken a closer look to the reviews of Weber *et al.* (1991); Deshmukh and Chaudhari (2011); Cheraghi *et al.,* (2011) and JE and Thiruchelvam, (2011), there are a lot of similarities, especially between the top ranked criteria.

Criteria	Dickson	Weber *et al.*,(1991)	Deshmukh and Chaudhari (2011)	Cheraghi *et al.,* (2011)	JE and Thiruchelvam (2011)
Quality	1	3	2	1	1
Delivery	2	2	3	2	3
Performance history	3	9	7	12	14
Warranties and claim history	4	23	13	-	21
Production facilities and capacity	5	4	4	6	6
Price	6	1	1	3	1
Technical capability	7	6	5	4	4
Financial position	8	9	6	7	9
Procedural compliance	9	15	13	14	-
Communication system	10	15	7	12	18
Management and organization	13	7	7	7	5
Repair Service	15	9	13	4	12
Geographical location	20	5	7	14	10

Table 2: Development of criteria in literature (based on Weber *et al.*, (1991); Deshmukh and Chaudhari (2011); Cheraghi *et al.*, (2011) and JE and Thiruchelvam, (2011))

Looking at to the top five (Price, Quality, Delivery, Production facilities and capacity and Technical capability), the highest rated criteria: Price, Quality and Delivery are the most important criteria in all reviews (Table 2). Though, the remark has to be made, Dickson mentioned the criteria Price sixth. Nevertheless, all reviews mention Price in the top three ranking. Production facilities and capacity are considered important, since it is in the top five ranking in two reviews and the proposed list of Dickson. Technical capability is also considered an important aspect for supplier selection, according to three out of four reviews. The importance of this criterion can be derived from the increase in specialization organizations have made. The financial position is considered important since it is one of the top ten listed criteria by Dickson and all four reviews list this criterion in the top ten.

Comparing the original criteria as stated by Dickson and the reviews, some differences arise. The criterion on Geographical location, Management and organization and Repair service gained importance. The Geographical location of the supplier gained significantly in importance. Dickson considered this criterion not important, but nowadays it is one of the top ten ranking criteria in three reviews. This can be due to the increased competition as a consequence of globalization (De Boer *et al.*, 2001; Deshmukh and Chaudhari, 2011). Management and organization gained importance since the publication of Dickson in 1966. The Repair service gained importance up to the 2000s; afterwards it became less important again, although it is still one of the ten most mentioned criteria in the overview (appendix 1).

Additionally, some criteria decreased in importance. Performance history was considered important by Dickson, since he ranked the Performance history third, though the reviews do not consider performance history that important. Although the criterion has decreased in importance, it is still at the tenth place of important criteria. Additionally, Dickson ranked Warranties and claim history, Procedural compliance and Communication system also in the top ten of most important criteria. The analysis shows these criteria have become significantly less important and are lowered respectively to the 24, 25 and 14th position (appendix 1).

5.1.3.Pre-qualification suppliers phase

During this phase, the 'pool' of available suppliers is reduced to a smaller set of suppliers. According to De Boer *et al.*, (2001), this pre-qualification phase can be defined as sorting rather than ranking the different suppliers. Although these models can also be used in the final choice phase, their sorting nature makes them more suitable for the pre-qualification phase (De Boer *et al.*, 2001).

Categorical methods

Suppliers are evaluated on buyer's experience and historical data. After the supplier is assessed on the different criteria an overall rating is conducted. The overall rating will be in the form of 'positive', 'neutral' or 'negative' (De Boer *et al.*, 2001; Pal *et al.*, 2013). The advantage of this approach is the creation of a clear and systematic structure (Vokurka *et al.*, 1996).

Cluster analysis

The selected suppliers are classified by a number of numerical scores, which are used by a classification algorithm to cluster the suppliers. These numerical scores are based on some predetermined criteria (e.g. quality, price). This way similar suppliers are clustered and different clusters can be distinguished (Holt, 1998). By plotting the clusters graphically, interpretation of the strong and weak points can easily be identified. A benefit of using the cluster analysis approach is that all the suppliers are assessed by a limited number of identified controlling criteria. Weightings have to be applied to the performance indicators to hierarchically order the criteria. The weightings cannot be conducted by the cluster analysis, although the analysis is able to apply these weightings (Holt, 1996).

Data envelopment analysis (DEA)

The DEA analysis divides suppliers into the categories 'efficient' and 'inefficient'. The suppliers are assessed on the criteria input and output (Pal *et al.,* 2013). DEA allows measurement of efficiency without having to specify the production function or the weights for the different inputs and outputs. The efficiency of a supplier is defined as the ratio between the weighted sum of the outputs divided by the weighted sum of the inputs (Braglia and Petroni, 2000).

5.1.4. Final choice phase

The most decision techniques published for the supplier selection can be classified in the final choice phase. During this phase the final choice out of the pre-qualified suppliers is made. The techniques mentioned are able to deal with multi-criteria decision problems. In Table 3 a summarized overview is created. In appendix 2 a more extensive reasoning and exploitation of the different techniques is outlined.

Category	Model	Specification
Linear weighting models	Linear weighting models	Assigning weights to criteria
	Quasi-compensatory models	Assigning weights and allowing for mutually compensation
	Analytical Hierarchical Process (AHP)	Elaborating on Quasi-compensatory models by adding the use of pair-wise comparison
	Analytical Network Process (ANP)	Based on the AHP-model, though considers relationships between criteria
	Fuzzy Sets Theory (FST)	Modelling preferences into weights for different criteria
	Multiple Attribute Utility Theory (MAUT)	Selecting international suppliers by dealing with multiple conflicting attributes
	Total Cost of Ownership (TCO)	Qualifying costs for purchased goods during their life cycle.
Mathematical programming models	Mixed integer programming	Optimizing problems with two or more criteria
	Goal programming	Making a trade-off between different goals on an interactive and graphical way
Statistical model	Cluster analysis	Categorizing suppliers by numerical scores which are clustered by a classification algorithm
Artificial intelligence	Case-based reasoning	Providing the purchaser with information on previous situations via software
	Artificial Neural Network (ANN)	Processing elements that are interconnected via software

Table 3: Overview decision techniques final choice phase (based on De Boer *et al.,* (2001))

As stated, a large number of multi-criteria decision techniques are available to deal with the multi-criteria supplier selection problem. Below, in Table 4, an overview is created of the techniques mentioned in the pre-qualification phase and the final choice. In the table is shown which techniques are able to deal with different procurement actions. These actions are based on the complexity and importance of the procurement decision. The different procurement actions are: new procurement actions, modified rebuy actions (leverage items), straight rebuy action (non-critical items) and straight rebuy (strategic and bottleneck items). The differentiation of procurement actions is based on the review of De Boer *et al.*, (2001) on different techniques able to deal with supplier selection problems.

		Linear weighting models							Mathematical programming models		Statistical model	Artificial intelligence			
		Linear weighting models	Quasi-compensatory models	Analytical Hierarchical Process (AHP)	Analytical Network Process (ANP)	Fuzzy Sets Theory (FST)	Multiple Attribute Utility Theory (MAUT)	Total Cost of Ownership (TCO)	Mixed integer programming	Goal programming	Cluster analysis	Case-based reasoning	Artificial Neural Network (ANN)	Categorical models	Data Envelopment Analysis (DEA)
Pre-qualification phase	New task	*	*	*										*	
	Modified rebuy	*	*	*		*					*	*	*	*	*
	Straight rebuy (routine items)	*	*	*		*					*	*		*	*
	Straight rebuy (strategic / bottleneck items	*												*	
Final choice phase	New task		*	*	*	*					*	*			
	Modified rebuy		*	*		*		*	*	*	*	*	*		*
	Straight rebuy (routine items)		*	*		*					*		*		
	Straight rebuy (strategic / bottleneck items	*	*	*	*	*	*	*	*	*	*				

Table 4: Applicability decision techniques in final choice phase (based on De Boer *et al.*, (2001))

5.2. Supplier evaluation

When the right supplier is selected, it is essential to evaluate the supplier to ensure the performances of the suppliers positively affect the results of the buying organization (Dickson as stated in Purdy *et al.*, 1994). The goal of supplier evaluation is to gain insight in the performances of the supplier by measuring and analysing the performances, to ensure actions can be taken in case of unacceptable performances. By accurately defining the performance metrics and the expected performances, the evaluation of suppliers supports the creation of a supply base that best suits the organizational goals (Harding and Harding, 2000). These metrics help the buying organization to align, focus and develop strategies to efficiently address their resources (Minahan and Vigoroso, 2002). Additionally, a firm needs to be able to identify the suppliers that create the biggest synergy (Narasimhan *et al.*, 2001; Simpson *et al.*, 2002).

Purdy *et al.*, (1994) have made a three-stage model, namely: preparation stage, the evaluation stage and the feedback stage. Because of the clear definition of different stages in supplier evaluation, this model will be considered in this study. This model gives specific insight in the perceived effectiveness of supplier evaluation. By making use of this model firstly the perspective of the buying organization will be presented, which will be followed by the perspective of the suppliers. The determination of the suppliers' perspective is composed by 49 organizations which were assessed by a survey, and additionally 25 people were interviewed. The participants all worked at different organizations with an average of 170 employees. All the suppliers were active in the automotive branch.

5.2.1. Preparation stage

During the preparation stage, the buying organization has to define and align the goals within the organization. The goals of the different strategic levels within the organization need to be embedded into the performance metrics. Often the goals at the corporate level of the organization are financial issues which should come forward in the expected performances of the suppliers. The non-financial issues regarding the performances of the suppliers are evident for the business and operational-levels within the organization and are referring to for example quality, research and development and communication.

Additionally, supplier evaluation needs to get recognition from all the management layers within the organization. By acknowledgement of the corporate level, the essence of supplier evaluation is underpinned. By regular reporting of the results of supplier evaluation to the corporate level of the organization, the progress which has been made and contributes to the corporate goals can be made clear. Furthermore, by communicating the importance of supplier evaluation towards the suppliers, the essence of the performances of the supplier can be underpinned.

Suppliers' perspective

During the preparation phase the supplier is preparing for the evaluation itself. This preparation makes the supplier look critically at the internal processes. By doing so, often the supplier already makes changes to increase efficiency (Purdy *et al.*, 1994). Therefore the suppliers themselves note this stage as most useful stage of the evaluation process, because it helps them to focus and increase effectiveness. Though, there has to be noticed the increase in effectiveness was especially shown in the evaluation, rather than the overall effectiveness of the organization (Purdy *et al.*, 1994). Additionally, besides paying attention to its different internal processes, the suppliers also pay significant attention to the documentation, by focusing on the type of and up-to-date documentation.

5.2.2.Evaluation stage

The actual evaluation of the suppliers can be a difficult task, since the information required for the performance metrics often comes from different systems the organization is working with. Furthermore there has to be made sure the right input will be used to determine the score of the supplier, which requires training of the personnel (Gordon, 2005).

The metrics used for the evaluation of the suppliers are the same metrics as used for the selection of suppliers, since the final selection of new suppliers essentially is a form of supplier evaluation (Krause and Ellram, 1997). As stated by Cavinato and Kauffman (2000), supplier evaluation has two different meanings. Firstly, the qualification of suppliers is referring to the pre-purchasing activities, which involves the pre-qualification and final choice for an appropriate supplier. Secondly, supplier performance evaluation evaluates the suppliers' actual performance on a regular basis.

Although the supplier selection metrics can also be used for supplier evaluation, only a selection of the supplier selection metrics will be used for the supplier evaluation on a regular basis. This is due to the fact that some metrics are considered more important by the buying organization, though changes rarely occur. An example can be the technical capability of a supplier.

By the evaluation of the performances of the supplier, areas that need extra attention can be identified.

Suppliers' perspective

According to Purdy *et al.*, (1994), the criteria considered most important according to the suppliers are: *continuous improvement, documentation, communication, quality, cleanliness, delivery, plant layout and focus on reality*. Additionally, a number of suppliers stated that a significant number of problems the supplier had to deal with remained undetected, since the evaluators used the official forms which did not bring up all the issues that were considered important according to the supplier. Some suppliers mentioned they only brought up a few problems since it was up to the evaluators to discover them (Purdy *et al.*, 1994).

5.2.3.Feedback stage

During the feedback stage it is critical the results of the evaluation will be communicated with the supplier. Though, there has to be kept in mind this communication has to be in the form of a dialogue in which the follow-up actions will be discussed. Information on both the goals and the capabilities has to be shared to come to an agreement on the future performances of the supplier. There has to be made sure the agreements have follow-up actions to effectively improve the performances of the supplier in line with the goals of the buying organization. One of the follow-up actions could be the participation of the supplier in the supplier development program to align the capabilities of the supplier with the goals of the organization. This dialogue and the follow-up actions are crucial to increase the performances of the suppliers (Gordon, 2005).

Suppliers' perspective

The feedback stage was considered very important according to the suppliers, since the evaluators provided the suppliers with insight in the strengths and weaknesses of the organization from an outsider's perspective. Though feedback was considered important, the type of feedback most of the time was related to documentation. Therefore, the feedback was considered not that useful.

Most of the techniques used are based on weighting scoring methods, which are based on opinions of purchasing managers. By making use of these methods, the knowledge of the purchasing staff is fully utilized, though the final ranking of the suppliers heavily depends on the pre-determined ranking, which causes the scoring to be subjective (Purdy *et al.*, 1994).

5.3. Supplier development program

As referred to in the feedback stage of supplier evaluation (paragraph 5.2.3), a supplier development program can be one of the follow-up actions agreed upon to improve the performances of the suppliers. A supplier development program can be defined as "the activities undertaken by a buying firm to improve supplier performance, supplier capabilities or both and to meet the buying firm's short- and/or long-term supply needs" (Krause *et al.,* 2000). These activities may include: supplier evaluation, feedback, performance expectations and education and training of suppliers' personnel (Krause and Ellram, 1997). Although the use of supplier development programs increases, there is no empirical evidence that such programs really improve the supplier performance (Krause *et al.,* 2000). In line with this, Porter (1991 as stated in Krause *et al.,* 2000) states many supplier development programs are not successful (Prahinski and Benton, 2004). Because of these unsuccessful programs, buying organizations have had the tendency to consolidate their purchases with fewer suppliers – which already performed well – and to develop long-term relationships with those suppliers (Krause *et al.,* 2000; Cousins and Menguc, 2006). These long-term relationships are valuable since these suppliers are more likely to have the infrastructure and organizational capabilities to cope with the requirements of the buyer organization (Narasimhan *et al.,* 2001). To increase the sourcing activities of the organization, effective communication and creating insight in the suppliers' performance is essential (Krause, 1997). To strengthen the relationships and improve the performances of critical suppliers, the buying organization can apply different strategies (Krause, 1997):

- *Enforce competition:* Enlargement of competition for the supplier can increase the suppliers' performance and does not involve any necessity of the buying organization.
- *Incentives:* Incentives can be created by commitment of future business or an increase in volume allocations.
- *Direct involvement:* The buying firm gets directly involved by the supplier. This involvement can be in the form of training and education of supplier's personnel or even providing the supplier from temporary personnel. Though, this strategy is also considered risky; when the relationship is pre-ended, the investment of the buying firm is gone (Krause *et al.,* 2000).

By applying supplier development in a pro-active way, an organization may experience a competitive advantage (Krause and Ellram, 1997). By applying a certain type of supplier development program, the buying organization has to consider the procurement strategy that is applied at the specific supplier (Table 5).

Procurement strategy	Supplier development program
Supply management (strategic items)	Incentives Direct involvement
Sourcing management (bottleneck items)	Incentives Direct involvement
Material management (leverage items)	Enforce competition
Purchasing management (non-critical items)	Enforce competition

Table 5: Procurement strategy and supplier development program (based on Krause *et al.,* (2000))

Although an organization can achieve significant benefits from the supplier development programs, there are some alternatives available, though these are rather limited. Alternatives for the supplier development programs are: manufacturing the purchased items in house or search for another supplier (Krause *et al.,* 2000).

5.4. Conclusion

Since organizations are increasingly depending on the performances of its suppliers, it is crucial that the performances of the suppliers are in line with the expected performances of the buying organization. Therefore, it is essential the right supplier is selected.

Since there are a large number of techniques which can be used for the multi-criteria supplier selection problem, there is searched for a technique which is able to deal with as much different procurement situations as possible, with the emphasis on the final choice phase.

During this decision, the problem definition phase and the criteria definition phase are not taken into account for the following reason: in the problem definition stage is stated this phase is not particularly complex and therefore no explicit technique is needed. In the criteria definition phase a few methods are shown. Additionally some publications focus on criteria to assess suppliers on, which are a valid benchmark (Weber *et al.,* 1991; Deshmukh and Chaudhari, 2011). In line with this statement, these criteria are further considered in this study. The metrics that should be used for assessing the suppliers according to the literature are based on the criteria formulated by Dickson in 1966. There have been a number of reviews, which ensure the validity of these criteria. Because of the different reviews that have been published, the overall number of articles in which the criteria are mentioned is used to determine which criteria are considered crucial. Looking at the reviews the following criteria; *Price, Quality, Delivery, Production facilities and capacity, Technical capability, Financial position, Management and organization, Geographical location, Repair service* and *Performance history* are considered as the ten most important criteria.

As shown in Table 4 the Quasi-compensatory models and the AHP methodology are applicable in most cases. After taking a closer look to both techniques, it can be derived the AHP methodology uses the Quasi-compensatory models as a basis and adds pair-wise comparisons.

It is stated by Tahriri *et al.,* (2008) the AHP methodology is a proved model for making supplier selection decisions. The AHP methodology offers the possibility to rank the criteria based on the judgment of the decision maker. This is an important aspect considering each organization is different and therefore demands regarding the suppliers differ. Considering these comments, the AHP methodology will be applied during this study.

During the supplier evaluation three different phases are differentiated. In the preparation stage it is essential the metrics on which the suppliers are assessed, contain the goals of the buying organization on corporate, business and operational level. By announcing the assessment, suppliers start evaluating their internal processes critically to increase efficiency. Though, they mainly focus on the performance metrics addressed by the buying organization.

During the actual evaluation it is critical that all the information needed is provided and generated in the right way, since based on these outcomes conclusions will be drawn. The topics addressed by the performance metrics, need to address all the important processes at the supplier.

In the feedback stage the results of the assessment are discussed and follow-up actions are formulated. It is important this feedback stage will be in the form of a dialogue in which the results are discussed and an agreement is made on the improvement of the performances.

One of the actions that can be considered to improve the performances of the supplier is by using a supplier development program. This program is formulated by the buying organization and can be in different forms: enforce competition, incentives and/or direct involvement. By deciding on the actions taken in the supplier development program, the type of procurement strategy applied by this supplier has to be taken in consideration.

6. Conclusion literature study

In this part an overall conclusion will be drawn on the literature study. By doing so, the first and second sub- question will be answered.

Different factors are of influence on the logistical performance of the organizations' suppliers. In paragraph 2.1 the different and most important characteristics of suppliers are mentioned as being culture, technology and relationship. These three elements affect how a supplier and its' employees are behaving. It determines if the supplier is capable of dealing with the requirements set by the buying organization and what type of relationship can be developed with the supplier.

The relationship arises from the trust the buyer organization has in the supplier, which has an influence on the level of commitment the supplier has towards the buying organization (Chapter 4). The interactions between these two elements form the basis of the relation and have a strong influence on how close the relationship will be.

The characteristics of the supplier, type of product and the type of relationship the buyer and supplier have, have a direct and indirect influence on the procurement activities of the buying organization regarding the supplier. The procurement strategy handled (Chapter 3) by the buying organization is to "minimize supply risk and make the most potential buying power" (Kraljic, 1983). In the Kraljic matrix a clear overview of different procurement strategies is created. The basis of the Kraljic matrix is the type of product that is procured. The importance of the procurement and the complexity of the supply market determine the type of good.

The supplier the procurement strategy can be derived from the type of good, the supplier characteristics and the relationship between the buying organization and the supplier. These different factors answer the first research question: *Which factors do have an influence on the performance of the suppliers?*

Since there has been quite some research on how to determine the performances of a supplier, different metrics have been proposed. Dickson proposed different metrics which have been reviewed by different authors. The proposed metrics and the analysis of the reviews on them is shown in paragraph 5.1.2. From these publications there can be concluded that *price, quality and delivery* are the most crucial metrics. *Production facilities and capacity* and *technical capability* are among the most important criteria, though these are considerably less important than the most critical criteria. Furthermore, *financial position, management and organization, geographical location, repair service* and *performance history* are the additional criteria ranked in the top ten of the analysis, though the importance of these criteria is considerably less.

The influences mentioned are the ten criteria that have most influence on the performance of the suppliers and therefore answer the second research question: *What performance metrics can be applied to assess the logistical performances of the suppliers?*

7. Theoretical framework

The theoretical framework (Figure 4), presented in this section, is based on the outcomes of the literature study. This gives an overview of the different relations which have to be taken into consideration to answer the research question. These relations are taken into account during the formulation of the supplier selection and evaluation metrics.

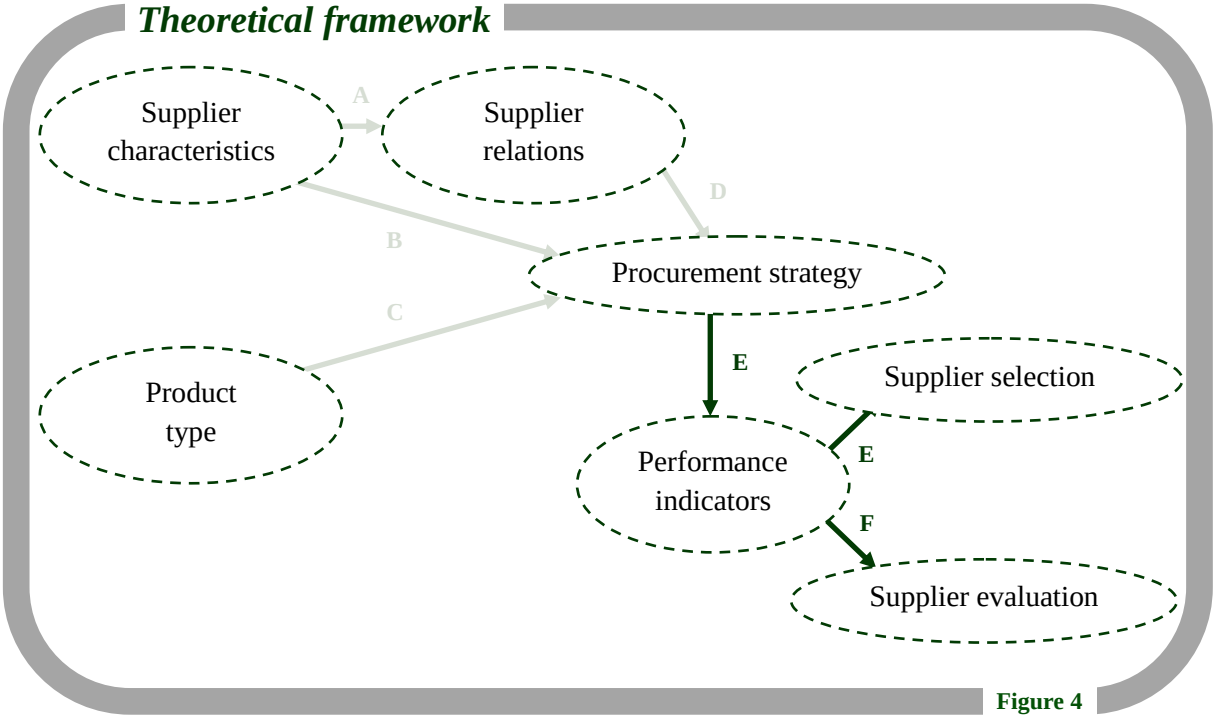

Figure 4

In the theoretical framework the different relations are indicated. The focus of this study lies on the relations indicated by the green arrows. Although the relations indicated by the grey arrows are not the focus of this study, they have to be considered since they all have an influence on the procurement strategy.

Relation A: The characteristic of a specific supplier influences the relation between the buying organization and the supplier. As mentioned in paragraph 2.1, the different elements of the supplier characteristics can be defined as culture, technology and relationship. The culture of the supplier is referring to the values within an organization. The relation might be positively influenced by this characteristic, especially when these cultural values are similar to those of the buying organization. In this way, both parties can more easily empathize with organizational aspects of the other party. The technology addresses the extent to which a supplier is capable of dealing with the requirements of the buying organization. This influences the relation in such a way that when the supplier is not capable of dealing with the technical requirements of the buying organization, the relation is negatively influenced, since, expectations are not met. By not meeting the expectations, trust and commitment will be influenced, which are characteristics of the supplier relation. Both these elements determine the type of relation that will be developed with the supplier.

Relation B: The supplier characteristics also have a direct influence on the procurement strategy of the buying organization. As stated in chapter 3, the procurement strategy is determined by the financial importance of the procurement and the complexity of the supply market. The complexity of the supply market is partly determined by the technology needed to produce the goods. Strategic goods, for example, might have very specific requirements on the product to be delivered. Whereas not all

suppliers are capable of dealing with these requirements, the procurement strategy should consider the availability of suppliers which are capable of dealing with the requirements. Therefore, the technology characteristic has an influence on the procurement strategy.

Relation C: The product type is crucial to the type of procurement strategy that will be applied. Since some products are more essential to the buying organization than others, naturally the importance of the supplier will vary. The Kraljic matrix as outlined in paragraph 3.1., creates insight in the different types of product and the related procurement strategies. In the Kraljic matrix different procurement strategies are defined, which are based on the type of product procured. In line with this matrix, the type of product has a direct influence on the procurement strategy applied by the buying organization.

Relation D: The relationship between the buying organization and its supplier has a direct influence on the procurement strategy applied by the buying organization. As stated in chapter 4, trust and commitment are the essential elements of the relation between the buying organization and the supplier. By showing a high level of commitment to the buying organization, the relationship between the organizations might change positively and therefore a different procurement strategy will possibly be applied.

The different relations described above all have an influence on the procurement strategy of the buying organization. In its turn, the procurement strategy itself has an influence on the performances of the supplier. This is due to the fact that a close cooperation with a supplier might ensure the supplier will perform differently compared to an open market negotiation. The development of this close cooperation is determined by the different relations (A, B, C and D) mentioned above. The different relations and elements outlined above contribute to the answer of the first sub-question: *Which factors do have an influence on the logistical performance of the suppliers?*

Relation E: Part of the procurement strategy is setting the requirements for the supplier of the buying organization. Once these requirements are set, it is important to gain insight in the performances of the suppliers to ensure these performances cope with the standards of the buying organization. Insight is created by making use of different performance metrics. The performance metrics are emphasized by different procurement strategies: one performance metric is more important within one procurement strategy than another metric is. Though, all the formulated performance metrics can be used in the different procurement strategies, but to a different extent of importance.

Relation F: Performance indicators can be separated into supplier evaluation and selection metrics. The supplier selection metrics are used for the selection of new suppliers. A number of potential selection methodologies have been proposed of which an overview is created in paragraph 5.1. By assessing the potential suppliers, an overview will be created on the level of performances these suppliers are able to deliver. This insight provides the buying organization the opportunity to select the supplier which fits best with the set standards. After this selection is carried out, a final choice can be made. Which metrics are emphasized most, is determined by the procurement strategy that will be applied.

Relation G: A number of formulated performance metrics are used for the evaluation of the performances of the suppliers. If the selection of the supplier has taken place, the supplier will be evaluated on a regular basis. By clearly defining the organizational goals, insight can be created in the performances and whether these are satisfying or need to be improved. In paragraph 5.2 different stages of the supplier evaluation are discussed.

The relations E, F and G are all related to the performance metrics applied by the buying organization. The procurement strategy has a direct influence on the performance metrics applied to gain insight in the performances of the suppliers. If the performance metrics are formulated, a difference can be made between the performance metrics which will be applied for supplier selection and the performance metrics which will be applied for supplier evaluation. The performance metrics for supplier selection are used to decide on the best, new supplier. The evaluation metrics are used to gain insight in the performances of existing suppliers. The performance metrics formulated answer the second sub-question: *What performance metrics can be applied to assess the logistical performances of the suppliers?*

The set of relations described above can be divided into two categories. The first category consists of relations A, B, C and D, which refer to the choice of a specific procurement strategy. This choice might be influenced by several factors, which should therefore be considered by the determination of the procurement strategy. The second category of relations (E, F and G) refers to the execution of the procurement strategy. These relations include the process of supplier selection and evaluation. Whereas the choice of procurement strategy has a central role, the relations should all be taken into consideration before the strategy can be applied. Although this study focuses on the second category, the first category will be taken into account.

8. Methodology

This chapter provides an overview of the methodology used during the empirical part of this study. Clarification will be provided in this chapter on the position of the different elements of the study. First an overview will be provided of the different stages which will be gone through. Additionally, clarification will be provided on the different data sources used.

8.1. Research design

To be able to answer the research question of this study, a case study research is conducted. A case study research is a qualitative method of investigating, which contributes to the aim of this study to create in-depth insight in the performances of the suppliers. Since these performances need to be determined for one organization specifically, generalization of findings does not apply. Therefore, a qualitative research design is more applicable than a quantitative research design (Eriksson & Kovalainen, 2008).

In terms of the practical approach of this study, a single case study is conducted. A single case study provides the opportunity to specifically focus on the specific case at hand. In this way, all aspects of the research can easily be applied to the organization of Vencomatic. Since there is no aim to generalize or compare cases, conducting a single case is sufficient.

8.2. Data sources

Different types of data sources are used to compose this study. The different data sources are described below, including the reasoning why these sources are used.

8.2.1. Literature

First, a literature study has been conducted. Different sources of literature are used. The literature study is based on scientific (E-) journals, the internet and books. The (E-) journals that are used are: *International Journal of Physical Distribution and Logistics Management*, *International Journal of Operations & Production Management*, *Harvard Business Review*, *International Journal of Production Economics* and *The Journal of Supply Chain Management: A Global Review of Purchasing and Supply*. Complementary information from case studies is also gathered by making use of scientific (E-) journals and the internet. The scientific (E-) journals used for the case studies were the same journals as used for the literature study. The case studies are used to complement the conclusions of the literature study and to test its validity.

8.2.2. Interviews

The conclusions of the literature study were the input for the empirical part of this study. The empirical part consists of several interviews and discussions with different types of respondents. Interviews were conducted in order to gather a broad variety of information. Interviews "allow us to enter into the other person's perspective" (Patton, 2002). Whereas the other person's perspective is of importance to the study, it is important to select the right respondents who are able to provide the information needed. Furthermore, the respondents should be able to represent their organization. In this way, not solely personal perspectives were obtained. All interviews were held in Dutch to prevent misunderstandings. The interviews served different purposes: from creating a better understanding of supplier selection processes, to determining performance metrics for Vencomatic specifically.

Comparable organizations

In order to create a basic understanding of possible ways to apply supplier selection and to gain insight in the performance metrics applied by comparable organizations, interviews were held with managers of comparable organizations. The selection of respondents included two main requirements: (1) the organization should be somehow comparable with Vencomatic and (2) the respondents should have a position which provides them insight in the supplier selection process of their organization. Mutually the respondents did not have to be comparable. Table 6 outlines the position of the interviewees and similarity of the organization to Vencomatic, which together support their participation to this study. The interview was semi-structured: thirteen questions were composed on forehand, which were to be answered openly. In this way, the interviewer could ask follow-up questions in case of unclear or unspecific answers. The interview guide can be found in appendix 4. The minutes of the interview were e-mailed to confirm the content of the interviews, to all respondents who preferred to receive them.

Organization	*Position interviewee*	*Similarity to Vencomatic*
Comparable organization I	Director supplier quality	An interview at comparable organization I is conducted since the automotive industry is known for being well capable in managing performances of its suppliers and comparable organization I offered the opportunity to gain insight in the methodologies applied by them.
Comparable organization II	Supply chain manager	The product portfolio of comparable organization II is comparable with the product portfolio of Vencomatic; both organizations offer the complete inventory for poultry stables.
Comparable organization III	Technical supplier manager	The products produced by comparable organization III are very innovative. This is also one of the strong and differentiating characteristics of Vencomatic.
Comparable organization IV	Chief procurement officer	The products produced by comparable organization IV are voluminous. This is in line with the goods of Vencomatic which are often voluminous and clustered.

Table 6: Overview different related organizations

Employees of Vencomatic

Furthermore, a number of interviews were held with employees of Vencomatic (Table 7), to gain insight in the current policy applied. The main focus was on the current policy of supplier performance measurement. Additionally, the respondents were asked towards their perspective about what the emphasis of the new policy should be. One requirement on the selection of the respondents therefore, was that they should be in a function in which they deal with suppliers. In order to gather a broad variety of perspectives, respondents of different hierarchical layers within the organization were selected. This is important since not all employees might feel the suppliers are assessed on the same aspects. For example, a manager might think of listed criteria a supplier is assessed on, while a subordinate might come up with undocumented criteria as being important.

Again, a semi-structured interview was conducted in order to get in-depth insight and create the opportunity to ask follow-up questions. The interview guide contained eleven open questions and can be found in appendix 6.

Employee Vencomatic	*Function*
1	Warehouse officer
2	Warehouse officer logistics
3	Warehouse manager
4	Purchasing manager
5	Quality officer
6	Project manager

Table 7: Overview interviewed employees Vencomatic

8.2.3.Discussions

Discussions, on the other hand, were organized to discuss numerous subjects. Some discussions aimed to create insight into a specific topic, while other discussions considered the options for decision making purposes. All discussions contributed to the consultation of specific performance metrics for Vencomatic and were held in Dutch to prevent misunderstandings. The respondents can be divided into two main groups, in terms of purpose of the discussion. The first group exists of four internal stakeholders and the second group consists of eighteen suppliers.

Internal stakeholders

The first group, the internal stakeholders, was approached to discuss about finalizing the performance metrics and the setting in which the assessment process should take place. The respondents are listed in Table 8, which also provides insight in their interest in the performance metrics.

Internal stakeholder	*Interest*
Manager Value chain and Quality officer	The quality department is involved with the formulation of the performance metrics since quality is considered essential by Vencomatic. The quality and innovativeness are considered as crucial competitive advantages by Vencomatic. Therefore, suppliers should be able to perform in line with these requirements.
Manager Purchase	The purchasing department is the appropriate department to have contact with the suppliers since orders are placed by this department. The purchasing department discusses the results of the metrics with the suppliers and the improvement plan.
Manager Production and Logistics	The logistical department is directly influenced by the performances of the suppliers. Because of this direct involvement the logistical manager is also involved in the formulation of the metrics.
Manager Warehouse	The warehouse is directly involved with the performances of the suppliers. Therefore, the warehouse manager is involved with the formulation of the performance metrics.

Table 8: Overview internal stakeholders Vencomatic

Suppliers

The second group involved are suppliers of Vencomatic. These suppliers served two functions within their participation in the study. On one hand, they were considered as external stakeholders to criticize proposed performance metrics. The reason for selecting suppliers as external stakeholders is found in the fact that they are familiar with the subject, so that they could provide feedback based on their knowledge and experience.

On the other hand, they were approached in their role as actually being suppliers. Within this function, their participation contributed to the study in terms of assessing them on the performance metrics. Their participation on both roles is undertaken within one moment of contact. In other words

they had to give feedback on the metrics and assess themselves on the metrics. This distinction of roles was made clear by the interviewer.

The specific selection process of the suppliers, based on the empirical part of this study can be found in appendix 15.

8.2.4. Additional data sources

Additionally, internal information of Vencomatic is used. These documents were in the form of shortcomings detected during the incoming inspection and reports of the Creditsafe institution (report on the financial health of an organization). This information was used to gain insight on specific performances of the suppliers.

8.3. Case study stages

In this phase the performance metrics are used to assess the suppliers. This empirical part contributes significantly to the aim of this study: giving recommendations on the improvement possibilities regarding the supplier performances. In order to become able to recommend on these performances, insight in the current performances has to be created. This insight is created by assessing suppliers on different performance metrics which are of specific importance.

Different steps had to be taken to come to these assessment metrics. Figure 5 shows the different stages an organization should go through in order to improve the performances of its suppliers, based on supplier selection and -evaluation.

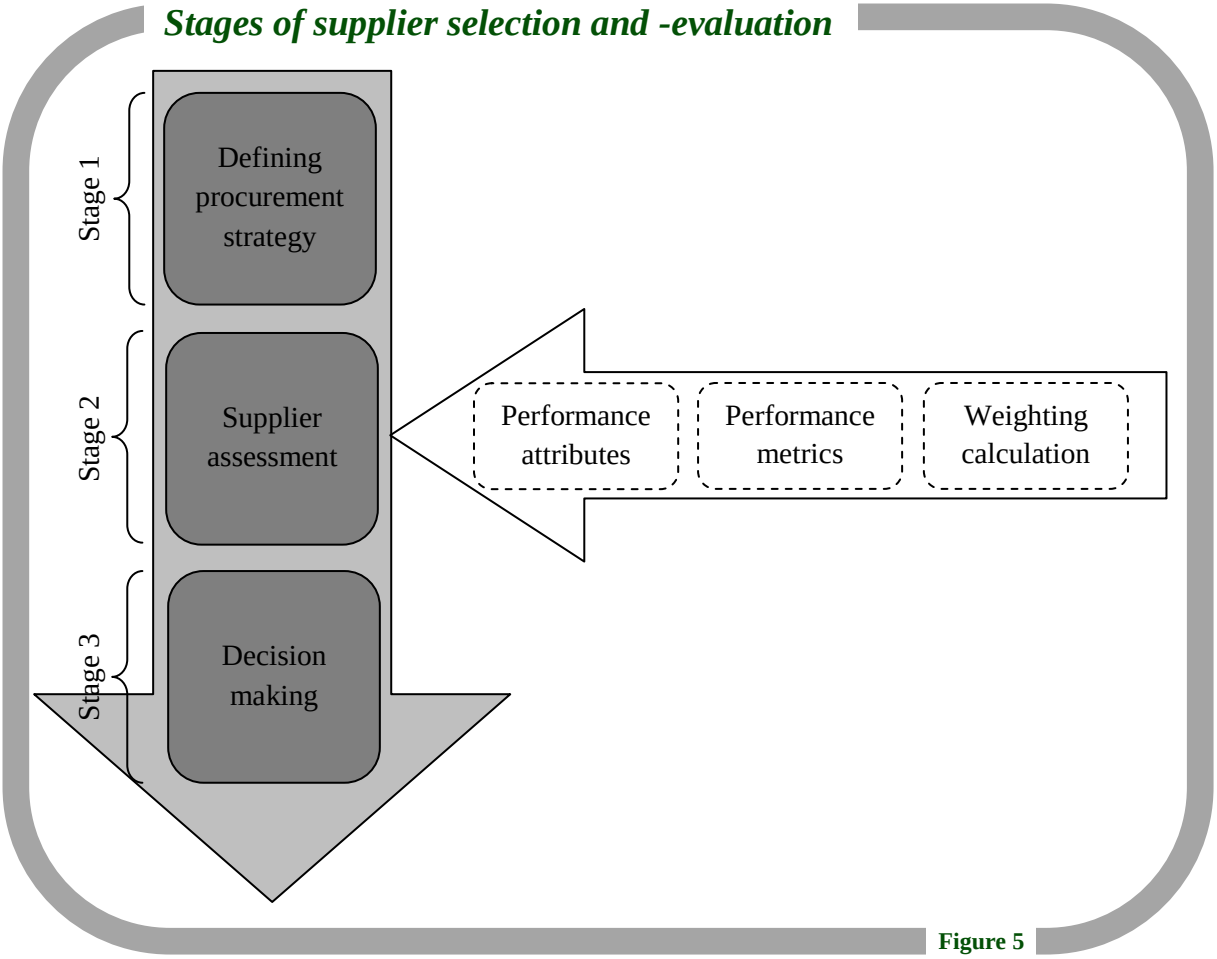

Figure 5

The process of supplier selection and -evaluation include 3 stages: (1) defining an appropriate procurement strategy, (2) assessing suppliers on specific performance metrics and (3) making decisions based on the results of the second stage. Whereas this study focuses on the stage of supplier assessment (second stage), this stage is carried out most extensively. In order to be able to assess the suppliers of Vencomatic, the performance metrics had to be determined. Determination of such metrics includes three aspects: performance attributes, performance metrics and weighting calculation (Figure 5). These three steps do not have to be carried out every time an organization wants to select and evaluate its suppliers, but do have to be determined once. In the case of Vencomatic, this had to be done during this study.

Stage 1: Defining procurement strategy

The first stage normally consists of determining the procurement strategy (Figure 5). The determination on the procurement strategy is based on different factors which influence the procurement strategy that is applied by the buying organization. The factors influencing the type of procurement strategy are: supplier characteristic, supplier relationship and product type (Figure 4). Since the focus of this study was on the second stage and the metrics should fit all potential procurement strategies, a more comprehensive approach is applied in this study. Together with Vencomatic, there is chosen to select one end product produced by Vencomatic itself. The components of this product should represent the different product groups, as outlined in the Kraljic matrix (appendix 14). By doing so all possible procurement strategies are taken into account by developing the performance metrics for Vencomatic.

Based on the end product, the suppliers involved in making this product are selected to take part in this study. The selected suppliers should represent the full database of suppliers of Vencomatic, in order to develop the best applicable performance metrics. Considering this, Vencomatic chose to select their 'Grando' breeder housing (figure 6) as end product, based on which the components and suppliers would be selected. This end product contains components of various product groups, as shown in Table 9.

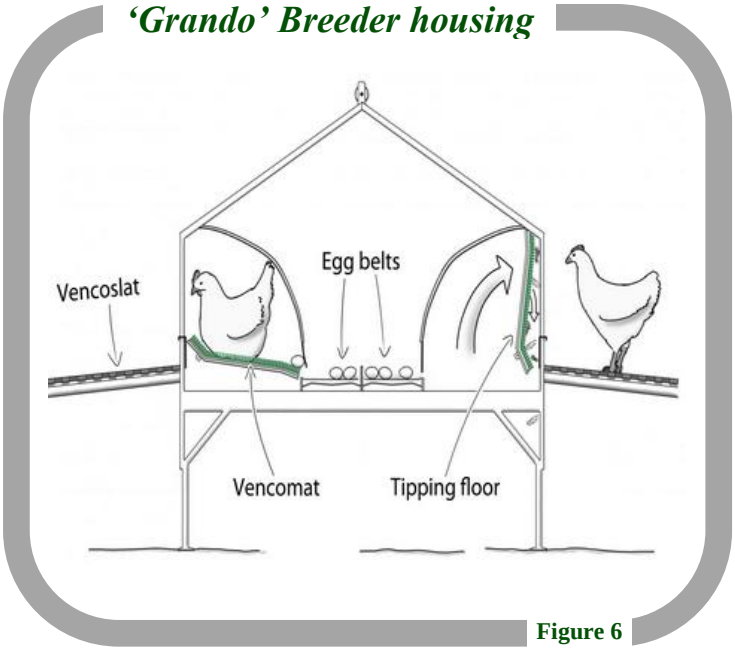

Figure 6

	All product groups (appendix 14)	*Product groups used in 'Grando' breeder housing (Figure 6)*
Strategic items	7	4
Bottleneck items	3	1
Leverage items	25	10
Noncritical items	20	4
Total	55	19

Table 9: Product groups Vencomatic versus product groups 'Grando' breeder housing

In Table 9, a comparison is made between the total number of product groups defined within Vencomatic and the number of product groups used in the end product. As can be derived from Table 9 a representative number of products groups is present in the 'Grando' breeder housing (Figure 6).

Stage 2: Supplier assessment

The second stage is about supplier assessment (Figure 5). To be able to assess suppliers on their performances, performance metrics had to be developed. This is done for Vencomatic specifically. First, performance attributes and more specific performance metrics were determined. This determination was carried out by applying existing literature to practice. The basis for the performance attributes and metrics came from the performance metrics formulated in the SCOR-model. The SCOR model is a framework to manage the activities of a supply chain as a whole. Since this study focuses on the determination of performance metrics to assess suppliers, this explicit part of the SCOR model is used within this study.

Performance attribute	*Performance metrics*
Reliability	Delivery performance
	Fill rates
	Order fulfilment
Responsiveness	Order fulfilment lead time
Flexibility	Supply chain response time
	Production flexibility upside
	Production flexibility downside
Costs	Total supply chain management costs
	Costs of goods sold
	Value added productivity
	Warranty/returns processing costs
Asset	Inventory days of supply
	Cash-to-cash cycle time
	Asset turns

Table 10: Performance attributes and metrics SCOR model (Kocaoğlu *et al.*, 2013)

Although the performance metrics of the SCOR model (Table 10) served as a basis, not all the issues regarding quality, information technology and administration are specifically addressed (Council, 2010). Therefore, it is not sufficient to only use the performance metrics formulated in the SCOR model during this study. In other words, not only the operation efficiency parameters but also the service effectiveness needs to be considered (Kleinsorger *et al.*, 1991 as stated in Lai *et al.*, (2002). Additionally, the important factors that have an effect on the selection of a supplier vary per organization. Therefore, an organization has to decide upon the selection criteria themselves (Olsen and Ellram, 1997b). This is in line with the statement of Kraljic (1983 as stated in Gelderman, 2003): 'No list of evaluation criteria is equally applicable to every industry'.

In accordance, the performance metrics of the SCOR model have been complemented. The additional metrics were selected from the reviews of the selection criteria by Dickson 1966 (literature study), case studies, interviews with comparable organizations and interviews with employees of Vencomatic. These additions/substitutions form the proposed performance metrics for Vencomatic.

Performance attributes and metrics

For the formulation of the final performance metrics, the systematic vendor rating procedure proposed by Yahya and Kingsman (1999) was used. To formulate the proposed metrics in a final form, a number of internal stakeholders participated in this study. Besides the internal stakeholders, suppliers are approached to criticize the proposed metrics. In this way, the performance metrics meet the requirements of Vencomatic and are supported by external parties. The latter also indicate the external validity of the metrics, since firms of different branches agree on the metrics.

Whenever the metrics are both internally and externally agreed upon, the metrics have to be finalized. This is done via a discussion with two of the internal stakeholders. The outcome of this discussion is validated by the other internal stakeholders, by proposing the comments to them. The procedures and outcomes of the involvement of these internal stakeholders and suppliers are outlined in the following paragraphs.

The internal stakeholders are first briefed on the goal of the performance metrics. After the goal is made clear, the proposed performance metrics were handed over to the internal stakeholders by mail. The stakeholders were asked if the metrics encompassed all the crucial performances a supplier should deliver. The additions and remarks of all the internal stakeholders were gathered by personal interviews of about one hour. An overview of the comments is shown in appendix 9. The additions proposed by the stakeholders are processed and combined into one list containing all the metrics. This master list was discussed with two internal stakeholder (manager purchase and manager production and logistics), to process and incorporate the comments. There was decided to implement the comments in cooperation with stakeholders since they had experience with supplier evaluation and these two stakeholders had the most comments. This meeting took around one and a half hour. After this meeting, the adaptations were discussed with the remaining two internal stakeholders, which both agreed.

Besides the internal stakeholders, suppliers were approached to finalize the performance metrics. As discussed in stage 1, the different product groups of the end product were used. After the product groups are selected, the suppliers of these product groups were identified. For the determination of the suppliers included in this study, a closer look has to be taken to the complete overview of all the suppliers of Vencomatic. The selection of the suppliers is based on the turnover the suppliers had at Vencomatic in 2013 and their geographical location. In appendix 15, the selection methodology of the suppliers which are included in this study is further explained. The suppliers included in the analysis are shown in Table 11. A clearly defined overview and detailed information of the suppliers which are assessed in this study is given in appendix 16.

Nr.	*Organization*	*Quadrant in Kraljic matrix*	*Nr.*	*Organization*	*Quadrant in Kraljic matrix*
1	Supplier L	Strategic goods	10	Supplier H	Strategic goods
2	Supplier N	Leverage goods	11	Supplier P	Strategic goods
3	Supplier E	Leverage goods	12	Supplier Q	Non-critical goods
4	Supplier A	Leverage goods	13	Supplier D	Non-critical goods
5	Supplier O	Leverage goods	14	Supplier R	Non-critical goods
6	Supplier F	Bottleneck goods	15	Supplier K	Leverage goods
7	Supplier M	Leverage goods	16	Supplier C	Non-critical goods
8	Supplier I	Leverage goods	17	Supplier J	Non-critical goods
9	Supplier B	Leverage goods	18	Supplier G	Non-critical goods

Table 11: Suppliers included in the analysis

Next to finalizing the performance metrics, the suppliers are asked to score themselves on the performance metrics, based on the performances they deliver to Vencomatic. Before the suppliers started scoring, there was explained these scores would be compared to the performances measured by Vencomatic. If these performances did not correspond, performances had to be improved due to the fact the performances had to meet to the performances that were agreed upon.

All the suppliers were contacted by phone to inquire their willingness to cooperate. During the phone call the general goal was explained. Additionally, an e-mail is sent containing all the performance attributes and metrics. The phone calls showed all the suppliers were directly willing to cooperate, except for one who wanted to discuss the collaboration internally. The internal collaboration resulted in a decision to not take part in this study. To increase cooperation, the feedback provided by the suppliers is anonymized, since several suppliers asked for this.

There is decided to interview half of the suppliers personally, and contact the other half by mail. Reason to make this distinction is due to the type of feedback. In a personal interview the interviewer is tending to provide additional information on the background of the metrics. By assessing several suppliers by mail, so without additional background information on the metrics, the clearness of the metrics could be tested.

When the suppliers were divided into two different groups, their position in the Kraljic matrix was taken into account. There is strived for incorporating suppliers of each quadrant of the Kraljic matrix in both ways of contact. This was possible, except for the bottleneck goods, since only one supplier is located in this quadrant. There was chosen to contact this supplier by a personal interview in order to gain background information.

The suppliers who were personally interviewed were asked to prepare the interview by gathering the needed information to score the performances. During the interview, first the general goal of the supplier selection metrics is explained again. Next, the different metrics were discussed one by one. There was asked for feedback on the performance metrics, to increase the validity of these metrics. Furthermore, the suppliers were asked to score themselves on the metrics regarding the performances they deliver to Vencomatic. Additionally, it is crucial the suppliers share the level of importance on supplier selection and the metrics used to do so. The suppliers assessed by a personal interview are: A, B, C, D, F, H, I, L and N.

Besides, a number of suppliers were assessed by mail. After the contact by phone, an e-mail is send in which the overall goal is explained again. In the attachment the performance metrics were provided in an excel sheet, on which the supplier is asked to give feedback and to score themselves on the performance metrics. After one week a reminder was send to the suppliers who did not respond. Additionally, the suppliers who did not responded after two weeks were contacted by phone, which resulted in a response of five out of nine (55,56%). The suppliers O, P, Q and R did not respond. Suppliers assessed via e-mail are: E, G, J, K and M.

An overview of the comments of the suppliers is shown in appendix 10. The feedback was discussed with the internal stakeholders (manager purchase and manager production and logistics), to process and incorporate the comments. In this way, processing of the comments of both the external and internal stakeholders is done consistently. This meeting took about one hour. After, the adaptations were discussed with the two remaining internal stakeholders, which both agreed.

Weighting

After confirming the final performance metrics, the weights of the different metrics have to be determined. The weights are determined by using the AHP methodology. According to the procedure proposed by Yahya and Kingsman (1999), the determination of the weights is done in accordance and

cooperation with the internal stakeholders mentioned. Since the determination of the weights is a time consuming process, the calculation was done with two internal stakeholders (manager purchase and manager production and logistics).

Interviews are conducted with the remaining two internal stakeholders to discuss the proposed weighting on the different performance attributes and metrics. The interviews took about one and a half hours each. Both internal stakeholders confirmed and underpinned the proposed weights. The calculation of these weights is shown in appendix 12.

Stage 3: Decision making

The third stage is about decision making. Normally, the scores of the suppliers will be analysed in this stage and conclusions will be drawn. The final decision is made on the performances of the supplier and the potential new supplier is selected.

However, the focus of this study is on the second stage of Figure 5. The executing of the third stage is therefore somehow different in this study. After the data of the second stage is collected, this data is analysed. Outstanding results are outlined and explained where possible. Next, these results are related to the Kraljic matrix in order to get an overview of differences between the four quadrants. Based on this division of the suppliers, strengths and weaknesses were identified. In case of weaknesses, suggestions were made to improve the suppliers' performances. In this way, the performances of the suppliers individually, as well as the performances of the suppliers within one quadrant are synthesized. In terms of the framework of this study, no conclusions or final decisions are made towards the selection of suppliers.

8.4. Validity

The validity of a study is determined by the internal and external validity. Ideally, the internal and external validity are high (Vaus, 2001).

Internal validity

The internal validity shows the confidence by which a research can support the conclusions which are drawn (Vaus, 2001). An extensive literature study has been conducted to create insight in the relationships between supplier performance and other factors. As stated in the literature study and the theoretical framework, different factors influence the performances of suppliers. Testing of all the mentioned relations would not be feasible within the set time frame. Since a number of relations are confirmed theoretically, though not in this specific case, the internal validity of this study could be improved by empirically testing these relations. However, to increase the internal validity of this study, a larger number of stakeholders could be involved in the process of formulating the performances metrics.

External validity

The external validity shows to which extend the results from study can be generalized beyond the specific study (Vaus, 2001). The study conducted is a case study which implies the study is based on a single or a series of cases (Vaus, 2001). Since the study is based on a single case, the external validity of this study is low. Additionally, a few suppliers are assessed in this study which gives an indication on the performances of the other suppliers. To increase the external validity of the study, interviews are conducted at organizations that are comparable to Vencomatic in one way or another. During the interviews, the literature is criticized and insight is created in how these organizations create insight in the performances of their suppliers. Taking in consideration this input, the external validity of the study is increased.

8.5. Reliability

The reliability shows to which extend a measurement generates the same output if the measurement is repeated (Vaus, 2001). Since the study conducted is a qualitative study, chances are high that a replication of the study would not generate the same outcome. This is due to the fact the interviews conducted are qualitative and semi-structured, which offered the possibility to ask additional questions to get more specific information. By repeating the interviews, it is dependent on the answers of the interviewee and the additional questions of the interviewer if the interview produces the same output. Though, during the interview there is tried to structure the interview, by asking the interviewee to answer the proposed questions in order to get reliable interviews.

Additionally, a number of suppliers are assessed in the study. Depending on the performances of the suppliers in a specific period, conclusions were drawn. If the study is repeated and the performances of the suppliers have changed due to for example an investment in outgoing inspection, the outcome of the assessment will be different. Therefore, there are a number of variables which have a big influence on the reliability of the study.

9. Determination of performance metrics

In this chapter a general analysis of the different inputs is used for the formulation of performance metrics. There is elaborated on the formulation of the performance metrics since it is an essential part of this study. Since the different inputs discussed in chapter 8 are used, the formulation of the performance metrics is positioned here to create a clear structure. After the performance metrics are finalized, the assessment of the suppliers took place which is discussed in chapter 10. This chapter provides insight in the formulation of the performance metrics.

9.1. Formulation performance metrics

As outlined in Chapter 9, performance metrics are determined in close collaboration with both internal and external parties. The basis for determination of the metrics was found in the SCOR model as presented in Table 10. The results of the different ways in which the needed data is gathered are outlined in the following paragraphs.

9.1.1. Literature study

In 1966 Dickson presented 23 criteria, which have been discussed in the literature study in paragraph 5.4. In appendix 1 an overview is given of these reviews and the importance of the criteria is determined by the number of times the criteria are mentioned in scientific articles. As stated in paragraph 5.4*: Price, Quality, Delivery, Production facilities and capacity, Technical capability, Financial position, Management and organization, Geographical location, Repair service* and *Performance history* are considered as most important criteria.

9.1.2. Case studies

Besides the literature study, some case studies are included to gain insight in the practical implications and the issues addressed by these studies. In appendix 3, an overview is given of the case studies included in this study.

Case study	*Metrics*							
	Quality	*Price*	*Production Facilities*	*Communication*	*Reliability*	*Flexibility*	*Technical capability*	*Reliability*
Top Fortune 150 organizations *(*Simpson *et al.*, 2002)	*	*	*	*				
Wholesalers and retailers (Germain and Dröge 1990)	*	*		*	*	*		
Electronic organization (Gencer and Gürpinar 2007)	*							
Dicksons´ criteria (Yahya and Kingsman, 1999; Tam and Tummala, 2001; Sevkli *et al.*, 2008)	*	*	*		*		*	*
Automotive manufacturers (Schmitz and Platts 2004)				*	*	*	*	*

Table 12: Most important outcomes of case studies

Table 12 gives an overview of the most important outcomes of the different case studies. All the criteria shown in Table 12 are mentioned more than once in the case studies included (appendix 3). As can be derived from Table 12: *Quality*, *Price*, *Communication* and *Reliability* are considered to be the most mentioned criteria.

9.1.3. Interviews comparable organizations

Below, the interviewed organizations are listed and the most important outcomes of the interviews (appendix 5) are mentioned (Table 13).

Organization	*Most important outcome*
Comparable organization I	-
Comparable organization II	-
Comparable organization III	Quality, Logistics, Technique and Costs (QLTC)
Comparable organization IV	Quality, Logistics, Technique and Costs (QLTC)

Table 13: Most important outcomes of interviews with comparable organizations

The supplier selection criteria Quality, Logistics, Technique and Costs (QLTC) are the criteria handled by the interviewed organizations. When there is taken a closer look at the literature, it is shown that the QLTC attributes are more popular in practice than in scientific literature. The literature found on QLTC refers to case studies at Comparable organization III. Both comparable organization I and II did not provided insight in the metrics used by their organization.

9.1.4. Interviews employees of Vencomatic

Below, the interviewed employees of Vencomatic are listed and the most essential criteria in their point of view (appendix 7) are mentioned.

Interviewee	*Metrics*		
	Packaging	*Repair service*	*On time delivery*
Warehouse officer	*		
Warehouse officer logistics	*		*
Warehouse manager	*		*
Purchasing manager	*		*
Quality manager	*		
Manager production and logistics	*		
Project manager	*	*	

Table 14: Most important outcomes of interviews with employees of Vencomatic

All the interviewees mentioned the packaging of the delivered goods (Table 14). The interviews show the packaging is essential for the goods to be delivered undamaged all over the world. Additionally three employees mentioned the on time delivery as an important metric to assess supplier on. Only the project manager mentions the repair service as an important metric to assess suppliers on.

9.2. Proposed performance metrics

Though, there has to be mentioned the metrics formulated will be used to assess the suppliers of Vencomatic, not the supply chain as a whole. Not all of the performance metrics are applicable to Vencomatic and its suppliers, since only the suppliers are assessed, not the complete supply chain. Therefore, the interpretation of some performance metrics will deviate from the initial meaning the SCC council gave to the different performance metrics of the SCOR model. In appendix 8, an overview of the argumentation of the proposed performance metrics is created.

9.3. Final performance metrics

10.3.1. Finalizing performance metrics internal stakeholders

The comments made by the internal stakeholders are outlined in appendix 9. These comments all focus on the finalization of the performance metrics, in order to specify them to Vencomatic. Below (Table 15) an overview is provided on how these comments are processed.

Metric	Processing of comment
Delivery performance and Order fulfilment	The comment stated these two metrics could be considered as one metric. There is noted that all the aspects mentioned at order fulfilment can be seen as product specifications. After discussion, there is agreed upon place, packaging and documentation can be seen as specifications of the product. This is not the case regarding delivery on *time*. Therefore, on time delivery is measured by the *metric order fulfilment* and *place, packaging* and *documentation* are measured by *delivery performance*.
Technical capability and Repair service	In line with this comment on responsiveness there is decided to not broaden the definition, though to reposition some metrics. The metric on *technical capability* is replaced to the performance attribute *assets*, since the knowledge on the technical requirements is an asset of the organization. Furthermore the metric *repair service* is replaced to the performance attribute *reliability*, since the repair service deals with the reliability of the supplier in case of shortcomings of the goods delivered.
Financial ratios	The comment on financial ratios is considered and, after discussion, agreed upon. There is decided to include financial ratios: *cash flow*, *current ratio* and *quick ratio.*
Communication system	Though, after discussion there is decided the pre-announcement on delivery is not needed if the supplier scores well on order fulfilment. If the supplier delivers the goods on the day which was accounted for, no pre-announcement is needed.
Strategic position	The additional selection metric on strategic position is considered to be not needed since this is already considered during the division of the products in the quadrants of the Kraljic matrix.

Table 15: Processing comments internal stakeholders

10.3.2. Finalizing performance metrics suppliers

Taking into consideration the feedback of the suppliers given during the interviews as well as comments made by mail several adaptations to the master list of performance metrics are made. Below (Table 16), the processing of the comments (appendix 10) is outlined.

Metric	Processing of comment
Management and organization	After discussing on the comment of employees council and the representation of employee rights by an employee's council there is decided to include the employees' council. As a consequence the trade union as well as an employee council is considered to be able to represent the rights of the employees well.
Research and development (R&D)	The comment of the applicability on *research and development (R&D)* for wholesalers is also considered (supplier C, D), though there is decided to leave the metric in since it is applicable for a large number of suppliers. Furthermore, if the metric is not applicable for the wholesaler, this will also be the case for the competitors of the supplier and therefore this metric automatically expires. If the metric is applicable for some wholesalers, it is a metric by which the supplier can distinguish.
Technical capability	The comment on the modern manufacturing equipment (supplier L) is discussed and there is decided the modern manufacturing equipment is shown by the metric *technical capability*. If the supplier invests in technical capability and this is applied in a pro-active way, the equipment of the supplier will be up-to-date.
Order fulfilment	The comment on making a distinction between late, early deliveries and the number of days is also discussed (supplier F). Though, this distinction will not be made since the supplier needs to meet the agreed performances. Therefore the supplier has to deliver the goods on the agreed time and place.
Repair service	The question if the *repair service* was referring to the repairs that need to be made, or considering the complaints. After discussion, there is decided to broaden the explanation on the metric repair service: *Measures if there is dealt with complaints regarding goods (e.g. repairs) within the set time frame.*
Financial position	The comment on the formulation of the metric (supplier I, E) is taken into account and there is decided to rescale the metric. The new scale will be in the form of a graph to visualise the scale.
Flexibility	The comments on the production process (supplier H, I, E) is considered. Up front there has to be clearly communicated to the supplier if the products are demand- or stock driven. If the supplier has insight in the type of product, it is up to the supplier if they want to score high on the metric flexibility by putting products on stock. Therefore, the metric regarding flexibility will not be adapted.
Quality costs	The comment that this metric does not create good insight in the performances of the supplier regarding quality (supplier E). After considering this comment there is decided this metric is closely related to the metrics delivery performance and order fulfilment. The combination of these metrics creates insight in the level of control the supplier has on its quality.

Table 16: Processing comments suppliers

The general comment made by all the suppliers except for one supplier (B), shows the interviewed suppliers all underpin the importance of the formulated performance metrics and supplier selection in general. By doing so, the performance metrics can be finalised and be used for the selection of suppliers of Vencomatic. An overview of the final performance metrics is shown in appendix 11.

9.4. Weights

After the finalization of the performance metrics, the weight of each individual performance attribute and metric has to be defined. As shown in paragraph 5.4., the AHP methodology is the most suitable to determine these weights. Table 17 provides an overview of the determined weights. The determination of these weights is shown in appendix 12.

Reliability		
Delivery performance	20,0%	
Order fulfilment	10,5%	
Repair service	4,6%	
Management and organization	4,8%	
Subtotal		***39,9%***
Responsiveness		
Order fulfilment lead time	7,7%	
Fill rate	7,7%	
Communication system	4,7%	
Subtotal		***20,1%***
Flexibility		
Flexibility (Demand)	9,4%	
Flexibility (Stock)	9,7%	
Subtotal		***19,1%***
Costs		
Quality costs	8,0%	
Subtotal		***8,0%***
Assets		
Financial position	6,0%	
Research and development (R&D)	3,4%	
Technical capability	3,5%	
Subtotal		***12,9%***
Total		***100%***

Table 17: Weighting performance attributes and metrics

The proposed weights are discussed with the remaining two internal stakeholders, which gave the following results:

The interview with the manager warehouse showed the weighting on the different performance attributes and metrics was in line with his preference. The weighting as shown in Table 17 shows the emphasis lies on the performance attribute reliability, the metric delivery performance and order fulfilment. This has a direct impact on the processes in the warehouse.

The interview with the value chain and quality officer showed the emphasis of the metrics is in line with his preference. The weighting shows the emphasis lies on the performance metric delivery performance which focuses on the quality of the product.

In line with these interviews there can be concluded that the proposed weightings on the different performance attributes and metrics can be finalised (Table 17).

10. Supplier assessment

In this chapter, the different phases of this case study are outlined (Figure 5). First the different procurement strategies are discussed and the choice for the selected suppliers in this study is motivated. The different suppliers included in this study, as discussed in chapter 8 are deviated in the different quadrants of the Kraljic matrix. Besides, the assessment of the suppliers takes place and scores of the suppliers regarding the different performance metrics are outlined and discussed. The performance metrics to do so are discussed in chapter 9. Furthermore the decision making phase is discussed. In this chapter the third sub-research question will be answered.

10.1. Kraljic matrix

Since different performances are required for different procured goods, the evaluation of suppliers might differ. Therefore, first a division has to be made between the different goods and the suppliers of those goods. This division will be made according to the Kraljic matrix. In line with the Kraljic matrix, Vencomatic wants to develop a procurement strategy for each quadrant of the matrix.

These procurement strategies are in line with the different strategies defined in the Kraljic matrix (Kraljic, 1983) and are complemented with the remarks of two internal stakeholders.

- *Supply management (Strategic items)*: Accurate demand forecasting and long-term relationships need to be developed. A risk analysis needs to be defined and collective research and development (R&D) activities are conducted to increase performance for both parties. A Cost Improvement Program (CIP) is applied and the performances of the supplier are structurally assessed. A Service Level Agreement (SLA) is conducted to ensure the supplier has good insight in the expectations of Vencomatic. The relationship developed with these suppliers can be defined as 'Partnership'.
- *Sourcing management (Bottleneck items)*: Vencomatic needs to look for opportunities to move these product groups to the left side of the Kraljic matrix. If this is not possible, back-up plans need to be defined and the inventories need to be secured by making use of long-term contracts. Furthermore, with the suppliers of these products is dealt in the same way as is with the suppliers of strategic items, except for collective research and development (R&D). Since the difference in procurement strategies is little, relationship with these suppliers is comparable with suppliers of strategic items. Therefore, the relationships developed can also be described as 'Partnership'. This is in line with the classification used by De Boer *et al.*, (2001), since the demands on which new suppliers are selected are considered the same for strategic and bottleneck items.
- *Materials management (Leverage items)*: Product substitution and price negotiations need to take place. Order volumes need to be optimized. Competitive bidding and short term contracts can be used by Vencomatic to fully exploit their buying power. Additionally, a Service Level Agreement is conducted to ensure the supplier has good insight in the expectations of Vencomatic. The suppliers allocated in this quadrant of the Kraljic matrix are called 'Preferred suppliers'.
- *Purchasing management (Noncritical items)*: Product standardization and the volumes need to be optimized by creating large quantities. Vencomatic needs to exploit its buying power by open market negotiations. The organizations in this quadrant of the Kraljic matrix can be defined as 'Suppliers'.

A classification of all the different product groups used by Vencomatic is made in the Kraljic matrix which is composed by the three purchasing managers (appendix 14). Since not all the product groups are present in the selected end product (‘Grando’ breeder housing) used in this study (paragraph 9.3), an additional Kraljic matrix is made with the identified suppliers of the end product (Figure 7). In this Kraljic matrix, all the suppliers used in the end product are shown.

Kraljic matrix ‘Grando’ breeder housing

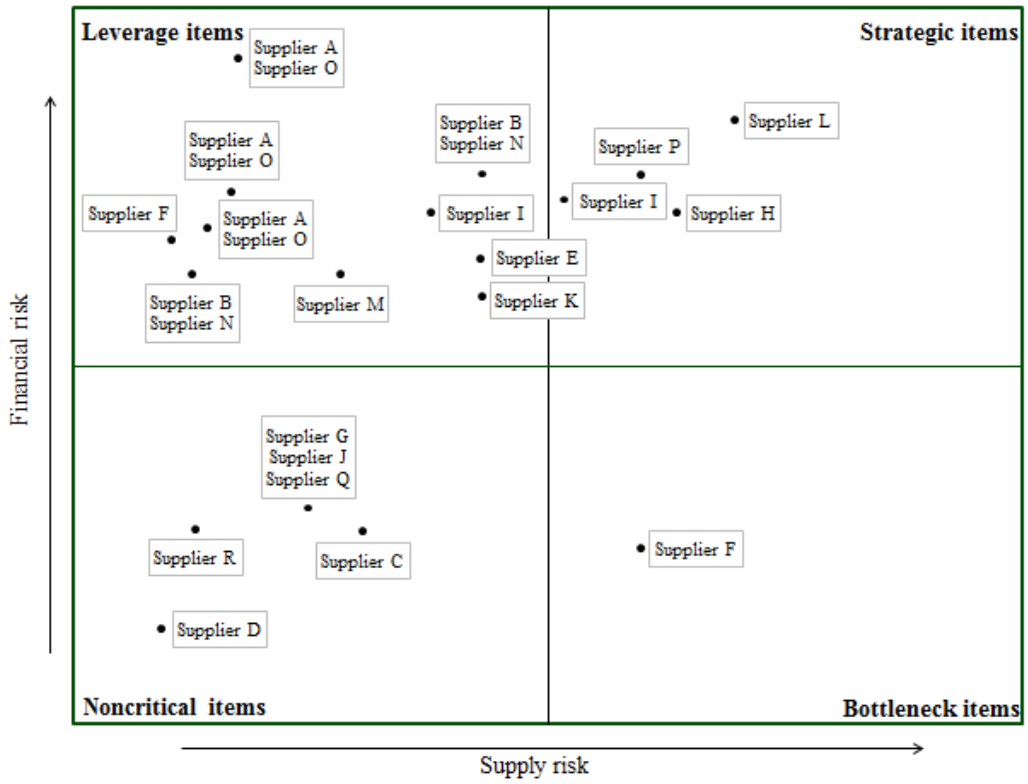

Figure 7

10.2. Assessing suppliers on performance metrics

To create insight in the performances of the suppliers of Vencomatic, suppliers are assessed on performance metrics. Since Vencomatic only has little reliable data on the performances of the suppliers regarding the performance metrics, there is decided to ask the suppliers to fill in the performances they deliver to Vencomatic. Additionally, the scores the suppliers filled in are compared with the data which Vencomatic already has available. By doing so, the third sub research question will be answered in this paragraph: *How do the suppliers perform considering the performance metrics?*

10.2.1. Supplier performances delivered to Vencomatic

Suppliers are asked to fill in scores on the performances they deliver to Vencomatic. An overview of these performances is created in Table 18. The suppliers O, P, Q and R did not cooperate in scoring themselves on the performance metrics. Therefore from now on, these suppliers are not furthermore considered.

Supplier performance															
Nr.	Metric	Quadrant Kraljic matrix													
		Leverage							Non-critical				Strategic		Bottleneck
	Supplier	*A*	*B*	*E*	*I*	*K*	*M*	*N*	*C*	*D*	*G*	*J*	*H*	*L*	*F*
1	Delivery performance	5	1	5	3	4	4	4	4	4	4	5	5	4	4
2	Order fulfilment	5	1	5	3	4	4	3	4	4	5	3	5	4	5
3	Repair service	3	3	3	5	2	5	3	3	3	-	-	3	4	5
4	Management en organization	5	3	5	5	5	5	4	4	5	5	4	5	5	5
5	Order fulfilment lead time	4	2	1	3	4	5	2	2	5	5	-	1	4	5
6	Fill rate	5	5	1	5	4	4	1	3	5	4	-	4	5	5
7	Communication system	3	2	2	5	4	3	4	4	4	3	2	3	3	5
8	Flexibility (demand driven)	3	1	2	5	3	4	3	5	5	1	-	1	4	5
9	Flexibility (stock driven)	5	5	2	5	3	4	2	5	5	5	-	5	5	5
10	Quality costs	1	5	5	4	4	4	2	4	5	3	-	4	4	4
11	Financial position	3	5	2	5	3	5	1	2	2	5	1	3	5	5
	- Cash flow	2	1	1	5	5	5	3	1	1	5	3	4	3	3
	- Current ratio	3	5	-	3	3	4	4	4	3	4	2	5	5	4
	- Quick ratio	2	5	-	1	-	2	4	3	2	3	1	5	5	2
12	Research and Development	1	5	1	2	4	5	1	1	4	1	1	3	4	2
13	Technical capability	5	5	5	4	5	5	4	5	5	4	5	5	5	5

Table 18: Performances of the supplier on the different performance metric

Note: Scale 1 (lowest score) to 5 (highest score).

The remark that has to be made is that the three sub-metrics at financial position (Table 18) are not filled in by the supplier themselves. To ensure the right values would be filled in, these values are filled in by Vencomatic, by making use of Creditsafe reports. Creditsafe is an institution, which provides reports on the creditworthiness of organizations. By making use of these reports no misunderstanding could arise on these scores, though there has to be mentioned the financial data used to assess the suppliers are from the year 2012.

As can be derived from Table 18, supplier J has six missing values, but there is no reason stated. Looking at the performance metrics which supplier J has not filled in, it can be stated that this is not due to unclearness of the metrics, because all other suppliers were able to score themselves on these metrics. Only on the metric repair service there is an additional supplier (G) who did not fill in a score. Looking at the comments of both suppliers, there is stated the repair service is not applicable to them. However, all the suppliers who deliver goods to Vencomatic need to have a procedure to deal with repairs.

Additionally, supplier E and K have not made their financial positions publicly, since their financial position is not known at Creditsafe or at the website of the organization.

10.2.2. Analysing scores

The scores of the suppliers can be analysed in different ways. By calculating the average score, some conclusions can be drawn on the average score regarding the different performance metrics.

However, by calculating the averages, no insight is created in the distribution of the scores. Therefore, the standard deviations are added to Table 19. A low standard deviation shows the distribution of the different scores is low.

Furthermore, in order to create a clear overview on the scores of the suppliers and the frequency of the scores, a frequency table (Table 19) is developed.

Nr.	Metric	Average Score	Frequency					Standard deviation
			1	*2*	*3*	*4*	*5*	
1	Delivery performance	4,0	1	0	1	8	4	1,0
2	Order fulfilment	3,9	1	0	3	5	5	1,1
3	Repair service	3,5	0	1	7	1	3	1,0
4	Management en organization	4,6	0	0	1	3	10	0,6
5	Order fulfilment lead time	3,3	2	3	1	3	4	1,5
6	Fill rate	3,9	2	0	1	4	6	1,4
7	Communication system	3,4	0	3	5	4	2	1,0
8	Flexibility (demand driven)	3,2	3	1	3	2	4	1,6
9	Flexibility (stock driven)	4,3	0	2	1	1	9	1,2
10	Quality costs	3,8	1	1	1	7	3	1,2
11	Financial position	3,4	2	3	3	0	6	1,6
	- Cash flow	3,0	4	1	5	1	4	1,6
	- Current ratio	3,8	0	1	5	5	3	0,9
	- Quick ratio	2,9	3	4	2	1	3	1,5
12	Research and Development	2,5	6	2	1	3	2	1,6
13	Technical capability	4,8	0	0	0	3	11	0,4

Table 19: Key numbers performance metrics

The metric research and development has the lowest average score. This is a consequence of 6 suppliers who have filled in the score 1 as shown in Table 19. Looking at these organizations, it shows two suppliers have stated to be a wholesaler, though this is not the complete, explaining justification, since four suppliers are production organizations. This broad range on answers explains the standard deviation which is relatively high. This metric refers to Vencomatic as looking for a specific type of suppliers, which do invest in research and development because of the innovative characteristic of Vencomatic. As can be derived from the scores, not all the current suppliers act in line with these expectations. Taking a look at the weighting of the metric (3.4%) it shows very little emphasis lies on research and development.

The metric technical capability has the highest score. This is a consequence of 11 suppliers who score themselves on the maximum score on this metric (Table 19) and therefore the standard deviation is low. This shows that all the suppliers consider themselves being capable of providing technical support and applying technical knowhow in a pro-active way. The technical capability is considered as a supplier characteristic (paragraph 2.1.2) though, there is very little emphasis on this metric since the weighting of the metric is 3.5%.

Taking a closer look to the financial metrics, the standard deviation of all the metrics, except for the current ratio, is relatively high. When taking a closer look to the individual financial metrics, the organizations which score low on the metric cash flow do not by definition perform badly on the other financial metrics. Looking at the weighting of the performance metric financial position (6.0%), there is little emphasis on this metric.

The metric flexibility for demand driven orders also has a high standard deviation, with an average score of 3.2. Looking at the frequency table (Table 19), the distribution of the scores is large since a number of suppliers score 1 and a number of suppliers score 5 on this metric. Since the distribution is large and different suppliers score high on this metrics, it shows there is potential for improvement. Possible explanations for the large distribution can be found in the manufacturing strategy handled by the supplier. As explained in paragraph 2.2., the manufacturing strategy handled by an organization has a direct effect on the lead time of the products. Looking at the weighting factor determined on 9.4%, the metric is considered as important.

The metric order fulfilment lead time also has a high standard deviation, though the average score is 3.3. As shown in Table 18, a number of suppliers score relatively low, while at the same time a number of suppliers score relatively high. Because of the large distribution and the high standard deviation, a closer look has to be taken to the scores of the suppliers. Since there is no direct explanation for the different scores of the suppliers, this metric has to be discussed more in detail with the suppliers who perform badly on this metric.

Besides looking at the key figures of the different performance metrics regarding all individual suppliers, a closer look will be taken to the scores on the performance metrics regarding the different quadrants of the Kraljic matrix.

Metric	Strategic	Bottleneck	Leverage	Non-critical
Number of suppliers	2	1	7	4
Delivery performance	4,5	4,0	3,7	4,3
Order fulfilment	4,5	5,0	3,6	4,0
Repair service	3,5	5,0	3,4	3,0
Management en organization	5,0	5,0	4,6	4,5
Order fulfilment lead time	2,5	5,0	3,0	4,0
Fill rate	4,5	5,0	3,6	4,0
Communication system	3,0	5,0	3,3	3,3
Flexibility (demand driven)	2,5	5,0	3,0	3,7
Flexibility (stock driven)	5,0	5,0	3,7	5,0
Quality costs	4,0	4,0	3,6	4,0
Financial position	4,0	5,0	3,4	2,5
- Cash flow	3,5	3,0	3,1	2,5
- Current ratio	5,0	4,0	3,7	3,3
- Quick ratio	5,0	2,0	2,8	2,3
Research and Development	3,5	2,0	2,7	1,8
Technical capability	5,0	5,0	4,7	4,8

Table 20: Average scores quadrants Kraljic matrix
Note: Scale 1 (lowest score) to 5 (highest score).

There has to be noted that the average score of the bottleneck is based on the scores of one supplier, since only one supplier is included in the analysis (Table 20). Therefore this quadrant is not taken into account during the analysis, in terms of not being generalizable. Only, issues of which can reasonably be assumed that they are related to this specific procurement strategy will be discussed.

The metric order fulfilment lead time shows large differences considering suppliers of non-critical- and strategic goods. Suppliers of non-critical goods perform much better. This can be due the fact that suppliers of strategic goods cannot afford to keep goods on stock, because of the value represented by this stock. For suppliers of non-critical items, this is a less important issue, for which these supplier do keep on stock. Whether the supplier can afford keeping on stock depends on the type of product. Therefore, the type of product is of influence on the procurement strategy applied by the buying organization (Figure 4).

On the metric financial position, the scores also differ between the different quadrants. The suppliers of strategic items score clearly better compared to the suppliers of non-critical items. Since this metric is composed by different financial metrics, these have to be taken into consideration.

On the financial position the suppliers of strategic goods score better compared to the suppliers of non-critical items. This can be derived from the fact that Vencomatic is a reasonable sized client for the suppliers of strategic items, by which a long term relationship is developed. This is not the case for the non-critical items. This is also shown by the large number of suppliers Vencomatic has.

On the current ratio the score also greatly differs in favour of the suppliers of strategic goods. Related to this, are the scores on the quick ratio. On this metric the suppliers of strategic goods perform significantly better compared to the suppliers of non-critical goods.

The considerably better financial performances of the suppliers of strategic goods can be derived from the procurement strategy applied by the clients of these suppliers. As stated in paragraph 11.2., long-term relations should be developed with suppliers of strategic goods. If these suppliers are capable of being a strategic partner for several clients, the financial cash flow is relatively certain. Opposite to this are the suppliers of non-critical goods, since their clients try to exploit their buying power as much as possible.

On the metric research and development, the scores between the suppliers of non-critical and strategic items differ. The investments in research and development of suppliers of strategic items is much larger compared to the suppliers of non-critical and bottleneck items. This can be due to the fact that the long-term relationships developed with suppliers of strategic items are aiming for the development of new goods. The long-term relationship developed between the supplier and the buying organization is of influence on the procurement strategy that will be applied (Figure 4). Additionally, the strategy (culture) within an organization, can also influence the investments in research and development are low (Figure 4). This also can be derived from the collective research and development activities that are undertaken with specific suppliers, not with suppliers of non-critical goods. This is due to the fact that these products are exchangeable with the products of other suppliers of non-critical goods and therefore the investments in research and development are lower.

10.2.3. Data from the database of income inspection

Vencomatic has data available which can be used to create insight in the performances of the suppliers. The database which is available contains data on shortcomings, observed during the income inspection. This inspection focuses only on the quality of goods delivered. Therefore, this data can only be used for the metric delivery performance, which is determined as being the most important metric of the supplier selection as shown in Table 17. By considering the data in this database, it can be analysed whether the performances the suppliers have filled (Table 18) are in line with the performances measured by Vencomatic.

Product type	Supplier	Number of orders with delivery date in 2013	Number of quality complaints in 2013	Measured Delivery performance	Stated delivery performance	Difference in delivery performance
Leverage	A	72	13	81,9%	> 99%	***-17,1%***
	B	157	4	97,5%	No track of complaints	-
	E	249	13	94,8%	> 99%	***-4,2%***
	I	128	16	87,5%	> 95%	***-7,5%***
	K	4	-	100,0%	> 98%	***+2,0%***
	M	213	21	90,1%	> 98%	***-7,9%***
	N	266	101	62,0%	> 98%	***-36,0%***
Non-critical	C	21	8	61,9%	> 98%	***-36,1%***
	D	217	7	96,8%	> 98%	***-1,2%***
	G	9	1	88.9%	> 98%	***-9,5%***
	J	8	5	37,5%	> 99%	***-61,5%***
Strategic	H	37	5	86,5%	> 99%	***-12,5%***
	L	85	22	74,1%	> 98%	***- 23,9%***
Bottleneck	F	258	53	79,5%	> 98%	***-18,5%***

Table 21: Delivery performance according to data Vencomatic

As shown in Table 21, the performances of the suppliers are worse than stated by the different suppliers. The supplier that performs best is supplier K who scores 100%. Though, there has to be taken into account the supplier had four deliveries in 2013. Nevertheless, this is the only supplier who scores better than stated.

The supplier performing second best is supplier B (Table 21). Though, when looking at the scoring of the supplier (Table 18), the supplier scores worst. This is a consequence of not keeping track of the complaints of Vencomatic. The performance of supplier B is 97,5% which would be a score of 3 by the performance metric (appendix 11).

Taking a look at the least performing suppliers, supplier J had complaints on the quality of the products on more than half of the orders. In addition, 9 out of 14 suppliers have a delivery performance below 90 %.

Looking at the cause of these performances (Table 22) is composed. This table (Table 22) shows the specifications of the shortcomings.

Specification	*Supplier*														
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*O*	*Total*
Technical	6	2	8	5	10	17	-	4	8	5	-	11	13	63	152
Packaging	2	-	-	-	1	-	1	-	5	-	-	2	-	2	13
Incorrect goods	1	-	-	-	-	7	-	-	-	-	-	4	2	8	22
Damage during transport	-	-	-	-	-	-	-	-	-	-	-	2	-	3	5
Incorrect number of goods	2	2	-	2		29	-	1	3	-	-	3	6	25	73
Total	11	4	8	7	11	53	1	5	16	5	-	22	21	101	265

Table 22: Specification comments database Vencomatic

Taking a closer look to Table 22, it is shown that 57% of the comments on delivered goods are related to technical specifications. One of the most important explanations can be derived from the strategy of Vencomatic and how this strategy is refined into the business- and operational processes. Vencomatic presents itself as a very innovative organization. Because of this innovative characteristic, Vencomatic invests up to 3%[1] of its turnover into research and development. Because of this research and development, new products are developed, which need to be produced by different suppliers. Since these products are developed by Vencomatic, they are custom made and therefore most of the time not standard products for the supplier.

10.2.4. Conclusion on the performances of the suppliers

Looking at the performances of all the suppliers, there is best performed on the metric management and organization and technical capability (Table 19). The high scoring on the metric management and organization can be justified by the norms and values which are considered standard within the Netherlands and even Northern Europe. Since all the suppliers are based in Northern Europe, this explains the high values.

Additionally, the scoring on the technical capability is high. This shows that all the suppliers consider themselves having all the technical knowledge needed and applying this knowledge in a pro-active way. It is hard to justify this high score since it might be assumed that all suppliers think they have the knowledge and act in a pro-active way. However, such behaviour is hard to define, without having a relation with the supplier.

The performances of the different quadrants of the Kraljic matrix also show some differences. The supplier of strategic items score highest on all the performance metrics except for the performance metrics: order fulfilment lead time, communication system and flexibility (demand driven).

The suppliers who deliver strategic items score lowest on the order fulfilment lead time. This is possibly caused by the fact that these suppliers produce make-to-order (paragraph 2.2.), though the production of the goods takes place in batches which are produced every three weeks (external stakeholder H, I, L, E, K). By producing like this the production time increases.

The score on the communication metric is remarkable since long-term relationships are developed with these suppliers. This can possibly derived from the fact that the products that these suppliers deliver are valuable and therefore the number of orders is lower compared to suppliers of non-critical

[1] Key financial figures Vencomatic 2010-2013

items. Possibly because of this lower number of orders, it is not profitable to do the investment for this type of communication.

On the metric flexibility (demand driven), the scores of the suppliers of strategic items are the lowest of the four quadrants. This can possibly be ascribed to the same reasoning as is done to the order fulfilment lead time.

Taking a closer look to the performances of the individual suppliers, there are a few suppliers who stand out regarding their scores. Supplier L scores relatively high (score 3, 4 or 5) on all the metrics, supplier K and M only score on one metric relatively low (score 1 or 2). When taking an additional look at the actual performances of the suppliers according to the data of Vencomatic (Table 21), it shows only supplier K has a score which was anticipated for (> 95%). Supplier M scores lower and supplier L scores much lower than the performances they filled in themselves on the metric delivery performance.

Since no more reliable data is available at Vencomatic, the conclusions have to be drawn based on these findings. These findings show that in general the suppliers think they perform considerably better on the performance metrics than they actually do according to the data of Vencomatic. This can be a consequence of not having insight in the performances delivered.

Additionally, it can be questioned whether all the suppliers filled in the realistic performances or instead filled in, unrealistic, high scores. The fact that the suppliers were informed of the fact the performance metrics would be used for supplier selection and -evaluation, could explain the high scores.

10.3. Decision making

In the decision making phase a decision is made on the selection of the supplier. Before a supplier can be defined as potential supplier, they have to cope with the knock-out metrics. These knock-out metrics are defined in line with the comments of the internal stakeholders on the practical determination of the performance metrics. The knock-out metrics defined are shown in table 23.

Metric	Minimum performance
Knock-out metrics	After discussion, there is decided to agree with the comment on the knock-out metrics and corresponding scores. The potential suppliers at least have to meet these knock-out metrics to be eligible to become a supplier of Vencomatic. The scores the suppliers have to score minimally are discussed and determined in cooperation with the internal stakeholders.
- Management and organization	The supplier has to score at least 2 points on this metric.
- Communication	The supplier has to score at least 2 points on this metric.
- Financial position	The supplier has to score at least 2 points on this metric. This metric includes the financial position, cash flow, current ratio and the quick ratio. These sub-metrics together account for the metric financial position, which allows them to compensate for one another.

Table 23: Knock-out metrics

This decision is based on the performances of the supplier on the different performance metrics and additionally on the aspect of price. The combination of these two aspects is in line with the comment on the practical determination of the performances of the suppliers (appendix 13) of one of the internal stakeholders.

After the decision on the supplier is made, there has to be checked whether the performances delivered by the supplier are in line with the agreed performances on which the supplier is selected. The monitoring of the performances of the suppliers can be referred to as the evaluation of suppliers. Therefore, the decision on the selection of a supplier and the monitoring of the performances of the supplier are closely related.

Where the performances of suppliers should be evaluated, the frequency and the performances on which suppliers are evaluated need to be clearly defined. The performances of the suppliers should be evaluated on three different levels. These levels of evaluation are based on the experience of the purchasing manager of Vencomatic.

The first level of supplier evaluation is on a yearly basis and the same performance metrics are used for this evaluation as in the supplier selection phase. The yearly evaluation of the performance metrics is carried out on a strategic level in which different departments of Vencomatic are present: purchasing, quality and logistics. Additionally, if the supplier is not able to deliver the performances as indicated, Vencomatic can decide either to start with the supplier development program (paragraph 5.3) or to break the contract and to start looking for a new supplier.

Although, the suppliers can be evaluated on the performance metrics on a yearly basis, this frequency is not enough to gain insight in the detailed performances of the supplier. An adjustment in the supplier's performances should be discussed timely. Therefore, there is decided - in agreement with the internal stakeholders - on a second level of supplier evaluation. This evaluation takes place on a quarterly basis and four performance metrics are used. The performance metrics used to evaluate suppliers quarterly are (Table 24):

Metrics	Underpinning
Delivery performance	As shown in the weight of this metric, it is considered very important. Therefore this metric is used during the quarterly evaluation.
Order fulfilment	The weight of the performance metric shows the internal stakeholders consider the order fulfilment as an important metric to evaluate suppliers on.
Order fulfilment lead time	Although the metric order fulfilment lead time is considered important, the weight of the metric cannot be considered very high (Table 17). Though, this metric is crucial since it directly influences the lead time of the products of Vencomatic.
Fill rate	The metric fill rate is considered as important as the metric order fulfilment lead time. In line with the metric order fulfilment lead time, the performances on the metric fill rate directly influence the lead time of the products of Vencomatic.

Table 24: Overview of the quarterly evaluation metrics

These particular performance metrics are used for the quarterly evaluation since they give a good and representative overview of how the supplier is performing. Additionally, these performances directly influence the internal processes within Vencomatic. Furthermore, these performance metrics are chosen due to the effectiveness of generating the data and the availability of personnel.

The evaluation of these performance metrics can be seen as the evaluation of the suppliers on tactical level. The purchasing department is always present during this evaluation. In case that the supplier is not performing in line with the agreed standards, the quality and/or logistics department are additionally present during the meeting.

Furthermore, during the day to day business there is contact between the supplier and Vencomatic to put in orders, answer questions and deal with complaints. This communication is handled by the purchasing department and can also be seen as a type of evaluation. This level of evaluation can be described as the evaluation of suppliers at operational level.

Evaluation level	Frequency	Standard present	Optional present	Performance metrics used
Strategic	Once a year	- Purchasing - Quality - Logistics	- Corporate management	Table 28
Tactical	Quarterly	Purchasing	- Quality - Logistics	Table 24
Operational	Day to day business	Purchasing	-	-

Table 25: Types of supplier evaluation applied by Vencomatic

Table 25 gives an overview of the different types of evaluation that should be applied by Vencomatic. By applying different levels of supplier evaluation, insight in the performances of the suppliers of Vencomatic is created and deviations can be detected timely.

11.Supplier performance improvement

In this chapter a reflection is made on the results discussed in paragraph 11.2. Since in the methodology part (paragraph 9.1) is stated a more comprehensive approach will be used in this study, in the first part of this chapter the deviation of the Kraljic matrix is handled. By doing so, suggestions can be formulated on how to improve the performances of the suppliers. Furthermore, a broader view is taken into consideration to come up with recommendations for Vencomatic to improve the performances of its suppliers. To do so, the different phases of this case study (Figure 5) are discussed and recommendations are given to improve the processes and increase the performances of the suppliers of Vencomatic. In this chapter the fourth and fifth sub-research question will be answered.

11.1. Supplier performance improvement

This paragraph reflects on the results which are discussed in paragraph 11.3. As shown in the different stages of supplier selection and –evaluation (Figure 5), a deviation between the different suppliers is based on the procurement strategy that is applied. By doing so the fourth sub-question can be answered: *How can the performances of the suppliers be improved?*

11.1.1. Strategic items

Order fulfilment lead time

The performances regarding order fulfilment lead time of suppliers of strategic items should be improved. It is important these performances are improved since these performances directly affect the amount of stock at Vencomatic. To improve the performances regarding this metric, there should be clarity among Vencomatic and its supplier about the production method and the effects on order fulfilment lead time. Furthermore, insight in the stock levels at different stages of the supply chain is important. By having insight in the different stock levels, these levels can be adapted to create the best stock levels.

Flexibility (demand driven)

Performances regarding demand driven flexibility of suppliers of strategic items should be improved. The improvement of flexibility decreases the lead time of the products sold by Vencomatic. To increase these performances, the suppliers should bring down the setup times for the production of the different batches. Additionally, the size of these batches should be decreased to be able to switch between batches more quickly. Vencomatic cannot directly influence the performances on flexibility of the suppliers. Though, Vencomatic can minimize the number of orders that require these performances of the supplier, by ordering timely.

Looking at the weight of the discussed performance metrics, it is important the performances of the suppliers of strategic items improve.

11.1.2. Bottleneck items

Quick ratio

The performances regarding the quick ratio of the suppliers of bottleneck items can be improved. The quick ratio gives an indication of the financial health of an organization. It shows if the organization is capable of fulfilling its obligations regarding current liabilities by the current assets. The quick ratio is closely related to the current ratio except for taking into account the stock values. These stock values are taken into account by the quick ratio though the current ratio does not account for them. Since part of these stocks are often needed for the organization to function normally, these stocks cannot be sold that easy. Therefore, these stocks cannot be taken into account to fulfil the obligations of current liabilities. To improve the quick ratio, the supplier can pay off the current liabilities and increase its cash position. Vencomatic cannot directly influence the quick ratio of the supplier.

Research and development

The research and development performances of suppliers that produce bottleneck items should be improved. The research and development metric gives insight in what priorities the supplier has. Vencomatic is looking for suppliers who are investing in research and development. To improve the performances of the suppliers on this metric, Vencomatic has to show the emphasis of them towards research and development. By doing so, the (pro-) active suppliers will act on that. Vencomatic can show their preference to suppliers with high investments in research and development by increasing the amount of business.

11.1.3. Leverage items

Quick ratio

The performances of the supplier of leverage items should be improved. These performances can be improved in the same way as stated in the sub-paragraph quick ratio at the bottleneck items.

Research and development

The supplier of leverage items should improve the performances regarding the research and development. At sub-paragraph research and development at bottleneck items is stated how to improve these performances, though the procurement strategy should be kept in mind.

11.1.4. Non-critical items

Financial position

Performances of the suppliers of non-critical items regarding the financial position can be improved. It shows the suppliers of non-critical items have generated a turnover below 15% in 2013 at Vencomatic. To improve this performance, these suppliers have to ensure their product portfolio is comprehensive enough for Vencomatic to order more goods at these suppliers. Additionally, the prices of these products have to be competing with the suppliers' competitors.

The actions taken by Vencomatic should be in the form of combining orders to increase buying power. The amount of business being done with suppliers of non-critical items should be increased and therefore the amount of different suppliers should be decreased.

Cash flow

The suppliers of non-critical items should improve the performances regarding the cash flow. The cash flow of a potential supplier refers to the net result of the organization in the past years. By having a positive net result for the past few years, the organization shows it is capable of generating revenues and therefore creates the possibility to increase its financial health.

The remark that has to be made is, if the organization decides to invest, on one hand this brings down the cash flow, while on the other hand this investment might improve other performances of the organization. To improve the performances regarding cash flow, the supplier can decide to bring down the costs within the organization or increase the margin on the sold goods and therewith the profit. Vencomatic cannot directly influence the performance of the supplier regarding this metric.

Quick ratio

The performances of the suppliers of non-critical items regarding the quick ratio should be improved. These performances can be improved in the same way as described at the sub-paragraph quick ratio at the bottleneck items.

Research and development

The research and development performances of supplier which produce non-critical items can be improved. Although these performances can be improved as described at the sub-paragraph research

and development at bottleneck items, the type of procurement strategy should be kept in mind to ensure the importance of this metric.

11.1.5. Conclusion improvement performances suppliers

To improve the performances of the suppliers, a number of suggestions are made. These suggestions are based on the different quadrants of the Kraljic matrix.

As can be derived from above, the quick ratio should be improved at all the different quadrants, except for the suppliers of strategic items. It is difficult for Vencomatic to influence the performances of the suppliers on this metric, since it cannot be influenced directly by Vencomatic. Since, it is hard for Vencomatic to improve these performances of the suppliers, there should be paid attention to this metric during the selection of suppliers.

The metric on research and development is also mentioned in all the quadrants of the Kraljic matrix except for the suppliers of strategic items. This shows the suppliers who have a long-term relationship with Vencomatic (suppliers of strategic items) know the importance of this metric according to Vencomatic. The other suppliers might not have such a close relationship with Vencomatic and therefore do not have enough insight in this preference. By the performance metrics defined in this study, Vencomatic shows the metrics on which suppliers should perform. By including the metric research and development, the importance Vencomatic assigned to this topic is shown.

11.2. Recommendations

To formulate recommendations for Vencomatic to improve the performances of its suppliers, a broader view has to be taken to consideration. The procedure of selecting and evaluating new suppliers is described below. Additionally, at the different stages recommendations, the fifth - and last- sub-question can be answered: *Which recommendations can be made to improve the logistical performances of the suppliers of Vencomatic?*

- *Determine procurement strategy (Kraljic matrix)*

Before Vencomatic decides to purchase certain goods, a closer look has to be taken to the type of goods that have to be procured. By classifying the goods in the different quadrants of the Kraljic matrix, there can be decided on the procurement strategy that has to be applied. This procurement strategy is essential, since it is closely related to the type of relationship that will be developed with the supplier. Additionally, the characteristics of the supplier have an influence on the procurement strategy, so these characteristics also have to be taken into consideration. After there is decided upon the procurement strategy, the potential suppliers can be selected.

- *Apply supplier selection*

Vencomatic sets requirements to its suppliers. To ensure the suppliers are capable of dealing with these requirements, supplier selection needs to be applied. After determination of the procurement strategy there can be looked after potential suppliers. These potential suppliers are assessed by the performance metrics as shown in appendix 11. Additionally, the potential suppliers need to meet the requirements of the knockout criteria, to be allowed to become a supplier. The potential suppliers that meet these requirements need to fill in the performances they will deliver to Vencomatic. The potential suppliers need to underpin the performances they fill in, by performances delivered at other clients. The three suppliers who score themselves best on these performance metrics are asked to come up with a price. The final choice of the supplier will be based on the technical-content performances (appendix 11) and the price.

- *Communication*

If the supplier is selected, it is essential the supplier has insight in the performances Vencomatic expects. Depending on the type of goods procured, a contract is settled between the supplier and Vencomatic. In this contract, specifications are made on price and general purchase conditions. Additionally, specifications and requirements need to be defined, to ensure the supplier has insight in the performances that are expected (e.g. technical specifications, delivery times). These requirements and specifications are defined in a Service Level Agreement.

- *Measure supplier performances*

If the supplier is selected and the specifications and requirements are clear, Vencomatic has to create insight in the performances of the supplier. Insight in the performances is created by supplier evaluation. Vencomatic has to look critically to how insight in the performances of the suppliers will be created. The systems used by Vencomatic, have to be equipped in such a way it produces reliable data on the performances of its suppliers.

The type of evaluation will take place as shown in Table 25. During the strategic level of supplier evaluation, the performance metrics formulated in appendix 11 are used. At the tactical level of supplier evaluation, four performance metrics are used for the evaluation (Table 24) of supplier evaluation. Supplier evaluation at operational level takes place on a day-to-day basis, for which no performance metrics are used. Though, the potential shortcomings identified during the day-to-day basis are registered, to take into consideration during tactical and strategic supplier evaluation. By regular interaction between the supplier and Vencomatic about the performances delivered, performances can be adjusted timely.

- *Responsibilities*

When the insight in the performances of the suppliers is created, it is important to have a clear view on who is allowed to take actions if the performances of the supplier are not in line with the agreements made. The different levels of supplier evaluation can have different consequences:

  - Operational level: essential is clarity on who is allowed to disapprove orders if they are physically delivered to Vencomatic. If the goods are delivered and do not meet the set requirements, the quality officer needs to be allowed to disapprove an order and send it retour to sender. Disapprovement of an order needs to be done in consultation with the purchasing department.
  - Tactical level: evaluation of suppliers at tactical level is done on a quarterly basis. The purchasing department will always be present during this meeting and, when needed, the quality and/or logistics department join. If the supplier has any shortcomings, these will be discussed during this meeting. If needed during this meeting, it can be decided to start with the supplier development program (paragraph 5.3). During this meeting the performance metrics discussed in Paragraph 11.1., should be taken into consideration.
  - Strategic level: The supplier evaluation at strategic level is on a yearly basis. During this meeting, the performance metrics (appendix 11) are used. The purchasing, quality and logistics department are all present during this meeting. If the supplier is not performing in line with the requirements, this is discussed during this meeting. Additionally, the Cost Improvement Program (CIP) is discussed. If the supplier does not meet the standards as stated during the selection, in this meeting can be decided to look for a new supplier.

- *Cooperation with suppliers*

During the interviews, different suppliers stated they wanted to increase the cooperation with Vencomatic to further optimize the relationship. By taking into account the procurement strategy Vencomatic wants to apply to this supplier, in case of strategic items there should be decided to increase the cooperation. This cooperation can have different forms:

- Product development: by cooperation during the development of new products, increased efficiency can be achieved through involvement of the supplier in an early stage. By doing so, the technical specifications can be developed in such a way the product is easy to produce and therefore less costly.
- Stock optimizing: a number of suppliers have stated to keep a number of specific products for Vencomatic on stock, to be able to always fulfil the demand of Vencomatic. Additionally, Vencomatic has a number of products if keeps on stock. By creating insights in the different stock-levels in the supply chain, these stocks can be optimized.

12. Discussion

This study aims to come up with an advice to improve the performances of suppliers. The study is conducted on behalf of Vencomatic and is performed in the form of a case study. The input of this study consists of: literature, interviews with internal stakeholders, employees, comparable organizations and suppliers and discussions which are held with internal stakeholders to process the input.

Looking at existing literature, it is remarkable that the topic of supplier performance is discussed without any direct link towards the subjects of procurement management and supply chain management. In this way, literature seems to do not take into consideration the influences of these two latter subjects on supplier performance. However, this study shows that these subjects are related to each other. Whereas supply chain management is a broad area of knowledge, procurement management is already more focused and even more specific is the topic of supplier performance. Without discussing these broader and more comprehensive topics and taking into account the influences those subjects can have, it is hard to increase the performances of suppliers. In order to become able to measure any performances of suppliers, an organization should determine requirements it wants the suppliers to meet. These specific requirements depend on the different operational, business and corporate goals the buying organization has. Furthermore, as shown in the theoretical framework of this study, the emphasis of supplier performance differs among the procurement strategy a buying organization applies. Considering this, it can be derived that supplier performance is not just a standalone subject.

Another remarkable topic discussed in literature is about supplier selection and supplier evaluation. On one hand, existing literature distinguishes supplier selection and supplier evaluation as two separate subjects. On the other hand, these subjects are discussed together, as being interrelated to each other and seen as one total concept. Since the selection as well as evaluation of suppliers comprehends similar activities at different moments, both ways of reasoning can be considered as being competent. Nevertheless, in terms of a practical approach - like in this study - it is best applicable to not distinguish supplier selection and supplier evaluation in all stages of supplier assessment. As shown in this study, it is important to define performance metrics which cover criteria on both supplier selection and supplier evaluation. Therefore, by determining performance metrics, the subjects of supplier selection and supplier evaluation should be seen as one same subject. However, this study demonstrates the use of different criteria for different purposes. Within the stage of supplier selection all performance metrics are taken into account by assessing the suppliers, as well as in the stage of yearly evaluation. But in the stage of intermediate evaluations, only several specific metrics are considered. This is done in order to ensure the manageability and accessibility of supplier evaluation. Evaluating all suppliers quarterly based on all performance metrics would be too intensive in terms of organizational practicality. So, whereas literature explains both subjects in a combining way as well as in a distinguishing way, this study argues to consider these subjects either combined or separated depending on the stage of supplier assessment.

13. Conclusion

The general conclusion will be derived from all the conclusions regarding the sub-questions. By considering these answers, a broad view has to be taken towards supplier performances. In this chapter the main question will be answered: In what way can Vencomatic improve the logistical performance of its suppliers?

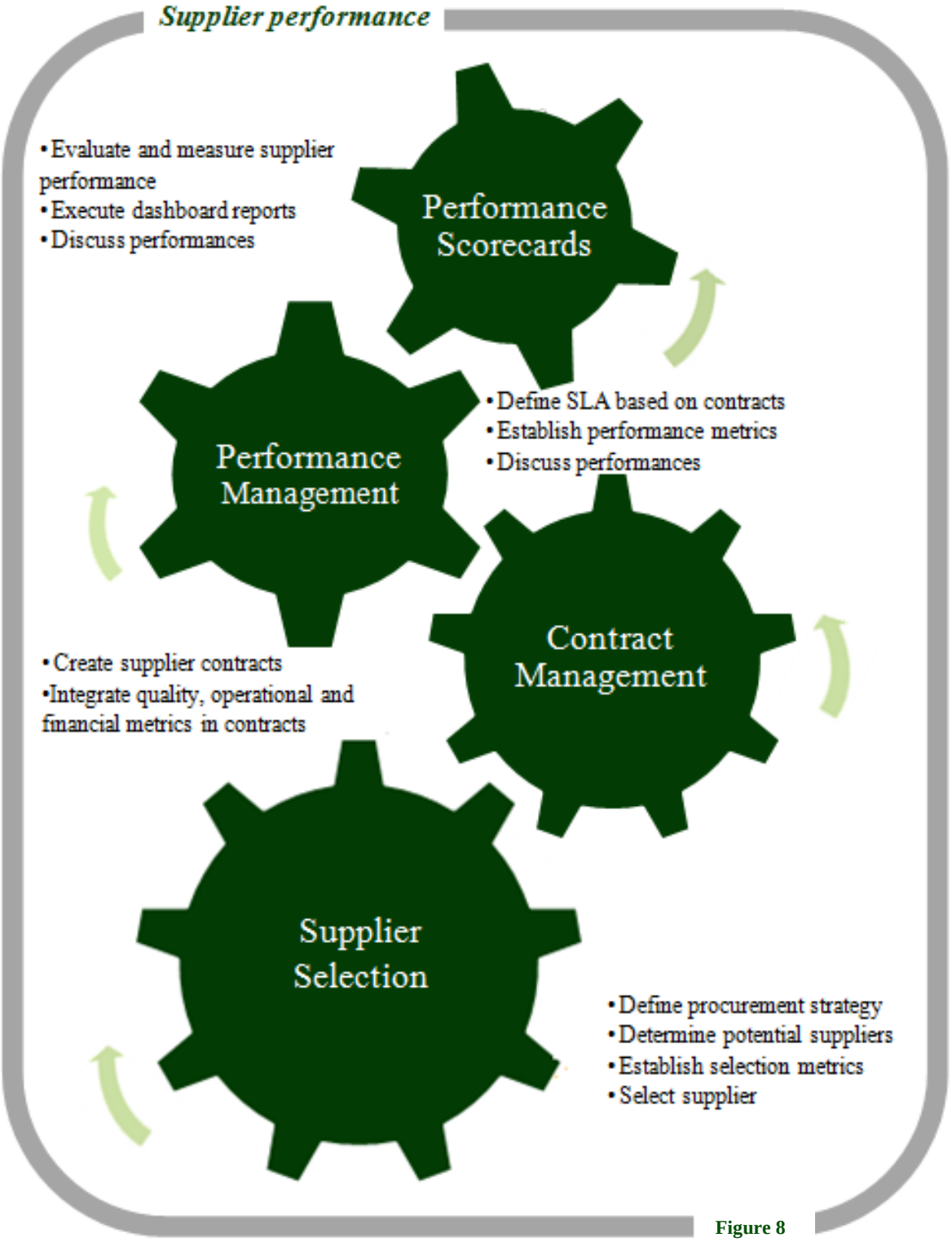

Figure 8

Answering the main question of this study will be done by making use of Figure 8. This figure gives a schematic overview of the different steps Vencomatic needs to take to improve the performances of its suppliers.

Supplier selection
To improve the performances of its suppliers, Vencomatic has to start questioning what kind of suppliers it needs and wants. This should be derived from the strategy which is handled by Vencomatic regarding its products. The innovative strategy applied by Vencomatic should be recognized and appreciated by its suppliers. By translating this strategy into the different procurement strategies applied by Vencomatic, a selection of suppliers can be made. The different procurement strategies are defined in accordance with the Kraljic matrix. The procurement strategy that should be applied by Vencomatic is determined by the characteristics of the potential supplier, the type of product procured and the relationship with the potential supplier. After determination of the right procurement strategy, the potential suppliers can be selected, by making use of the performance metrics defined in appendix 11.

Contract management
After the supplier is selected, the agreed contract is the basis for the performances the supplier and Vencomatic need to deliver. Within this contract, the purchasing conditions are defined. Additionally, agreements regarding quality, delivery and price are set within a Service Level Agreement. It is crucial this contract contains all the agreements made, the performances expected to create clarity and a clear basis on which the relationship between Vencomatic and the supplier is based.

Performance management
Once clarity is created on the performances expected from both parties, physical deliveries can be carried out. Measurements are made regarding these physical deliveries to create insight in the performances. The performances delivered need to be in line with the agreements made in the contract. To create insight in whether these performances are in line, the performance metrics defined in appendix 11 are discussed on a yearly basis. During this discussion the performances are evaluated and potential shortcomings are detected and discussed. If there are shortcomings, depending on the deviation of the agreed performances, there can be decided to ask the supplier to come up with an improvement plan, start with a supplier development program or look for a new supplier. Depending on the procurement strategy and the size of the deviation, there can be decided how to improve the performances.

Performance scorecards
Although the performances of the suppliers are discussed on a yearly basis, this frequency is not enough if performances deviate significantly from the agreed performances. Therefore, Vencomatic should assess the supplier on the performance metrics defined in paragraph 11.1 on a quarterly basis. By assessing the suppliers quarterly, Vencomatic is faster able to address these performances to the supplier and measures can be discussed to improve these performances.

As can be defined from the described steps above, it is a complete process Vencomatic has to work with to improve the performances of its suppliers. By selecting the right suppliers which fit the defined procurement strategies, improvements on the performances will be made. It is crucial for Vencomatic to take into consideration all these steps and not just one, since the process as a whole potentially improves the performances of suppliers.

Limitations

Despite the careful execution of this study, some limitations should be outlined. The results of this study come from a single case. Therefore, the results are not directly generalizable. However, the aim of this study was to give recommendations to Vencomatic, in order to improve the performances of its suppliers. Considering this, the aim of this study serves only one case, in which generalizability was not intended.

Besides, the supplier assessment was carried out by the suppliers themselves. They were asked to score themselves on the different performance metrics, by reflecting on the performances they deliver to Vencomatic. As results shown, several suppliers scored their performances on a higher level than actually was the case. Although a more objective way of scoring (reliable measurements from Vencomatic) might have created different insight in the supplier performances, the choice of assessing this way was well considered on forehand. Assessing suppliers by an internal employee would result in a standard – like always done – way of assessing suppliers, while the aim of this study is to improve this process.

The different performance metrics emphasise different performance metrics. Due to the fact that Vencomatic does not use any formal ways of assessing supplier performance, there is decided to first define the performance metrics and start assessing suppliers on these metrics. Since the time period of this study was limited, this differentiation is not carried out.

Additionally, the representation of bottleneck products is limited while only one supplier of bottleneck products is assessed. Because of the approach used to identify suppliers based on an end product, produced by Vencomatic, the representation of all product groups could not be manipulated. Although a high representation could not be established, there was chosen to ensure a representation of all product groups at least on a minimum level of one supplier per product group.

Directions for future research

Because of the single case approach of this study, the results are not generalizable. In order to become able to generalize findings, it might be interesting to execute the research on a broader scale. More cases should be used to define overall performance metrics applicable in different contexts.

Next, it would be interesting to investigate the long term effects of the determined performance metrics and the use of those metrics. In this way, the practical application of supplier selection and supplier evaluation by using this method can be examined. When this method of supplier selection and supplier evaluation is considered to be applicable and worthy, the process can be standardized within the organization.

Furthermore, as shown in the results, a buying organization does not have (much) direct influence on the financial situation of its suppliers. A research towards potential influences a buying organization can have on the financial situation of its suppliers would contribute to the practical and theoretical area of supplier performance management.

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Appendices

Appendix 1 Overview selection criteria

Dickson 1966	Criteria	Review of (Weber *et al.*, 1991)		Review of (Cheraghi *et al.*, 2011)		Review of (Deshmukh and Chaudhari, 2011)		Review (JE and Thiruchelvam, 2011)		Total	
Publishing year articles		1966-1991		1990-2001		1992-2007		2001-2010			
Rank		*Rank*	*Number of articles*	*Rank*	*Number of articles*	*Rank*	*Number of articles*	*Rank*	*Number of articles*	*Rank*	*Number of articles*
1	Quality	3	40	1	31	2	42	1	37	2	150
2	Delivery	2	44	2	30	3	37	3	36	3	147
3	Performance history	9	7	12	4	7	5	14	10	10	26
4	Warranties and claim history	23	-	-	-	13	2	21	5	24	7
5	Production facilities and capacity	4	23	6	10	4	22	6	20	4	75
6	Price	1	61	3	26	1	44	1	37	1	168
7	Technical capability	6	15	4	11	5	16	4	24	5	66
8	Financial position	9	7	7	7	6	15	9	17	6	46
9	Procedural compliance	15	2	14	2	13	2	-	-	25	6
10	Communication system	15	2	12	4	7	5	18	7	14	18
11	Reputation and position in the industry	8	8	29	1	12	3	17	8	11	20
12	Desire for business	21	1	-	0	21	-	29	2	33	3
13	Management and organization	7	10	7	7	7	5	5	22	7	44
14	Operating controls	13	3	-	0	7	5	-	-	22	8
15	Repair service	9	7	4	11	13	2	12	11	9	31
16	Attitude	12	6	11	5	19	1	19	6	14	18
17	Impression	25	2	14	2	21	-	24	4	22	8
18	Packaging ability	13	3	-	0	13	2	24	4	19	9
19	Labour relations record	15	2	30	1	13	2	19	6	17	11
20	Geographical location	5	16	14	2	7	5	10	12	8	35

Dickson 1966	Criteria	Review of (Weber *et al.*, 1991)		Review of (Cheraghi *et al.*, 2011)		Review of (Deshmukh and Chaudhari, 2011)		Review (JE and Thiruchelvam, 2011)		Total	
Publishing year articles		1966-1991		1990-2001		1992-2007		2001-2010			
Rank		*Rank*	*Number of articles*	*Rank*	*Number of articles*	*Rank*	*Number of articles*	*Rank*	*Number of articles*	*Rank*	*Number of articles*
21	Amount of past business	21	1	-	0	21	-	29	2	33	3
22	Training aids	15	2	-	0	13	2	-	-	29	4
23	Reciprocal agreements	15	2	14	2	19	1	-	-	26	5
New	Reliability	-	-	9	-	-	-	12	11	17	11
New	Flexibility	-	-	10	-	-	-	7	19	12	19
New	Consistency	-	-	14	-	-	-	-	-	-	0
New	Long-term relationship	-	-	14	-	-	-	24	4	29	4
New	Process improvement	-	-	20	-	-	-	10	12	16	12
New	Product development	-	-	21	-	-	-	7	19	12	19
New	Inventory costs	-	-	22	-	-	-	-	-	-	0
New	JIT	-	-	23	-	-	-	21	5	26	5
New	Quality standards	-	-	24	-	-	-	-	-		0
New	Integrity	-	-	25	-	-	-	21	5	26	5
New	Professionalism	-	-	26	-	-	-	24	4	29	4
New	Research	-	-	27	-	-	-	-	-	-	0
New	Cultural	-	-	28	-	-	-	-	-	-	0
New	Environmental and social responsibility	-	-	-	-	-	-	15	9	19	9
New	Occupation safety and health	-	-	-	-	-	-	24	4	29	4
New	Commitment	-	-	-	-	-	-	15	9	19	9
New	Economy situation	-	-	-	-	-	-	32	1	36	1
New	Political situation	-	-	-	-	-	-	29	2	35	2

Table 26: Overview selection criteria

Appendix 2 Multi criteria decision making techniques

Linear weighting model

By far linear weighting models are the most applied approach to deal with supplier selection (Weber *et al.*, 1991; Vokurka *et al.*, 1996). The linear weighting models place weights on the different criteria. The biggest weight indicates the highest priority (De Boer *et al.*, 2001). Deriving these weights is done by an assessment procedure. Decision makers can evaluate the criteria in terms of importance. By assigning weights to the different criteria a total score for each supplier can be calculated. Linear weighting models are able to deal with incomplete, qualitative and unstructured purchasing situations. Examples of linear weighting models are:

- Linear weighting models: Weightings are assigned to each criterion. The highest weighting indicates the highest importance. The suppliers are assessed to these criteria; the highest ranked supplier should be selected.
- Quasi-compensatory models: In a linear weighting model a high score on one criterion can compensate a low score on another criterion. In a quasi-compensatory model this compensation is not possible. These models can also be applied in the pre-qualification phase (De Boer *et al.*, 2001).
- Analytical Hierarchical Process (AHP): The AHP model continuous on the Quasi-compensatory models. Additionally the AHP model makes use of pair-wise comparison to determine the weights of the different criteria. By applying the AHP model, only a verbal, qualitative statement regarding the importance of one criteria versus another is needed to rank the alternatives (De Boer *et al.*, 2001).
- Analytical Network Process (ANP): The ANP model is generalised of the AHP model. The ANP model is capable of incorporating relationships of different factors into the model. The AHP model is a starting point for the ANP model (Pal *et al.*, 2013).
- Fuzzy Sets Theory (FST): The FST model offers a way to model preferences into setting weights for the different criteria (De Boer *et al.*, 2001).
- Multiple Attribute Utility Theory (MAUT): This technique is used for international supplier selection and is capable of handling multiple conflicting attributes (Tahriri *et al.*, 2008).
- Total Cost of Ownership (TCO): This technique summarizes and qualifies costs associated with supplier selection accountable for the purchased items during its life cycle. This technique is only applied to relatively simple cases, because it is a complex method (De Boer *et al.*, 2001; Tahriri *et al.*, 2008).

Mathematical programming models

Mathematical programming offers a mathematical way of dealing with the supplier evaluation problems. A mathematical objective function has to be formulated to maximize profit or minimize costs, which will be solved by changing the variables in the objective function. An advantage of the mathematical programming models is that the objective function has to be formulated which makes the objective explicit. A disadvantage of the mathematical programming models is that only quantitative criteria are considered. The mathematical models assume predetermined levels on quality and service (De Boer *et al.*, 2001). Examples of mathematical programming models are:

- Mixed integer programming: These models deal with optimization problems involving two or more criteria (Pal *et al.*, 2013).
- Goal programming: Goal programming allows to make a trade of between the different goals on an interactive and graphical way (Karpak *et al.*, 2001).

Statistical models

Statistical models deal with the stochastic uncertainty. This uncertainty is by not knowing how demand for services will develop. In the previous mentioned models this uncertainty is also present, although there is not explicitly death with (De Boer *et al.,* 2001). Though the statistical model deals with this uncertainty, there is dealt with uncertainty for one criterion at the time. Soukoup in De Boer *et al.,* (2001) introduced a simulation model for unstable demand, which can also be applied in the pre-qualification phase. Although it is applicable in this phase these models are only capable of dealing with a modified rebuy (leverage items). An example of statistical model is the cluster analysis, which is already defined in the pre-qualification phase.

Artificial intelligence

The artificial intelligence models are based on computerized systems that can be trained by historic data. When a situation occurs the non-expert purchaser can consult the system. The system is based on artificial intelligence and is able to assist during the selection of a supplier. The systems are able to deal with the complexity and uncertainty involved in supplier selection (Pal *et al.,* 2013). As stated by Vokurka *et al.,* (1996) the artificial intelligence models can also be applied in the pre-qualification phase of the supplier selection problem. Stated by Vokurka *et al.,* (1996), the artificial intelligence models can only be applied in with modified rebuy (leverage items). Examples of artificial intelligence are:

- Case-based-reasoning: Case-based-reasoning is a software driven database, which provides the purchaser with useful information about previous situations (Pal *et al.,* 2013).
- Artificial Neural Network (ANN): The ANN model processes elements that are interconnected. By doing so it saves time and money, though the model requires special software and qualified personnel (De Boer *et al.,* 2001; Tahriri *et al.,* 2008).

Appendix 3 Case studies

Since all organizations procure goods, every organization has to deal with the performances of suppliers. Though, this is more essential for one organization than it is for another. Therefore, studies have been conducted on the process of supplier performance measurement. Case studies create insight in the potential issues previous studies have revealed. In line with this, some case studies are mentioned to create insight in these performance metrics.

Top Fortune 150 organizations and Institute for Supply Management members

As stated by Simpson *et al.*, (2002) less than 10% of the organizations who took part in the study, had a formal weighted supplier evaluation system and even 45.5% of the organizations indicated that they did not have a formal method for the evaluation of the suppliers at all. Considering the average sales of the respondents was $3.861 million and 23% of the organizations had between 5.000 and 79.000 employees, this was noted remarkable. According toSimpson *et al.*, (2002) quality is considerably more important over the other criteria. Additionally the most important criteria are meeting the customer requirements and continuous improvements. Furthermore facilities, open communication and logistics and distribution are considered important.

Wholesalers and retailers

The case study by Germain and Dröge (1990), has 369 respondents of which 148 wholesalers and 221 retailers. The average sales were $483 million and the wholesalers and retailers are mostly active in the food and building materials sector. The price, quality and communication were considered as the most important aspects. Additionally aspects considered during the study in hierarchically order are: On-time delivery, easy to work with, flexible, positive attitude, customer support, management quality, complete orders, willing to customize service, consistency order cycle, early notification of disruption, short order cycle and packing quality.

Electronic organization

In Gencer and Gürpinar (2007) a case study is conducted at a major electronic organization. The organization employs 615 people to realize the design, manufacturing, purchasing and after sales of electronic installations. The selection of suppliers takes place by making use of 45 supplier selection criteria, which are divided under main attributes: business structure of the supplier, manufacturing capability of the supplier and the quality system of the supplier. Weights on the different attributes and criteria are determined by making use of the expert opinion, translated into weight by making use of the AHP methodology. The suppliers are evaluated on these criteria and if they cope with the requirement of the buying firm they are added to the list of approved suppliers. New order will only be offered to these approved suppliers.

Dicksons' criteria

Additionally there are several case studies which started with the criteria formulated by Dickson and conducted internal expert interviews (Yahya and Kingsman, 1999; Tam and Tummala, 2001; Sevkli *et al.*, 2008). As stated by Yahya and Kingsman (1999), there are only slight differences between the criteria stated by Dickson and the interviews with the experts, at least the six main topics are the same only changed in order. In the other case studies, the criteria have been modified for the specific buying organization, though the original criteria stated by Dickson can be derived. In these case studies the order of main topics is: Quality, Delivery, Price, Production facilities, Geographical location, Technical capability and Reliability.

Automotive manufacturers

Schmitz and Platts (2004) conducted a case study at four major organizations, active in the automotive industry. The organizations provided information on quality management and the selection and evaluation of suppliers. It showed that the initiative by which the supplier performance measures are introduced have an impact on the handling and the outcome of the metrics. The study showed, when the initiative to implement performance metrics came from the purchasing department, the outcome was mostly used as a reporting and in exception as a management tool. When the initiative came from the logistical department it is used during the day-to-day work and used to frequently interact with the suppliers. Also the downgrading of suppliers was done more easily when the supplier was not performing up to the standards. The evaluation criteria considered in the case study: Communication, Delivery performance, Flexibility and Reliability. The concluding remark of the study showed the most important function of supplier performance measurement is: Using the performance metrics as a communication tool to regularly interact with the suppliers.

The most important outcomes of the different studies are shown in Table 27.

Case study	Performance metrics defined	
*Top Fortune 150 organizations and Institute for Supply Management members (*Simpson *et al.,* 2002)	- Quality - Price - Meeting the customer requirements	- Continuous improvements - Facilities - Open communication - Logistics and distribution
Wholesalers and retailers (Germain and Dröge 1990)	- Price - Quality - Communication - On time delivery - Easy to work with - Flexibility - Positive attitude - Customer support	- Quality management - Complete orders - Customize services - Consistent order cycle - Early notification of disruption - Short order cycle - Packaging quality
Electronic organization Gencer and Gürpinar (2007)	- Business structure - Manufacturing capabilities	- Quality
Dicksons' criteria (Yahya and Kingsman, 1999; Tam and Tummala, 2001; Sevkli *et al.,* 2008)	- Quality - Delivery - Price - Production facilities	- Geographical location - Technical capability - Reliability
Automotive manufacturers (Schmitz and Platts 2004)	- Communication - Delivery performance	- Flexibility - Reliability

Table 27: Overview defined performance metrics case studies

Appendix 4 Interview guide comparable organization

Graag wil ik u vragen om de vragen te beantwoorden vanuit de positie die u binnen de organisatie heeft. Daarnaast worden de antwoorden die u geeft geanonimiseerd en op een vertrouwelijke manier behandeld.

1. Op welke criteria worden de leveranciers in de leveranciersbeoordeling beoordeeld?

2. Is de uitkomst van de beoordeling een cijfer, percentage of anders?

3. Wordt aan alle beoordelingscriteria dezelfde wegingsfactoren toegepast?

4. Hoe zijn deze wegingsfactoren bepaald?

5. Wat zijn de wegingsfactoren die worden toegepast?

6. Wat gebeurt er met een leverancier die aan één van de voorwaarden niet kan voldoen?

7. Hoe wordt dit teruggekoppeld aan de leverancier?

8. Worden de leveranciers begeleid om aan de voorwaarden the kunnen (blijven) voldoen?

9. Worden er contracten afgesloten met de leveranciers?

10. Is er voor iedere leverancier een beoordeling?

11. Worden leveranciers betrokken bij de ontwikkeling van nieuwe producten?

12. Wordt er onderscheid gemaakt tussen strategische en ‘reguliere’ producten die ingekocht worden?

13. Wordt er onderscheid gemaakt tussen leveranciers selectie en evaluatie?

Appendix 5 Interviews comparable organizations

Comparable organization I

Director Supplier Quality

28 February 2014

Since the establishment of comparable organization I, it is an organization who concentrates in innovation, while the group of which the organization is part of, is more measurement based.
Quality is important since it is directly related to the customer experience. Comparable organization I considers reliability and service as the most important aspects of quality. If the quality is not up to the standards of comparable organization I**,** it can embrace high costs. If the quality of the goods supplied to comparable organization I is not coping with the standards of comparable organization I, it can cause serious costs if this is not detected on time. Particularly regarding the fact 75 to 80% of the comparable organization I trucks are purchased items. Comparable organization I calculates with a factor ten: If the purchased goods costs one euro, it costs ten euro to detect the defect and one hundred euro to replace the good etc.

The quality department operates independently from the purchasing department. Reason for this independency is the close link and the entangled goals. The purchasing department has to make sure the purchased goods are delivered while the quality department has to ensure the quality of these goods. The goal of the different departments of comparable organization I is to produce trucks. This goal can be in violation with the goal of the quality department. For this reason the quality manager reports directly to the business manager.

The performances of the suppliers are very closely related to the selection of the supplier according to comparable organization I. Before a supplier is allowed to deliver to Comparable organization I, they have to pass a severe selection procedure. A first selection of the suppliers is based on interviews between the purchasers and quality inspectors of comparable organization I and the potential new supplier. Out of this selection around three suppliers are left, who are assessed by an audit. During this audit there will be assessed on: safety, Corporate Social Responsibility, ISO/TS-16949, logistics, factory outlay, Electronic Data Interchange (EDI), guarantee procedures and delivery times. If a supplier is selected, they have to take part in the Production Part Approval Process (PPAP). In line with this process, the good and the supplier have to establish that they are able to cope with the standards applied by Comparable organization I.

The goods delivered by the suppliers are directly positioned closely to the assembly line. If there are any errors detected, the batch will be removed from the assembly line. Within one hour there is decided, if the goods are still used or the complete batch will be disapproved. If the goods have to be sorted, this will be done by an external organization. The next three deliveries of this supplier will be checked and the costs related to the sorting and checking will be charged to the supplier. There is deliberately chosen for an external organization to prevent tangled interests.

The evaluation of the suppliers is based in the PPM (parts per million) margin of error. Suppliers are rated, based on the errors per million. On a yearly basis the score of the supplier is calculated and reviewed: <50 is an A supplier, 50-750 is a B supplier and >750 is a C supplier. If the supplier is not an A supplier, they have to come up with a plan how to reach the error margin of <50 per million. Additionally the A suppliers are rewarded by a certificate and the twenty-five worst suppliers are guided by Comparable organization I to improve their performances.

Comparable organization II

Supply Chain Manager

11 March 2014

Comparable organization II is part of a larger group of organizations. The turnover of the organization is around 50 million and is generated by the selling of the inventory of poultry stables. Comparable organization II delivers the complete inventory for the poultry stables, though only the feed and water systems are produced by themselves.

The main focus of comparable organization II at their supplier is based on quality and lead time. The customers of comparable organization II demand a lead time of the goods of around four to five weeks. In line with this the suppliers of comparable organization II have to be able to deal with these lead times. Additionally the quality has to be up to the standards of comparable organization II.

An incoming control is done on the delivered goods. An inspection is done by the quality department, who (dis)approves the goods. If the goods are not up to the standards, in corporation with the procurement department is decided if the goods will be approved or send back.

Communication with the suppliers takes place, when problems occur. On first hand this communication takes place by mail and additionally if needed with a personal conversation. This communication does take place in an informal way.

Although performance management of suppliers is considered important, there has to be kept in mind that comparable organization II is operating in a specific market. This means, most of the time there are only a few suppliers available for certain goods. So insight in performances is important, though the consequences for suppliers with bad performances are limited. Furthermore customers often have requirements on the brands used in the inventory of the stable. Therefore comparable organization II does not always have the option to choose for a certain supplier.

Innovation does take place in cooperation with the suppliers, though on a small scale.

When a new supplier is selected a few criteria are taken in consideration: size (market share, turnover), specifications of the articles produced and the past business with the supplier. The personnel intervention with the supplier is considered important. Additionally extra information about the supplier is gathered at competing colleagues.

Regarding the logistical performances of the suppliers, most of the goods are delivered on time. Even quite a number of goods are delivered early, though this does not cause problems at comparable organization II.

Comparable organization III

Technical supplier manager

20 March 2014

The machines produced and sold by comparable organization III have very high requirements regarding quality and technical specifications. The selling price of these machines varies heavily.

If comparable organization III needs a new good, there is first decided what kind of good it is. They differentiate:

- *Shelf products*. These goods can be selected form the catalogue of the supplier, there are no specific requirements.
- *Built to print.* These goods are designed by comparable organization III and a supplier is sought after who is capable of producing these goods. The blue-prints of the components are designed and owned by comparable organization III.
- *Built to print plus.* These goods are designed by comparable organization III although the supplier is already selected during the designing process. Additionally the supplier is asked to assist during the design of the good. The blue-prints of the components are owned by comparable organization III.
- *Wide box.* Of these goods the functions and technical specifications are known, e.g. measurements, material, quality etc. The good is further designed by the supplier in line with the specifications of comparable organization III. The blue-prints of the components are owned by the supplier.
- *Black box.* Of these goods only the functions are known. The specifications are set by the suppliers in cooperation with comparable organization III. The blue-prints are owned by the supplier.

Before a new supplier is allowed to deliver goods an organization III is made of worldwide suppliers which are able to deliver the good. Mostly the goods required by comparable organization III are so specific there is a maximum of a couple of suppliers. These suppliers are conducted on: Quality, Logistics, Technique and Costs (QLTC) during an audit. During this audit the suppliers are checked on: (technical) competences, continuity, financial dependence (max. 25%), reliability, history. Additionally comparable organization III decides up on what kind of goods the supplier is capable/allowed of delivering, as shown above. Since comparable organization III move along with the financial fluctuations of the world economy they look for suppliers who have additional customers who move anti-cycle. The score of the supplier during the audit of comparable organization III will be discussed with the supplier, to create accordance on the scores. Each of the aspects (Quality, Logistics, Technique and Costs) is controlled by different departments. To make sure the suppliers meet the requirements different team are conducted:

- *Supplier Account Team (SAT)*. These teams check if the suppliers meet the requirements. In line with this, the suppliers are rated from A to E. The A suppliers meet all the requirements and the E suppliers do not meet the requirements at all. If the suppliers are not able to meet the requirements, the supplier needs to come up with improvement plan. This plan is conducted together with the comparable organization III.
- *Product Family Team (PFT)*. These teams make decisions based on good categories. For example they look for suppliers who are capable of delivering different components since the sourcing can be done more efficient.

- *Strategic Product Family Team (SPFT).*These teams look for strategic sourcing, if different suppliers are needed and how to develop the relationship with the supplier.
- *Strategic Sourcing Commission (SSC).* The teams also look for strategic sourcing and if partnerships with suppliers need to be developed. These teams can involve board members of comparable organization III.

Comparable organization III wants to work in a transparent way. The production process is completely screened and the costs associated with this process are discussed. Not all the suppliers want to work in such a transparent way, although this has the strong preference of comparable organization III.

Portals in logistics and quality are equipped to create insight in the supply chain. The response time of the suppliers decreases by making use of these portals. The suppliers need to arrange their production process in such a way that all the goods can be delivered within a timeframe of 9 weeks.

Preferably comparable organization III wants to have insight in the suppliers position regarding the aspects checked during the audit. Additionally organization III requires the suppliers also check their suppliers on critical points, to create insight in the supply chain. Although this is not preferred, sometimes comparable organization III also checks the supplier of the supplier and even further. This to create insight in the complete supply chain, so crucial components can be delivered and as less unexpected events as possible happen. If necessary organization III even intervenes in the supply chain to make sure their goods can be delivered in time. This can be in financial form, training of personnel, placement of personnel of comparable organization III at the supplier or goods on loan to be able to produce the goods.

Comparable organization III wants to have so much insight in the supply chain, since it is very expensive if the production of a machine comes to a hold. Additionally often components are needed which do not even exist, this means the requirement of the suppliers are very high. Therefore, if needed comparable organization III is willing to assist the supplier in development of the good in different ways.

Since the machines operate in dust free environments there are special requirements regarding the (packaging) specifications. The packaging specifications are seen as specifications of the goods. Therefore although the good is in line with the specifications, if the packaging is not right the good can still be refused.

Comparable organization IV

Chief Procurement Officer (CPO)

24 March 2014

Comparable organization IV looks after (automated) material handling solutions. The organization has locations all over the world and has references at Nike, Amsterdam airport, Tesco and TNT and annual sales of around 720 million. The material handling takes care of warehouse automation, package handling and baggage handling. The solutions provided by Comparable organization IV are all custom-made and performed on a project base.

About two years ago Comparable organization IV conducted a project to increase the number of complete deliveries at an agreed planning. The outcome of this project showed the internal communication could be improved.

At the starting of the project Comparable organization IV started reasoning backwards. They started with the goods (agreements with the customer) a salesman delivered and how these goods coped with the goods needed by the project managers. Working backwards showed the essence of the information provided which the next link in the network needed to be able to do a good job. This project made the organization focus on the alignment of the internal processes. It provided clear information on which information was needed and what the employees expected from each other. This made the demand regarding the supplier became more clear and therefore the performances of the suppliers increased.

There has to be noticed there is referred to a network of links instead of a chain. This is since different information is provided by different departments and in line with this, different employees. Because of this network employees have to be aware of the consequences if the information is not provided on time.

Additionally this way of reasoning provided the possibility to handle problems in a pro-active way. Acting in this way showed the problems were solved and did not occurred again. Just actively solving the problems did not guarantee the problems would not occur again, since employees are working in a network rather than a chain.

The project showed it should be clear what the organization expects forms a supplier. Since Comparable organization IV is working on a project base some flexibility is demanded form the suppliers. They stated it should be clear to the supplier what is expected from them, flexibility or performing well in line with the performance indicators since both works contradictory. The organization has to decide which aspects have priority and this has to be clearly communicated to the suppliers.

During the selection of the suppliers Comparable organization IV uses the QLTC (Quality, Logistics, Technique and Costs) criteria to assess the supplier on. Additionally Comparable organization IV is assessing suppliers on Sustainability, since this is a pre-requisite to keep the license-to-produce.

Since the outcome of the project showed good communication is essential to deliver a good end product, the different departments and employees grade each other on the communication. This grading is discussed on a monthly basis and particular cases are discussed. An additional advantage of discussing the communication on a monthly basis is that employees know it is about constructive criticism which improves communication even further. To indicate the importance of these meetings the Chief Operations Officer (COO) is also present at these meetings.

Appendix 6 Interview guide employees Vencomatic

Graag wil ik u vragen om de vragen te beantwoorden vanuit de positie die u binnen Vencomatic heeft. Daarnaast worden de antwoorden die u geeft geanonimiseerd en op een vertrouwelijke manier behandeld.

Huidig beleid

1. Hoe is de algemene indruk van de prestaties van de leveranciers van Vencomatic?

2. Hoe worden deze prestaties geregistreerd?

3. Op welke criteria wordt een leverancier beoordeeld?

4. Zijn alle aspecten die gemeten worden even belangrijk?

5. Wordt er onderscheidt gemaakt tussen de verschillende soorten producten (strategisch, regulier)?

6. Wat wordt er gedaan met het inzicht in de prestaties van de leveranciers?

7. Worden de resultaten besproken met de leveranciers?

8. Wat zijn de consequenties voor leveranciers die slecht presteren?

9. Welke invloed hebben slechte prestaties van de leveranciers op uw werkzaamheden?

Toekomstig beleid

10. Hoe zouden de resultaten van de metingen naar de leverancier gecommuniceerd moeten worden?

11. Wat zouden de consequenties moeten zijn voor leveranciers die slecht presteren?

Appendix 7 Interviews employees Vencomatic

Warehouse officer

7 April 2014, Eersel

Vencomatic has some special requirements regarding the packaging requirements since the products are all loaded in truck or containers. The diversity of the products sold by Vencomatic is very big. When the trucks and containers are loaded the length, weight and volume of the products has to be taken in consideration since these constraints can all be limiting.

Current policy

The average performance of the suppliers is good, though there always are some exceptions. The most shortcomings of the suppliers are on the way packing the products. In the current policy the performances of the suppliers are not registered. Although the performances are not formal registered, insight in the performances of suppliers is created by notifying the purchasing department when something is not right. In consultation between the purchasing and the logistical department a decision is made on how there is dealt with the products which do not meet the requirements. Most of the time, when possible the problems are corrected by Vencomatic and the supplier is informed on the shortcoming. When Vencomatic cannot overcome the shortcomings of the products, the product is returned to the supplier.

The performance of the supplier regarding the on time delivery is the most important metric. Additionally meeting the requirements regarding the packaging is an important aspect on which the suppliers need to perform. Though the logistical department considers packaging as an important aspect, they realise the purchasing department needs to make a considering regarding the (extra price) packaging and the purchasing price.

The purchasing department is the only department which has contact with the suppliers. According to warehouse officer, the purchasing department only communicates the performances of the suppliers, when these are not sufficient with the requirements of Vencomatic.

New policy

In the new policy the suppliers need to be assessed in line with a number of metric (packaging, on time delivery, article number of Vencomatic clearly visible). There needs to be one employee responsible to assess the suppliers and communicate theses results to the suppliers every six-months. The employee that should be appointed to asses these suppliers logically should be an employee of the quality department. There needs to be regular communication with the suppliers, both when the suppliers perform positive and negative, e.g. every six month. When the performances of the supplier do not meet the requirements, there needs to be communicated every three months.

If the performances of the supplier do not meet the requirements of Vencomatic, the extra costs that need to be made to cope with the requirements of Vencomatic need to be charged to the supplier. This is necessary since the bad performances of the suppliers otherwise have negative effects on the reputation of Vencomatic.

Quality officer

10 April 2014, Eersel

The procured goods that are delivered are inspected during the income control. Though the income control is done by random sampling, so only a slight percentage of the products is checked. This income control is performed on the quality of the product (product technical), not on the type of product and the number of products.

Since the incoming inspection is not 'complete', problems with the product specifications occur in the process of picking and assembling the products.

Current policy

The performances of the suppliers are moderate. Performances of the suppliers regarding the packaging are not coping with the standards of Vencomatic. The selection of the supplier is based on the price and the geographical location, preferably regional.

Furthermore authorizations are not completely clear. It is not clear who is authorized to send the products back to the supplier if the products do not cope with the standards handled by Vencomatic.

As stated during the income inspection, the products are checked on quality. If products are not coping with the standards of Vencomatic, this is reported in the database. Furthermore pictures are made of the shortcoming. During the incoming inspection there can be decided if the products are accepted or not depending on coping with the standards of Vencomatic. If the products are not accepted the quality department is authorized to send the products back to the suppliers. Though the quality department only has this authority regarding the specifications of the product, not regarding the packaging.

New policy

During the selection of the suppliers there has to be taken into account, the supplier will be capable of dealing with the standards of Vencomatic. If the supplier is selected, Vencomatic needs to improve the communication with the supplier; the supplier needs to know exactly what is expected.

In the new policy the quality department should be authorized to make any decisions about doing business with suppliers. The quality department should together with the purchasing department approve to do business with a supplier. Furthermore there should be one person who is authorized to send the products back if the product not copes with the standards regarding the packaging, quality etc.

If the product not copes with the standards, depending on the situation the supplier should come over to Vencomatic to inspect the product and to come to an agreement.

Furthermore when the R&D department develops a new product, the packaging should also be designed with it. Therefore right from the beginning it is clear to the supplier what Vencomatic expects and how the products need to be packed.

Warehouse officer logistics

23 Mei 2014, Eersel

Current policy

In the current policy a number of suppliers confirm orders, though they know they cannot manage the delivery date. Although they try to deliver on time it often happens the suppliers are not able to meet the confirmed delivery date.

The performances of the supplier of Vencomatic are currently not formally measured. Though not formally, the performances of the suppliers are measured by sampling the suppliers which did not perform according to the standards of Vencomatic in the past. The outcomes of the measurements are since recently registered in an excel-file.

The criteria on which the suppliers are assessed during the incoming control are: on time delivery, packaging, documentation and the right number of products.

There is no emphasis on certain criteria, since if the supplier does not perform in line with one of the named criteria this causes stress and extra costs.

The complaints regarding the bad performances are communicated by mail to the purchasing department. The feedback of these complaints is provided by the purchasing department by mail. Only the bad performances of the suppliers are registered. Communication takes place on these performances and how these can be improved.

No differentiation is made between different type of products, since all the products are needed to assemble the end-product.

If the performances of the suppliers are not in line with the requirements of Vencomatic, communication takes place. If these performances do no improve in time, there is looked for a new supplier.

New policy

In the new policy there has to be consultation between the subordinates and the management, on the selection of new suppliers. This is needed since some goods have special requirements regarding packaging.

In the new policy the incoming inspection needs to have a file in which all the shortcomings can be registered. These shortcomings need to have a follow-up action by the purchasing department in the form of communication with the supplier. There need to be an option to add appendices to create clarity on the shortcoming.

Furthermore the purchasing department should work with contracts on the delivery of products. When the suppliers do not meet the requirements of the contract, this can be seen as breach of contract and therefore when needed there can be looked for a new supplier.

Clarity has to be created on who is allowed to return the goods to the supplier if they do not meet the requirements. During the incoming inspection there should be allowance to return the goods to the suppliers.

Warehouse Manager

9 April 2014, Eersel

When Vencomatic is placing a new order at the suppliers, the supplier has two days to confirm or dismiss the order. After these two days the order is definitive and the supplier is deemed to deliver the right products, at the right time for the right price.
Vencomatic handles a norm which states that the supplier should deliver the products two days before Vencomatic has planned to deliver the products to their customers. The problem with the suppliers is that a number of suppliers know this norm and therefore deliver the products at a later stage than the norm.

Current policy
Currently the suppliers are not formally assessed. If the supplier performs according to the requirements of Vencomatic depends on the last four deliveries. If these deliveries are in line with the requirements, it is a 'good' supplier. The metrics most critical for the warehouse are the on time delivery and the packaging requirements. These aspects are considered equally important.

If the products not cope with the standards of Vencomatic the purchasing department is contacted and a decision is taken on what to do with the products. The purchasing department contacts the supplier and gives feedback to the warehouse on the follow-up activities. The purchasing department has no direct insight in the consequences of bad performances of the suppliers.

The consequences for Vencomatic of late deliveries are a short processing time for the employees of the logistical department which enhances time-pressure.

New policy
In the new policy it is important the performances of suppliers are formally registered. This is essential to underpin the communication to the supplier about the performances. These performances should be communicated on a monthly basis to be able to act quickly if performances decrease.

If the performances of the suppliers decrease this should be communicated to the supplier. This communication first takes place by mail and phone and in a later stage by personal communication. Eventually when the performances of the supplier do not increase in line with the agreements made, the supplier is not allowed to make any new deliveries.

Furthermore the supplier should be involved with the development of new products. In line with this involvement the number of specific products demanded by Vencomatic will decrease, which will increase the performances on timely delivery and packaging.

Manager purchase

8 April 2014, Eersel

The purchasing department places orders at suppliers of Vencomatic. The department has arranged with the suppliers that if the supplier is not able to deliver the order, the purchasing department of Vencomatic is notified within seven days. Although this agreement is made with the suppliers, not all the suppliers stick to these appointments.

The quality department makes use of a database in which the shortcomings/errors are registered. According to the purchase manager not all the shortcomings are listed in this database, since only the errors observed during the incoming inspection are registered. The additional shortcomings observed during the picking of the orders are not registered in this database.

Current policy

The performances of the suppliers are quite good. These performances of the suppliers cannot be underpinned by numbers since this is not formally registered. Although the suppliers are not formally assessed, in an informal way the suppliers are assessed on a number of metrics: Delivery date, correct numbers, price, packaging and documents. Additionally there is also assessed on quality although this is not performed by the purchasing department, but by the quality department. The importance of the metrics mentioned is in hierarchical order.

A difference is made between A, B and C products. The difference is based on the yearly turnover each product generates. The difference between these products is made, to keep a clear view on the physical products in the warehouse by making use of cycle counting.

The performances of the suppliers are only discussed with the suppliers if the performances not cope with the requirements of Vencomatic. When these performances not improve, reclamations will be done. If the performances after these reclamations not improve there will be looked out for a new supplier. It is rare a supplier is not allowed to deliver anymore.

If the supplier does not deliver in line with the requirements of Vencomatic, this causes a lot of ad hoc work for the purchasing department. This is since the shortcomings of the supplier are noticed if the products are physically delivered and these problems have to be solved in a short term.

The purchasing department is striving for as few new suppliers as possible. By being timely involved in the development of new products, the purchasing department is trying to purchase the needed products at current suppliers.

New policy

In the new policy the suppliers needs to be assessed on a number of metric. It is important the insight in the performances of the suppliers is created easily. The outcomes of the assessment should be discussed quarterly, with the 20 worst performing suppliers. There should be made a distinction between the different types of products in line with the Kraljic matrix. The suppliers should be selected based on the different types of products and weightings of the different performance metrics should be different. Furthermore the consequences for not coping with the standards of Vencomatic should be defined.

Project Manager

9 April 2014, Eersel

The products sold by Vencomatic need to be assembled on location to complete the systems in the poultry stable. On the products it stated if it is possible to temporary store the products outside during the assembly of the poultry stable. Though since it is stated on the product that a number of products cannot be stored outside, during the assembly it is often not possible to store the products inside. Although this is the responsibility of the customer, the packaging should be accounted for the products to be stored outside.

Current policy

The performance of the suppliers can be improved. Especially since the focus of the project leader is on packaging and quality. The packaging is essential since damaged products can cause major delays during the project. Furthermore the quality of the product and the repair service of the supplier are considered important. Since the products are sold all over the world, the project leader considers it important the supplier is prepared to get over to the assembly site to do repairs. If the project leader experiences any problems with products, these shortcomings are registered in the same database that is used for shortcomings during the incoming inspection. Although there is registered there is no feedback on what the follow-up actions are regarding the shortcoming.

Although the shortcomings are registered in a database, no concrete overview can be created on the performances of an individual supplier. No difference is made between the different kinds of products e.g. strategic regular products. This difference is not made since the missing of one component can stop the assembly of the total project given that some of the projects are realized in the middle of the desert. Because of this assembly site, products are all delivered by Vencomatic and no products are purchased locally.

New policy

The project leader states the packaging of the product is a product characteristic. Therefore during the design of the product by R&D, also a design should be made on the packing of the product. By designing packaging for the products the bargaining power of the purchasing department is stronger since the supplier directly knows the all the demands. Additional to this a number of standard packages have to be designed to ensure not every product gets a specific packaging, this would increase the product price. This packaging is necessary since there are different requirements regarding on the products: waterproof, fragile and stackable.

A distinction has to be made between the more and less expensive products regarding the packaging. Since a large number of products are send all over the world the packaging is essential to be able to meet the requirements of Vencomatic when the product is handed over to the customer. Therefore there has to specifically be defined what the packaging requirements are regarding the different products.

Additionally if the suppliers are not able to cope with the demands of Vencomatic regarding the products specifications there have to be strict consequences to this. In the current policy Vencomatic is not consistent in these consequences, which need to change in the new policy.

Appendix 8 Argumentation performance metrics

The proposed performance metrics are based on the SCOR model. The adaptations made are based on literature, case studies, interviews with comparable organizations and interviews with employees of Vencomatic.

Reliability

Starting at the performance attribute Reliability is referring to the predictability of the outcome of the process (Council, 2010). The importance of the reliability is underpinned by the concluding remark on the case studies. The performance metrics *delivery performance* and *order fulfilment* are defined in line with the SCOR model. The delivery performance is measured by:

- Is the right *product* delivered?
- Is the right *quantity* delivered?
- Do the products meet the product *specifications*?
- Are the products delivered regarding the right *costs*?

If the supplier is not coping with one of these metrics, the order does not meet the requirements.
Additionally the order fulfilment is measured by:

- Are the products delivered at the right *time*?
- Are the products delivered at the right *place*?
- Is the *packaging* of the products in line with the standards handled by Vencomatic?
- Are the right *documents* delivered with the products including: packing list, order number, article numbers?

If the supplier is not coping with one of these metrics, the order does not meet the requirements.

The metric *fill rates* is applied since a number of products used in the 'Grando' breeder housing are produced in line with the make-to-stock strategy. Since the fill rates of the suppliers have a direct influence on the stocks of Vencomatic, this metrics is considered (Kocaoğlu *et al.*, 2013).

Responsiveness

The performance attribute Responsiveness is referring to the speeds at which tasks are performed (Council, 2010). The *order fulfilment lead time* metric is defined in line with the SCOR model.

Flexibility

The performance attribute Flexibility is referring to the ability to respond to external influences (Council, 2010). The performance metrics *production flexibility upside* together with the performance metrics *production flexibility downside* is defined. The metrics are defined together since the suppliers of Vencomatic both need to be able to perform flexible in both scaling up and scaling down.

The performance metrics *supply chain response time* is not defined in the main list since the competitive advantage of the supplier is not of interest to Vencomatic and the flexibility in the production already defined is in the production flexibility.

Costs

The performance attribute Costs is referring to the costs of the operating process (Council, 2010). The *total supply chain management* metrics is not incorporated in the main list, since this metrics is referring to the total supply chain which is not applicable in this case.

The *cost of goods sold* metric is rephrased to fit the aim of this study better. The costs of goods sold are made more specific and incorporate *quality costs*:

- *Part inspection* since the current/previous delivery did not meet the standards
- *Rework / corrective work* to correct shortcomings of the supplier
- *Supplier visits* for product inspection
- *After shipments* caused by failure of the supplier

The quality costs are directly linked with the delivery performance and order fulfilment. If the supplier gains low scores in delivery performance and order fulfilment it can be derived the supplier should invest to ensure quality and timely delivery (Quality costs). If the supplier gains high scores in delivery performance and order fulfilment and the quality costs are low it can be derived the supplier is well capable of managing their suppliers.

The *value added productivity* metric is not applicable in this case, since this has an effect on the financial results of the supplier. Only if these results are extremely low, the continuity of the supplier can be jeopardized which can have an effect on Vencomatic. Though since the financial position of the supplier cannot be derived from this metric, it will not be included in the main list.

The performance metric *warranty/return processing costs* is rephrased. The warranty/return processes costs refer directly to the cost made for the warranty/return process. Although costs are an important aspect, Vencomatic focuses on the best solution in line with the customer demands. Though the best solution for the customer often is not the cheapest solution. Since Vencomatic considers the warranties/returns as a service to the customer, it is not a part of the cost attribute and is better referred to as repair service.

Asset

The performance attribute Asset is referring to the ability to efficiently utilize the used assets (Council, 2010). The performance metric *inventory days of supply* is not considered, since it is referring to "the number of days is takes to get goods produced and sold" (Kocaoğlu *et al.,* 2013). This is not applicable since this study is focusing on the performances of the suppliers and the long shelf life of the supplier does not have an influence on the performances the supplier delivers to Vencomatic.

The *cash-to-cash cycle time* is also not applicable since the products purchased by Vencomatic are purchased in line with the purchase terms the supplier has agreed upon. The supplier first has to agree upon the purchase terms of which the payment terms are part of, to be allowed to make any physical deliveries to Vencomatic.

The *asset turns* performance metric is rephrased to the focus of the supplier on product development expenses. The investments of the supplier on product development how eager the supplier is on developing new products, which can facilitate the innovation process of Vencomatic.

Additions on SCOR performance metrics

Additional sources (literature study, interviews with comparable organizations, case studies and the current policy) are used for the formulation of the performance metrics. By making use of these inputs, some adaptations and additions are made to the performance metrics defined by the SCOR model.

As defined by the literature study, some additional issues are considered important during the selection of the suppliers. The *Price* is considered the most important metric according to the literature study. Since this metric is not explicitly defined in the SCOR model an additional metric will be defined on *Price*, which incorporates the *complaisance with sector price behaviour.* Additionally this is in line with the interviews with the comparable organizations III and IV and the case studies.

The second most important metric according to the literature study is *Quality*, which are taken into account by delivery performance (Kocaoğlu *et al.,* 2013). Also the interviews with the comparable organizations (III and IV) showed Quality is an important performance metric, since it is part of the QLTC methodology applied by these organizations. Looking at the most important metric according to the case studies, Quality is derived as the most important metric.

The third most important metric according to the literature is *Delivery*. The delivery is considered by the metric order fulfilment (Kocaoğlu *et al.,* 2013). This is underpinned by the 'L' of the QLTC methodology and is referring to logistics. Logistics is directly linked to delivery, according to the interviews with the comparable organizations (III and IV). The interviews with employees of Vencomatic about the current policy show the packaging is named as a very important aspect. Though packaging is considered as an part of the order fulfilment (Kocaoğlu *et al.,* 2013). Additionally on time delivery is considered as a critical metric according to the interview about the current policy. On time delivery is also considered in the metric delivery.

The fourth most relevant metric are the *Production facilities and capacity*, the capacity is covered by the Flexibility metric. Additionally the production facilities are considered by the metric Management and organization, which is considered the seventh most metric according to the literature.

The fifth metric is the *technical capability*, which is defined as a separate metrics since Vencomatic is partly relying on the technical capability of their suppliers. The importance of this metric is underpinned by the 'T' in the QLTC methodology used by the interviewed comparable organizations. Therefore the technical capability is an added metric.

The sixth metric is the *financial position* of the supplier. This is defined as an additional metric, since the financial position can influence the ability of the supplier to deliver the ordered products, which has a direct effect on the performances of Vencomatic.

The seventh most important metric according to the literature are the *Management and organization* of a supplier. This is considered important because of the effect arguable management of a supplier can have a significant effect on the reputation of Vencomatic. Since management and organization is not explicitly considered in the SCOR an additional metric is used.

The eight most important metric is the *geographical location* of the supplier. The geographical location considers transportation costs and trade barriers. These transportation costs and trade barriers (financially) are already incorporated in the price metrics. Additionally lead time and trade barriers (time) can be an issue, though this is considered in the order fulfilment lead time. Therefore the geographical location is not explicitly considered by a metrics.

The ninth most important metric is the *repair service*. This metric is considered by a metric which also is in line with the warranty/return processing costs of the SCOR model. Since these costs are not explicitly calculated for, though the service is considered more important, the repair service is explicitly mentioned by a performance metric.

The tenth most important metric according to the literature is the *performance history* of a supplier. Since Vencomatic is focusing on the current and future situation, the performance history is not explicitly mentioned. Additionally the performance history as a supplier of Vencomatic can be derived from the evaluation of the supplier in the past.

Additionally the concluding remark on the case studies shows, communication is considered as an important metric on which suppliers should be assessed. When there is taken a closer look to the literature study the communication system is ranked 14th. The metric on the communication, covers all the QLTC attributes formulated and therefore also at these organizations considered as important.

Appendix 9 Comments internal stakeholders

Comments made by the different internal stakeholders are:

- The *delivery performance* and *order fulfilment* can be considered as one metric, since the different aspects mentioned by order fulfilment can all be considered as specifications of the product. The *packaging* can be considered as quality of the good. Additionally *place, documentation and time* are considered as specifications of the goods.
- The performance attribute *Responsiveness* now only considers the speed at which tasks are performed. This definition is too specific and needs to be broadened.
- Some additional financial ratios should be considered, since the financial condition of the supplier is important. These ratios' can be derived from the Dun & Bradstreet rapports which are requested occasionally.
- The *communication system* should be supplemented with a pre-announcement before the physical delivery is made. This pre-announcement is used to make a detailed planning on the logistical department for the next day/week.
- An additional selection metric can be the strategic position of the supplier, the competition Vencomatic should be considered.

Appendix 10 Comments suppliers

The comments made by the suppliers who are personally interviewed are shown below.

- Supplier N: The rights of the employees are not represented by a trade union, though by an employee's council. This council also represents the rights of the employees and therefore should also be mentioned in the statement on the employee rights at the management and organization metric.
  It should be considered if the final rating on 'bad', 'moderate' and 'good' will be applied. If the final rating will be applied, additional rating segments have to be formulated since more and clear differentiation between the performances of the suppliers has to be made.
- Supplier B: The final decision in the end is based on price. The price of the goods is not incorporated in these metrics, while the emphasis should be on price.
- Supplier C: During the selection of the suppliers it should turn out if each supplier is willing to provide insight in the cash flow. Additionally it is recommendable to make use of ´A´, ´B´ and ´C´ suppliers. Furthermore the investment in research and development (R&D) does not apply since this supplier is a wholesaler.
- Supplier D: It is good to create insight in the performances of the different suppliers. By doing so suppliers are able to differentiate themselves.
  The metric on research and development (R&D) does not apply since this supplier is a wholesaler.
- Supplier F: Differentiation has to be made in the metric on order fulfilment. This distinction should be made on deliveries too early and too late and additionally the numbers of days, since the problems caused by late deliveries are larger than early deliveries. The weighting should also be different since deliveries which are very late cause bigger problems than deliveries which are a bit late.
  Additionally the added value offered by this supplier does not become clear by these metrics. This supplier states to be able to deliver order demand driven, while their components only deliver in batches.
- Supplier H: There has to be considered how to deal with partial delivery of orders. Some orders are delivered in different deliveries, which date has to be considered by these metrics.
  The flexibility metrics are important to create insight, though the supplier does not has complete insight in what goods of Vencomatic are demand and stock driven. Furthermore the products delivered to Vencomatic are partly kept on stock so in this case flexibility is no problem. Though the production of new batches is once every three weeks, therefore if the product is not a stock product for the supplier, the flexibility decreases dramatically.
- Supplier I: The metric on the financial position is not formulated well, since the supplier is not able to fill in their position. Flexibility is not a problem, if the changes in the order are communicated timely. If the changes are communicated before the production of the batch starts the production can be adjusted.
- Supplier L: The financial position of the supplier is crucial to ensure the supplier cannot endanger the continuity of the buying organization. Additionally the modern manufacturing equipment is a competitive advantage this supplier has, though this is not directly shown in the performance metrics. Supplier L produces the products for Vencomatic also in batches. Regarding the flexibility, most of the products are kept on stock.

Additionally the comments of the suppliers who are contacted by mail

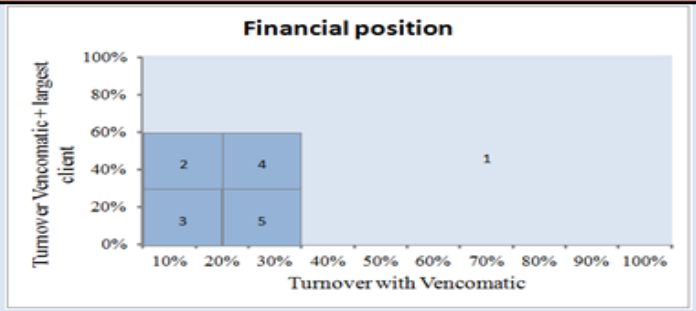
- Supplier E: Regarding the metrics repair service and flexibility it depends on if the supplier keeps the product on stock, since some products are only produced in batches every three to four weeks.
  The metric on financial position is not formulated well.
  The quality costs do not provide much information on how the supplier performs regarding quality.
- Supplier G: This supplier stated repair service was not applicable to them without any specific reason.
- Supplier J: No feedback is given.
- Supplier K: The products are produced in batches. If the orders of Vencomatic reach the volume of a complete batch, the batch is planned to produce. Because of busyness at the factory, delivery times and therefore flexibility strongly fluctuates.
- Supplier M: No feedback is given.

Appendix 11 Final performance metrics

Supplier selection					
Attribute	**Metrics**	**Units**	**Calculation**	**Scale**	**Score**
Reliability: The reliability attribute addresses the ability to perform tasks as expected. Reliability focuses on the predictability of the outcome of a process (Council, 2010)	***Delivery performance:*** Measures the quality • Product • Quantity • Specifications - Packaging - Place - Documentation - Costs	Percentage	Number of deliveries without complaints / Total number of orders	> 99%	5
				98% - 99%	4
				95% - 97,99%	3
				< 95%	2
				No track of complaints	1
	Order fulfilment: Measures if the delivery is on time	Percentage	Number of deliveries on time / Total number of orders	> 99%	5
				98% - 99%	4
				95% - 97,99%	3
				< 95%	2
				No track late deliveries	1
	Repair service: Measures if there is dealt with complaints regarding goods (e.g. repairs) within the set time frame	Percentage	Number of repairs that is within the set time frame / Total number of repairs	Within three days new components and technical staff on site	5
				Within two days new components on site	4
				Within two days new components delivered at Vencomatic	3
				Within five days new components delivered at Vencomatic	2
				No delivery	1
	Management and organization: Measures the responsibility and attitude of the organization	Performance levels (poit.one, 2010)	Number of statements that apply to the supplier	Ensures respect for the human rights regarding child labour, discrimination on race, sex, religion, politics.	5 (five statements applicable)
				Ensures rights of the employees are represented by trade union / employees council	4 (four statements applicable)
				Ensures quality and safety standards are ensured by certification	3 (three statements applicable)
				Ensures respect for the environmental issues	2 (two statements applicable)
				Ensures efficient policies regarding complaints	1 (zero or one statement applicable)

Supplier selection					
Attribute	**Metrics**	**Units**	**Calculation**	**Scale**	**Score**
Responsiveness: The responsiveness attribute describes the speed at which tasks are performed (Council, 2010)	***Order fulfilment lead time*** : Time between placing the ***demand*** driven order to delivery of the order	Business days	-	< 8 Days	5
				8-9 Days	4
				10-12 Days	3
				13-15 Days	2
				> 15 Days	1
	Fill rate: Time between placing the ***stock*** driven order to delivery of the order	Business days	-	≤ 1 Days	5
				2 Days	4
				3 Days	3
				4 Days	2
				≥ 5 Days	1
	Communication system : Measures if the supplier able to deal with electronic order processing	-	-	Electronic Data Interchange (EDI)	5
				Digital order processing (two ways, the supplier is able to import the file into their system and answer automatically)	4
				Digital order processing (one way, the supplier is able to import the file into their system automatically)	3
				E-mail	2
				No digital order processing	1
Flexibility: The flexibility attribute describes the ability to respond to external influences and the ability to change (Council, 2010)	***Flexibility*** : The number of days to achieve an unplanned 20% increase or decrease in ***demand*** driven orders without cost penalty	Business days	-	<1-2	5
				3-4	4
				5-10	3
				11-15	2
				>15	1
	Flexibility : The number of days to achieve an unplanned 20% increase or decrease in ***stock*** orders without cost penalty	Business days	-	<1-2	5
				3-4	4
				5-6	3
				7-10	2
				>10	1

Supplier selection

Attribute	Metrics	Units	Calculation	Scale	Score
Costs: The cost attribute describes the cost of operating the process (Council, 2010)	***Quality costs:*** Measures costs of • Part inspection • Rework / Corrective wor • Supplier visits • After shipments	Percentage (Harding and Harding, 2000)	Prevention quality costs / collective quality costs	< 0,1 %	5
				0,1 - 0,49%	4
				0,5 - 0,99%	3
				1 - 2%	2
				> 2%	1
Assets: The Asset attribute describes the ability to efficiently utilize assets (Council, 2010)	***Financial position*** : Financial dependence and stability	Percentage	Turnover with Vencomatic and the turnover with Vencomatic + the largest client		
	- Cash flow	-	-	Past 5 or more years a positive cash flow	5
				Past 3 or 4 years a positive cash flow	4
				Past (2) year(s) a positive cash flow	3
				Past year a negative cash flow	2
				More than 1 year a negative cash flow/no information available	1
	- Current ratio	%	Current assets / Current liabilities	> 2%	5
				1,5% - 2%	4
				1% - 1,49%	3
				0,75% - 0,99%	2
				< 0,75%	1
	- Quick ratio	%	(Current assets - Inventories) / Current liabilities	> 1,5%	5
				1,26% - 1,5%	4
				1% - 1,25%	3
				0,75% - 0,99%	2
				< 0,75%	1

Supplier selection					
Attribute	**Metrics**	**Units**	**Calculation**	**Scale**	**Score**
Assets: The Asset attribute describes the ability to efficiently utilize assets (Council, 2010)	***Research and development (R&D) investement:*** The investments done in R&D	Performance levels	Investment in R&D (€) / Annual turnover (€)	≥ 4%	5
				≥ 3% < 4%	4
				≥ 2% < 3%	3
				≥ 1% < 2%	2
				< 1%	1
	Technical capability : Measures if the supplier is capable of dealing with the technical requirements	Performance levels (poit.one, 2010)	-	All the engineering knowledge is present and used in a pro-active way	5
				The engineering knowledge is present and used to actively overcome technical shortcomings raised	4
				Has engineering knowledge and is capable of meeting the all the engineering requirements	3
				Basic engineering knowledge is present	2
				Has no engineering knowledge, not capable of dealing with engineering requirements	1

Table 28: Overview final supplier selection metrics

Appendix 12 Weighting performance metrics

Performance attributes

To determine the weight on the different performance attributes, pair-wise comparison have to be made on the different performance attributes. In 1980, Saaty developed a method for the pair-wise compression. Saaty proposed a nine-point scale to determine the relative importance of one performance attribute over another. Though this scale is proposed, it is considered not possible to use a nine point scale in this study. The different internal stakeholders came with the suggestion to use the proposed scale, though from one to three. This way the scale used becomes (Table 29):

Scaling AHP model	
1	Attribute A and B are equally important
2	Attribute A is moderate more important than attribute B
3	Attribute A is much more important than attribute B

Table 29: Scaling AHP model

By using this scale a pair-wise comparison can be and the different attributes can be prioritized. In Table 30 the comparison that is made for between two performance attributes. This comparison is made between all the performance attributes defined in appendix 11.

	More important than		Equal	Less important than		
Delivery performance	3	2	1	2	3	Order fulfilment

Table 30: Pair-wise comparison between the different attributes

In the matrix (Table 31) the outcome of the pair-wise comparisons is shown. In a diagonal line the number one is already filled in, since each criterion is equally important to itself. Additionally the column total is calculated.

	Reliability	Responsiveness	Flexibility	Costs	Assets
Reliability	1,00	3,00	3,00	3,00	3,00
Responsiveness	0,33	1,00	2,00	2,00	2,00
Flexibility	0,33	0,50	1,00	3,00	3,00
Costs	0,33	0,50	0,33	1,00	0,33
Assets	0,33	0,50	0,33	3,00	1,00
Column total	***2,33***	***5,50***	***6,67***	***12,00***	***9,33***

Table 31: Outcome pair-wise comparison between different performance attributes

In the following table (Table 32) the normalised scores of the different performance attributes is shown. The normalized score is calculated by dividing the value by its column total. The sum of all the values in the row adds up to the *cumulative normalized score row total.* Additionally the average is calculated by dividing the cumulative normalized score row total by the total number of performance attributes. By multiplying the average with one hundred the percentage can be calculated and is shown in Table 32.

	Reliability	*Responsiveness*	*Flexibility*	*Costs*	*Assets*	Cumulative normalized score row total	*Average*	***Percentage***
Reliability	0,43	0,55	0,45	0,25	0,32	1,99	0,40	***40%***
Responsiveness	0,14	0,18	0,30	0,17	0,21	1,01	0,20	***20%***
Flexibility	0,14	0,09	0,15	0,25	0,32	0,95	0,19	***19%***
Costs	0,14	0,09	0,05	0,08	0,04	0,40	0,08	***8%***
Assets	0,14	0,09	0,05	0,25	0,11	0,64	0,13	***13%***
Cumulative normalized score column total (Should be 1)	***1***	***1***	***1***	***1***	***1***	5		***100%***

Table 32: Assigned percentage attributes

If the percentages are calculated there has to be checked if the scores assigned to the different attributes are consistent. This check is done by calculating the consistency ratio. The consistency ratio is calculated by matrix multiplication. Matrix multiplication is done by multiplying the row of each performance attribute by the column with the average values. After the matrix multiplication outcomes are divided by the average of the performance attribute which is called the deviation ratio.

	Matrix multiplication	*Average*	Deviation ratios	
Reliability	2,2	0,40	5,52	
Responsiveness	1,13	0,20	5,64	
Flexibility	1,05	0,19	5,51	
Costs	0,42	0,08	5,22	
Assets	0,67	0,13	5,21	+
Sum deviation ratios			27,10	
First correction			0,105	
Consistency ratio			0,094	Should be < 10%

Table 33: Calculation consistency ratio performance attributes

To calculate the consistency ratio all the deviation ratios are added up, which is divided by the number of attributes (5) and decreased by the number of attributes. This generates the value of 0.42. The first correction is calculated by the number of attributes minus one, the value of 0.42 is divided by this outcome (Table 33). To calculate the consistency ratio the value of the first correction is divided by a statistically determined value of 1.12 shown in Table 34. This number corresponds with the number of attributes used in this comparison. This consistency ratio should be below ten percent, which shows the percentages assigned to the different attributes are consistent.

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Table 34: Random index table (Saaty 2001 in Pradhan and Routroy, 2014)

Performance metrics

The assigned percentages to the different attributes are calculated as stated above. Additionally the same calculation has to be made for the different performance metrics. The scale proposed in Table 29 and Table 30 for the pair-wise comparison is also used by assigning the percentages to the different metrics. Below the calculation and the assigned percentages of the different performance metrics are explained.

In the matrix (Table 35) the outcome of the pair-wise comparisons is shown. In a diagonal line the number one is already filled in, since each criterion is equally important to itself. Additionally the column total is calculated.

	Delivery performance	Order fulfilment	Repair service	Management and organization	Order fulfilment lead time	Fill rate	Communication system	Flexibility (Demand)	Flexibility (Stock)	Quality costs	Financial position	Research and development (R&D)	Technical capability
Delivery performance	1	2	3	3	2	2	3	3	3	3	2	3	3
Order fulfilment	0,5	1	3	2	2	2	3	0,5	0,5	3	1	1	1
Repair service	0,33	0,33	1	1	0,5	0,5	1	0,33	0,33	2	0,33	1	0,33
Management and organization	0,33	0,5	1	1	0,5	0,5	0,5	0,33	0,33	2	0,5	1	0,5
Order fulfilment lead time	0,5	0,5	2	2	1	1	2	0,5	0,5	3	0,5	2	1
Fill rate	0,5	0,5	2	2	1	1	2	0,5	0,5	3	0,5	2	1
Communication system	0,33	0,33	1	2	0,5	0,5	1	0,33	0,33	2	0,5	0,5	0,5
Flexibility (Demand)	0,33	2	3	2	2	2	3	1	1	3	1	2	2
Flexibility (Stock)	0,33	2	3	3	2	2	3	1	1	3	1	2	2
Quality costs	0,33	0,33	0,5	0,5	0,33	0,33	0,5	0,33	0,33	1	0,33	0,33	0,33
Financial position	0,5	1	3	2	2	2	2	1	1	3	1	3	3
Research and development (R&D)	0,33	1	1	1	0,5	0,5	2	0,5	0,5	3	0,33	1	3
Technical capability	0,33	1	3	2	1	1	2	0,5	0,5	3	0,33	0,33	1
Column total	***5.67***	***12.5***	***26.6***	***23.5***	***15.3***	***15.3***	***25.1***	***9.82***	***9.82***	***34.1***	***9.33***	***19.2***	***18.7***

Table 35: Outcome pair-wise comparisons

In Table 36 the normalised scores of the different metrics is shown. The normalized score is calculated by dividing the value by its column total. The sum of all the values in the row adds up to the *cumulative normalized score row total.* Additionally the average is calculated by dividing the cumulative normalized score row total by the total number of metrics. By multiplying the average with one hundred the percentage can be calculated and is shown in the Table 36. The *final assigned percentages performance metrics* is calculated by dividing the percentage in Table 32 by the sum of all the performance metrics which are part of one performance attribute multiplied by the percentage of the particular performance attribute.

Normalized score	Delivery performance	Order fulfilment	Repair service	Management and organization	Order fulfilment lead time	Fill rate	Communication system	Flexibility (Demand)	Flexibility (Stock)	Quality costs	Financial position	Research and development (R&D)	Technical capability	Cumulative normalized score row total	Average	Percentage	Final assigned percentages performance metrics
Delivery performance	0,18	0,16	0,11	0,13	0,13	0,13	0,12	0,31	0,31	0,09	0,21	0,16	0,16	2,190	0,168	16,83%	20.0%
Order fulfilment	0,09	0,08	0,11	0,08	0,13	0,13	0,12	0,05	0,05	0,09	0,11	0,05	0,05	1,149	0,088	8,84%	10.5%
Repair service	0,06	0,03	0,04	0,04	0,03	0,03	0,04	0,03	0,03	0,06	0,04	0,05	0,02	0,502	0,039	3,86%	4.6%
Management and organization	0,06	0,04	0,04	0,04	0,03	0,03	0,02	0,03	0,03	0,06	0,05	0,05	0,03	0,522	0,040	4,02%	4.8%
Order fulfilment lead time	0,09	0,04	0,08	0,08	0,07	0,07	0,08	0,05	0,05	0,09	0,05	0,10	0,05	0,900	0,069	6,92%	7.7%
Fill rate	0,09	0,04	0,08	0,08	0,07	0,07	0,08	0,05	0,05	0,09	0,05	0,10	0,05	0,900	0,069	6,92%	7.7%
Communication system	0,06	0,03	0,04	0,08	0,03	0,03	0,04	0,03	0,03	0,06	0,05	0,03	0,03	0,546	0,042	4,20%	4.7%
Flexibility (Demand)	0,06	0,16	0,11	0,08	0,13	0,13	0,12	0,10	0,10	0,09	0,11	0,10	0,11	1,410	0,108	10,84%	9.4%
Flexibility (Stock)	0,06	0,16	0,11	0,13	0,13	0,13	0,12	0,10	0,10	0,09	0,11	0,10	0,11	1,454	0,112	11,18%	9.7%
Quality costs	0,06	0,03	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,04	0,02	0,02	0,356	0,027	2,74%	8.0%
Financial position	0,09	0,08	0,11	0,08	0,13	0,13	0,08	0,10	0,10	0,09	0,11	0,16	0,16	1,425	0,110	10,96%	6.0%
Research and development (R&D)	0,06	0,08	0,04	0,04	0,03	0,03	0,08	0,05	0,05	0,09	0,04	0,05	0,16	0,803	0,062	6,18%	3.4%
Technical capability	0,06	0,08	0,11	0,08	0,07	0,07	0,08	0,05	0,05	0,09	0,04	0,02	0,05	0,845	0,065	6,50%	3.5%
Cumulative normalized score column total (Should be 1)	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***13***	***1***	***100%***	***100%***

Table 36: Normalized values and percentage allocation

If the percentages are calculated there has to be checked if the scores assigned to the different attributes are consistent. This check is done by calculating the consistency ratio.

	Matrix multiplication	Average	Deviation ratio
Delivery performance	2,327	0,168	13,827
Order fulfilment	1,200	0,088	13,577
Repair service	0,522	0,039	13,537
Management and organization	0,546	0,040	13,583
Order fulfilment lead time	0,944	0,069	13,638
Fill rate	0,944	0,069	13,638
Communication system	0,561	0,042	13,380
Flexibility (Demand)	1,500	0,108	13,832
Flexibility (Stock)	1,541	0,112	13,786
Quality costs	0,371	0,027	13,529
Financial position	1,524	0,110	13,907
Research and development (R&D)	0,863	0,062	13,967
Technical capability	0,880	0,065	13,528
Sum			177,729
First correction			0,056
Consistency ratio			***0,036***

+

Should be < 10%

Table 37: Calculation consistency ratio performance metrics

The consistency ratio is calculated by matrix multiplication. Matrix multiplication is done by multiplying the row of each performance attribute by the column with the average values. After the matrix multiplication outcomes are divided by the average of the performance attribute which is called the deviation ratio.

To calculate the consistency ratio all the deviation ratios are added up, which is divided by the number of attributes (13) and decreased by the number of attributes. This generates the value of 0.671. The first correction is calculated by the number of attributes minus one, the value of 0.671 is divided by this outcome. To calculate the consistency ratio the value of the first correction is divided by a statistically determined value of 1.56 shown in Table 34. This number corresponds with the number of attributes used in this comparison. This consistency ratio should be below ten percent, which shows the percentages assigned to the different attributes are consistent.

Appendix 13 Remarks practical determination

Comparable organizations

As can be derived from Table 13 most of the comparable organization gave feedback on the way of selecting and evaluating suppliers rather than on the performance metrics itself. Below the different remarks are shown.

- The most important evaluation of the supplier is during the selection of a new supplier
- The independency of the quality department
- The limited number of supplier available
- If the performances of the supplier are not in line with the agreed performances, the supplier has to come up with an improvement plan.
- Making a clear distinction between the different purchased products. Decide upon the type of products the supplier is allowed to deliver.
- The packaging specifications are considered as specifications of the product.
- The statement on the internal processes is considered important. After all, first the internal process has to be correct, before the suppliers can be addressed on their performances. The internal process of Vencomatic is not the focus of this study and will therefore not be further discussed.

Employees Vencomatic

As shown in Table 14 a number of employees gave feedback on the performance metrics as well as feedback on the process of supplier selection and evaluation. The feedback yielded is shown below:

- The assessment of the suppliers should take place in a formal way
- There is strived for as minimal new suppliers as possible, because of the already large supplier portfolio
- If the suppliers are not performing in line with the performances on which the contract is based, the consequences should be clear for both the supplier as well as Vencomatic.
- There should be clear authorization on which employees are allowed to disapprove the delivered goods

Internal stakeholders

- *Price* is considered as an important metric. Since price is considered the most important metrics if the suppliers perform well on the other metrics, price should be considered separately. The supplier should be assessed on technical/content performance and separately on price. The suppliers that cope with the standard of Vencomatic are qualified make a price for the products demanded.
- Some knockout metrics have to be defined. These are the minimum criteria which all the suppliers have to meet, if they do not they cannot become a supplier. No difference is made between the type of products the supplier delivers. The knockout criteria that have to be defined are:
    - The supplier at least has to score a 2 on the Management and organization metric.
    - The supplier at least has to score a 2 on the Communication system metric.
    - The supplier at least has to score a 2 on the metric financial position. This metric includes the financial position, cash flow, current ratio and the quick ratio. These sub-metrics together account for the metric financial position, which allows them to compensate for one another.

- A distinction has to be made between metrics that will be used for the selection of the suppliers and for the evaluation of the suppliers. This distinction has to be made since a number of metrics should only be assessed during selection, during the yearly evaluation and during the quarterly evaluation.
  These performance metrics and the reasoning why these performance metrics are used during the quarterly evaluation of the suppliers is further discussed in paragraph 11.4.
- It has to be questioned if the scale and score should be determined up front. Since it is difficult to determine up front how the suppliers will score on the different metrics, the scale becomes wider. If the scale is determined after the suppliers are assessed, the scale becomes more specific, by which a better insight of the performances of the suppliers can be created.
- The visualization of the table should be improved. Additionally the different terms should be explained. By doing so, the model will be better usable.

Suppliers

- Supplier A: This supplier is also currently setting up supplier evaluation. Preparatory to the selection of a supplier different type of purchasing strategies (Kraljic matrix) are defined. To each purchasing strategy a different type of suppliers are required. This supplier differentiates ´A´, ´B´ and ´C´ suppliers, which puts different requirements on the performances of the suppliers. During the procurement of a good, there first has to be decided on the purchasing strategy which automatically selects the type of supplier needed. The next step is the selection of a supplier which can be defined as a ´A´, ´B´ or ´C´ supplier. The differentiation between the ´A´, ´B´ or ´C´ supplier should also be made in this supplier selection.

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Appendix 14 Kraljic matrix all product groups Vencomatic

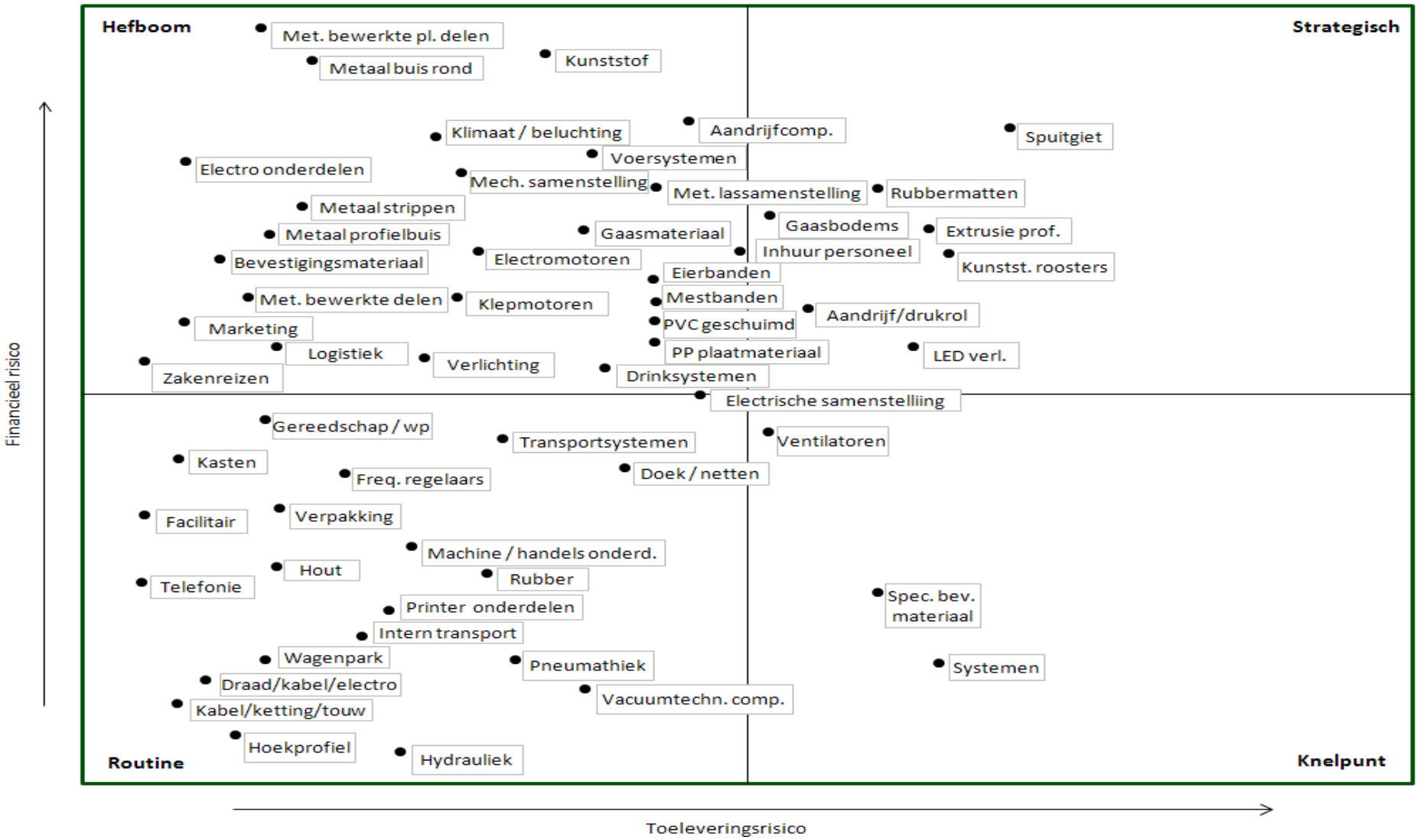

Figure 9: Kraljic matrix, product groups Vencomatic

Appendix 15 Selection suppliers included in the study

The total number of suppliers used by Vencomatic is 1090. A closer look to the suppliers shows that 772 suppliers have delivered for €10.000,00 or less on goods and services in 2013. Looking at the total purchased amount of approximately €61.500.000 in 2013, it can be stated these suppliers can be appointed as sporadic suppliers. Therefore these suppliers will not be included in the analysis.

For the analysis 319 supplier are left. The table (Table 38) below shows the distribution of the different suppliers based on the delivered goods and services in 2013.

Range	*Number of suppliers*
€ 10.000 < € 100.000	222
€ 100.000 < € 250.000	45
€ 250.000 < € 500.000	17
€ 500.000 < € 1.000.000	19
€ 1.000.000 < € 2.500.000	10
€ 2.500.000 < € 5.000.000	5

Table 38: Financial distribution suppliers Vencomatic > €10.000,-

Looking at the suppliers for the 'Grando' breeder housing there is a wide range of suppliers (Table 39). Looking at the biggest suppliers of Vencomatic, the five largest suppliers of Vencomatic are all included in the analysis. Additionally three suppliers of the range between €1.000.000 and €2.500.000 are included. In addition four suppliers are included in the range of €500.000 and €1.000.000, two supplier in the range of €250.000 and €500.000 and two suppliers in the range of €100.000 and €250.000. The last range determined are the suppliers between €10.000 and €100.000 of which three suppliers are included.

Considering the height of the turnover the supplier generated at Vencomatic in 2013, the biggest suppliers are the most important to include in the analysis. Since the large suppliers take account for a significant percentage of the deliveries, which ensures their performances have a big influence.

Organization	*Turnover with Vencomatic*	*Organization*	*Turnover with Vencomatic*
Supplier L	€ 4.211.773	Supplier H	€ 619.931
Supplier N	€ 3.933.000	Supplier P	€ 613.258
Supplier E	€ 2.880.321	Supplier Q	€ 521.747
Supplier A	€ 2.628.745	Supplier D	€ 460.761
Supplier O	€ 2.542.602	Supplier R	€ 366.853
Supplier F	€ 1.761.073	Supplier K	€ 227.961
Supplier M	€ 1.398.582	Supplier C	€ 119.123
Supplier I	€ 1.223.614	Supplier J	€ 43.365
Supplier B	€ 988.311	Supplier G	€ 26.261

Table 39: Suppliers 'Grando' breeder housing including the turnover with Vencomatic in 2013

Additionally there is taken a look at the geographical distribution of the suppliers. This distribution has to be taken in consideration since currently the suppliers of Vencomatic are distributed all over the world. Table 40 gives an overview of the geographical distribution of the suppliers of Vencomatic.

Country of origin of the goods delivered to Vencomatic	*Number of suppliers*	*Country of origin of the goods delivered to Vencomatic*	*Number of suppliers*
Austria	1	Italy	5
Belgium	9	Mexico	1
Canada	1	Poland	4
China	2	Portugal	1
Denmark	4	Romania	1
England	4	Russia	2
France	2	South Korea	1
Germany	11	South Africa	1
Hungary	1	Sweden	1
Indonesia	1	Thailand	1
India	2	The Netherlands	259
Iran	1	Tunisia	2

Table 40: Geographical distribution suppliers Vencomatic > €10.000,-

Although a number of supplier have their headquarters located in the Netherlands, their suppliers, who make the direct deliveries to Vencomatic are located in foreign countries. Supplier A is a supplier of metal components and has their suppliers located in different EU countries like though the main suppliers are located in Italy. Furthermore Supplier F and Q both have supplier located in China who deliver the products directly to Vencomatic.

Vencomatic is aware of the position of the supplier as an intermediary, though this is accepted. The main reason for this acceptance is to have a clear contact point and who is responsible. Therefore the county of origin is defined as the Netherlands. Table 41 shows that thirteen suppliers of the 'Grando' breeder housing are located in the Netherlands. This is a percentage of around 72%, while the percentage of the total number of supplier of Vencomatic is 82%, these.

Organization	Country of origin of the goods delivered to Vencomatic	Organization	Country of origin of the goods delivered to Vencomatic
Supplier L	Belgium	Supplier H	Belgium
Supplier N	The Netherlands	Supplier P	Iran
Supplier E	The Netherlands	Supplier Q	China
Supplier A	The Netherlands	Supplier D	The Netherlands
Supplier O	The Netherlands	Supplier R	The Netherlands
Supplier F	The Netherlands	Supplier K	The United Kingdom
Supplier M	The Netherlands	Supplier C	The Netherlands
Supplier I	The Netherlands	Supplier J	The Netherlands
Supplier B	The Netherlands	Supplier G	The Netherlands

Table 41: Geographical distribution suppliers 'Grando' breeder housing

From the analysis shown above it can be derived the suppliers of the 'Grando' breeder housing are representative for the total number of suppliers of Vencomatic.

Appendix 16 Overview information suppliers included in the study

Nr.	*Organization*	*Components*	*Country of Origin*	*Turnover with Vencomatic*
1	Supplier L	Injection moulded plastic components	Belgium	€ 4.211.773
2	Supplier N	- Metal welding components - Metal shaped parts	The Netherlands	€ 3.933.000
3	Supplier E	Egg belt	The Netherlands	€ 2.880.321
4	Supplier A	- Round metal tubing - Metal striping - Metal profiles	The Netherlands	€ 2.628.745
5	Supplier O	- Round metal tubing - Metal striping - Metal profiles	The Netherlands	€ 2.542.602
6	Supplier F	- Special fastener components - Fastener components	The Netherlands	€ 1.761.073
7	Supplier M	Gear rack driving	The Netherlands	€ 1.398.582
8	Supplier I	- Gauze material - Gauze bottom	The Netherlands	€ 1.223.614
9	Supplier B	- Metal welding components - Metal shaped parts	The Netherlands	€ 988.311
10	Supplier H	Extrusion profiling	Belgium	€ 619.931
11	Supplier P	Rubber matting	Iran	€ 613.258
12	Supplier Q	Mechanical components	The Netherlands	€ 521.747
13	Supplier D	Electronic components	The Netherlands	€ 460.761
14	Supplier R	Wood components	The Netherlands	€ 366.853
15	Supplier K	PVC foamed components	The United Kingdom	€ 227.961
16	Supplier C	Rubber components	The Netherlands	€ 119.123
17	Supplier J	Mechanical components	The Netherlands	€ 43.365
18	Supplier G	Mechanical components	The Netherlands	€ 26.261

Table 42: Different suppliers of components for the 'Grando' breeder housing