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Supplier Evaluation System in the Food Industry

Master Thesis

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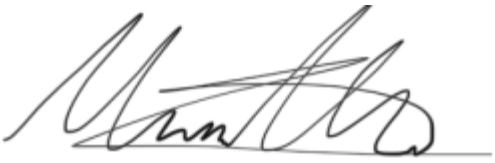

Marcus Wuttke

Abstract

Evaluating suppliers is something that the majority of companies has to do and is something that often is a complex problem with many parameters and variables involved. This is especially true for a company like Kiviks Musteri that purchases a variety of different products from all over the world from different types of suppliers that come from different cultures and backgrounds. It is also essential that the suppliers and purchased goods meet demands in a vast amount of different areas including sustainability, food safety, origin and quality to name a few. This thesis has been conducted in collaboration with Kiviks Musteri, hereafter referred to as The Company (TC).

This thesis has looked into TC's current supplier evaluation process and has analysed both how this process can be improved, and how this process can be integrated into a new supplier evaluation IT-system. This has been done by conducting a case study on The Company to thoroughly analyse their current situation and process, and comparing this to a comprehensive literature review of different areas within supplier evaluation. This case study showed that the current evaluation process was inadequate in several ways, especially regarding how the attributes and performance measures are designed and constructed in regards to evaluating and assigning scores to the suppliers. This led to a new suggested model being constructed with new attributes, scoring scales, attribute weights and quantification of previously purely qualitative attributes and performance measures. In relation to this a model for supplier monitoring and product control has also been constructed using game theory and Nash equilibrium.

This suggested process has also been incorporated into a new proposed supplier evaluation IT-system. This suggested system has been designed as a cloud-based solution and with an emphasis of being easy-to-use. The goal of this IT-system is to gather all the data being used in the evaluation into a better structure, decrease the manual labour needed for the evaluation, increase the flexibility of the process and provide better and more meaningful data as a basis of decision making. In this proposed IT-system there are suggested functionalities, design and data requirements that aim to fulfill the objectives and goals of the system. To illustrate this an interactive mock-up of the system has been created to give the reader a feel for how the system works and how users can use this system to carry out their tasks in the supplier evaluation process in an effective and efficient way.

Keywords: Supplier Evaluation, Supplier Evaluation Process, Supplier Evaluation in the Food Industry, Supplier Evaluation System, Supplier Evaluation IT-system

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Chapter 1

Introduction

This chapter describes the background to this master thesis together with its purpose, problem formulation and research questions. A brief description of the company is provided and also the focus & delimitations and the structure of the thesis.

1.1 Background

Strong supplier evaluation is something that is important from a business perspective for multiple reasons. It helps in identifying risk factors and hidden waste and cost drivers in order to be able to react proactively and earlier to problems that might arise. It also increases performance visibility and can increase the performance of the suppliers due to being able to more clearly be able to identify areas or procedures that need improvement.

What attributes and performance measures to evaluate suppliers on can be hard to determine and vary between industries, companies and product groups (Mohsen, 2020) (Segura et al, 2019). Therefore companies need to investigate what attributes and performance measures are going to give the best representation of the quality of their suppliers, both for current and new potential suppliers. Evaluating all suppliers on every possible attribute and performance measure is not only irrelevant but also very resource-intensive (Mohsen, 2020). Challenges also arise in determining the importance of different attributes and performance measures and weighting the criteria accordingly (Segura et al, 2019) (Olhager, 2019).

When evaluating suppliers a lot of attributes and performance measures are going to be purely qualitative which poses challenges when comparing and ranking suppliers against each other (Taherdoost & Brard, 2019) (Segura et al, 2019). These attributes and performance measures need to be quantified in a meaningful and representative way in order to achieve high quality comparisons and rankings among the suppliers.

The relative importance between buyer and supplier is also something to consider in the future relationships with the supplier (Olhager, 2019). A choice between small and local suppliers and larger international suppliers will have an effect in many different departments throughout the company and requires analysis and consideration.

TC wants to improve their current evaluation process to further increase quality and insight in their supply chain and their suppliers. Furthermore, this improved process is going to be digitized to make it easier to manage, both internally at The Company but also for the suppliers. Due to suppliers being located in multiple countries with different levels of

IT-knowledge it is of great importance that this new system is user-friendly and well-integrated with TC's existing systems and procedures.

1.2 Purpose

The purpose of this research project is to improve and digitize TC's supplier evaluation process.

1.3 Problem Formulation & Project Description

The purpose of this research project is divided into two parts. The first part is to develop an improved model and process for evaluating TC's suppliers. This model will act as guidelines as to how TC evaluates their suppliers and the workflow related to it. The goal of this model is to improve TC's knowledge on their suppliers and improve the decision basis on their supplier selection to further increase quality and control throughout TC's supply chain.

The second part consists of digitizing this new process in a new system that is integrated with TC's current systems and procedures. The scope of this project will be set together with the IT-department at The Company to determine whether it is manageable within this research project or if it is too extensive and more suitable as its own project. In the case that it’s too extensive, the second part of this research project will consist of a detailed project plan for this system on how it would work, what functions should be implemented, how it could be integrated with TC's current systems and how to operate it. A major focus on this system is also that it is user-friendly and easily implemented.

1.4 Company Description

The Company is a family owned producer of a wide array of products in the fruit industry which became Sweden's first professional cultivation of fruits when it was founded in 1888. As of 2019 TC has a turnover of 754 MSEK and 200 employees. Their main products are different types of juices, wines, marmalades and ciders being most recognised for their apples and apple products that they grow themself in Skåne. TC produces over 600 different articles, both their own products and products for other brands with the distribution between the two being about 50-50.

In addition to their main production site in TC they also have a farm and café in Solnäs since 2015, another production plant in Stenhamra since 2014 and an office in Stockholm. The Company holds certificates in many different areas, for example FSSC 22000 in food safety,

ISO 14001 & Krav in sustainability and Fairtrade relating to social responsibility. TC overall has had a large growth the past 20 years, almost quadrupling their turnover between 2000 - 2020. (TC Musteri's introductory presentation, 2020)

1.5 Research Questions & Contributions

The contribution from this thesis to The Company is improved quality and control throughout the supply chain and in a more effective process that demands less resources to manage. The goal is that the new process increases the identification of risk factors and hidden waste and cost drivers, and also improves supplier performance and performance visibility. The goal with the new system is to streamline the handling of data and make it easier for both TC and their suppliers to manage as well as also demanding less resources.

The research questions are the following:

Q1: How should The Company evaluate their suppliers and what should this process look like?

Q2: How could this process be integrated in an effective and easy-to-use IT-system?

1.6 Focus & Delimitations

The focus of the first part of this research project is to evaluate and improve TC's supplier evaluation process, not actually evaluating their suppliers. This means that this project will cover evaluations methods, workflow, risk indicators, correlation factors, etc., partly by analysing current data on the suppliers that TC possesses.

The same logic goes for the second part of the project as well. The focus will be on designing and make a recommendation for what the system should look like. This will include for example, what data from the suppliers should be present in the system, how this data should be collected and added to the system and how to make it user friendly for TC to use. An interactive mock-up of the IT-system will be made with a suggestion of what the system could look like, but the actual development of this system will be left for future research.

1.7 Report Structure

Chapter 1: *Introduction* covers the background to the thesis and what its purpose and goals are. The chapter will also give a description of TC as a company and how this thesis can help both them and research in general.

Chapter 2: *Methodology* will cover how the research and writing of the thesis is conducted. The methods, approaches and strategies will be explained and discussed and summary of the chosen methodologies will be presented.

Chapter 3: *Literature Review* will cover how the author has conducted the review of current knowledge and theories on the subject as well as a frame of reference of the knowledge and theories reviewed. This chapter will also explain what type of information is searched for and why it is relevant for The Company and the thesis as a whole.

Chapter 4: *Empirical Data* will show and explain all the data gathered throughout the thesis. This includes how TC's current supplier evaluation process works, how evaluations are conducted today and what attributes and performance measures TC are using today. This chapter will also cover the case study on ICA's supplier evaluation process used for comparison.

Chapter 5: *Analysis* will compare TC's current situation to theories found in the literature review. Improvement areas will be discussed and a suggestion on design of TC's new IT-system will be presented.

Chapter 6: *Recommendation* will present the suggested actions TC should take from here. This has been divided into short term goals where TC could take action right away and long term goals which should be used as a guide for more long term improvements.

Chapter 7: *Conclusion* will summarize the thesis with a focus on the identified problems, the suggested solutions and how well the research questions were answered. Suggestions for future research will also be presented.

Chapter 2

Methodology

This chapter describes the different strategies, methods and approaches being used in the research of this thesis. Each section will have an explanation of how it works and a motivation of why it is useful in this thesis. The chapter ends with a description of how a case study is structured and carried out.

2.1 Research Methods

When conducting research it is important to have a predetermined method and strategy for how the research should be conducted. The chosen research method depends on the nature of the research being conducted. According to Höst et al, (2006) there are four main research methodologies.

1. Descriptive: A descriptive study can be made within an area where there exists a lot of knowledge and the goal with the research is to in depth analyse a specific problem or phenomenon.

2. Exploratory: The goal of this research is to analyse an area where there currently is little or non pre existing knowledge.

3. Explanatory: The goal of this research is to find explanations or links as to why a phenomenon exists or occurs.

4. Problem Solving: A problem solving methodology can be used when there is a clearly identified problem that needs to be analysed.

This thesis has two main research questions and will use different methodologies in order to answer each of them. For the question about the evaluation process an exploratory methodology will be used. Even though there are a lot of general theories and knowledge about supplier evaluation, a customized process for TC that fits all of their needs has not been researched before.

For the second research question about creating a new supplier evaluation IT-system for the supplier evaluation, a mix between the exploratory and problem solving methodology will be used. The analysis in the first part will provide a clear answer for what the supplier evaluation process will look like and therefore we have a clearly identified problem digitizing this process, which is the part where a problem solving methodology is used. The exploratory part of the digitization is the design of the system and how the data should be presented to TC.

This since there is very little knowledge in this area since TC doesn't currently have an IT-system dedicated to supplier evaluation.

2.2 Research Approach

There are two main ways of conducting research on an observed phenomenon, a deductive approach and an inductive approach.

The deductive approach starts with a predetermined theory that is broken down into more specific hypotheses that can be tested. Thereafter data or observations are collected which are then used to either prove or reject or the hypotheses. Based on this we can either confirm or disprove our original theory.

The inductive approach is roughly the opposite of the deductive approach. In the inductive approach we start with some data or observations and then determine what logical conclusions could be drawn from this data. Hypotheses that could explain this data or observations are formed and tested and theories are formed as a result of confirming these hypotheses. An illustration of these approaches can be seen in figure 2.1.

According to Young et al (2020) you can also combine these two approaches among a spectrum between the two. This approach can be useful when analysing complex phenomenons with a lot of factors that affect them. An example of this when analysing qualitative data is what Young et al (2020) refers to as constructivist grounded theory, where the data is analysed with the goal of contributing to previous understandings of a phenomenon.

In this thesis a mix of these approaches will be used. Some theories are formed early in the process and then either confirmed or rejected, but also a lot of observations will be made where the pattern is studied which then leads to hypotheses and theories.

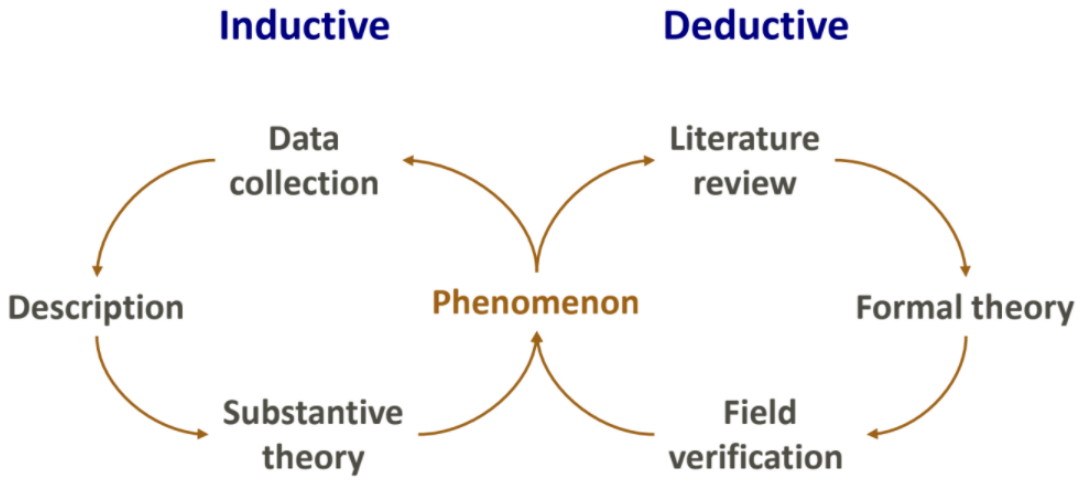


Figure 2.1: The inductive and deductive approach (Woodruff 2003, referred by Olhager 2020)

2.3 Research Data Collection

When conducting research there are two types of data that can be collected, quantitative and qualitative. Quantitative data is often easier to analyse and present in the form of graphs or charts since it is composed of numerical information. Qualitative data on the other hand is information in the form of words and concepts. Qualitative data could for example be a description of the working conditions at the supplier or a description of how the supplier is working with sustainability. This information is very hard to quantize and needs to be analysed in different ways than the quantitative data. This section will show what type of data needs to be gathered, how it is going to help the research, how it can help TC in their supplier evaluation and how it is going to be collected.

2.3.1 Quantitative Data

Quantitative data can either be collected and analysed in its own form or derived from other types of data. For example, data that is being collected in its own form could be how many percent of the time the order from the supplier was delivered on time. Another quantitative measure that is derived from other data could be a numerical supplier risk score that depends on several other other factors, some of them also quantitative and some even qualitative.

Quantitative data is analysed using mathematical models and statistics. The goal of the analysis is to help TC better interpret the data to get a better understanding of what it means and to help make it easier to do complex comparisons between suppliers that include multiple variables. The statistics part can also help make predictions or probability measures about future events.

A challenge in this thesis is trying to quantify part of the data being used in the supplier evaluation process that is being used in a qualitative fashion today in order to make it easier to present, understand and compare with other supplier data. One of the benefits of quantifying data is that it is going to be the same whoever looks at or uses the data, which eliminates biases.

2.3.2 Qualitative Data

Qualitative data can oftentimes be harder to analyse than quantitative data. According to Gibbs (2008) there are two activities involved in analysing qualitative data. The first one is developing an awareness of the kinds of data that can be collected and examined and how to describe and explain this data. The second is practical activities that assists with the kinds of data and the large amounts of it that need to be examined. This is referred to as the practicalities of qualitative analysis.

Due to the nature of qualitative data it is easier to draw biased conclusions from this data and therefore it is important to take measures against these biases (Moss, 2016). Moss describes four common biases when analysing qualitative data.

- Representative: Misinterpreting how phenomena affect each other due to not analysing enough the base rate of how phenomena occur by themselves.
- Holistic: Interpreting that phenomenons are more connected than they are and drawing inaccurate conclusions from this.
- Elite: Putting too much weight into conclusions from well known researchers or publications without analysing lesser known research enough.
- Confirmatory: Actively looking for research that supports the author's previous beliefs or theories.

To eliminate these biases it's important to keep them in mind throughout the analysis, conduct thorough research and approach the sources in an objective way.

2.4 Research Strategies

According to Yin (2014) there are five majors research strategies, experiment, survey, archival analysis, historical and case study. The appropriate strategy is determined based on the form of the research questions, if it requires control over behavioural events or if the focus is on contemporary events.

Strategy	**Form of research question**	**Requires control over behavioural events**	**Focus on contemporary events**
Experiment	how, why	yes	yes
Survey	who, what, where. how, many, how much	no	yes
Archival analysis	who, what, where, how many, how much	no	yes/no
History	how, why	no	no
Case study	how, why	no	yes

Table 2.1: Research strategies, Yin (2014)

In this thesis a case study will be used in order to analyse TC's specific situation regarding the supplier evaluation process and the IT-system that handles this process. This case study will be complemented with a more shallow case study of ICA's supplier evaluation process and IT-system that will serve as a benchmark and a ground for comparison to TC's situation.

The case study will be supported by a series of interviews with the purchasing and supply chain departments at TC as well as an interview with Senior Buying Manager at ICA, Marcus Welin Sandgren. The interviews with TC will have an unstructured approach with the goal of creating a broad and general view of TC's evaluation process. The interview with ICA will be conducted with a semi-structured approach mixing predetermined questions with a more open discussion to look at more specific areas that will serve as a foundation for the comparison with TC. The interview guide for this interview can be found in the appendix.

2.5 Case Study

The research in this thesis has been conducted in the form of a case study at The Company. According to Yin (2009) there are six steps in a case study: plan, design, prepare, collect, analyse and share. After the first step of planning the case study the rest of the steps are conducted in an iterative way. This model is illustrated in figure 2.2. This section will describe the different steps in this process and how it is applied to TC.

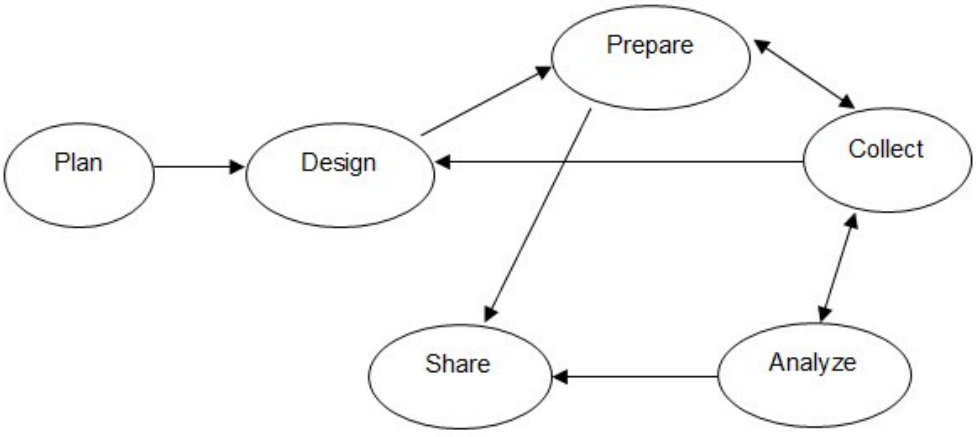


Figure 2.2: Case Study Research Process, Yin (2009)

2.5.1 Planning the Case Study

The planning part of the case study is firstly about deciding whether a case study is the right method for the intended research in the first place. According to Yin (2009) a case study is suitable if the main research questions are “how” and “why” questions, which this thesis has. It is also recommended if the researcher has little or no control over behavioral events and if the phenomenons analysed are contemporary rather than historical.

2.5.2 Designing the Case Study

The first part of designing the cases is determining the unit of analysis of the case and setting the limits and bounds of the case. The units of analysis is what is being researched in the case study. In this case on The Company the units of analysis is the supplier evaluation process and the supplier evaluation IT-system.

The case study can either be designed as a single case study or as a multiple case study. The multiple case study can provide comparisons or support that leads to valuable insights or more robust conclusions, but requires more time and resources. This thesis will use two case studies, the in depth one on The Company and a more shallow one on ICA to be able to make comparisons between the two.

The design of the case should be evaluated on four parameters in relation to the what the quality of the research could be once finished. These four parameters are: construct validity, internal validity, external validity and reliability.

Construct Validity

The construct validity is to which degree the research actually analyses what it claims to. To achieve this multiple interviews with people at TC in different positions was conducted to get a broad view of both the evaluation process and evaluation IT-system from multiple sources. Information was also gathered from internal documents and presentations. The author was also given access to internal supplier data used for evaluation.

Internal Validity

To achieve internal validity it is important to investigate that no unaccounted for factors affected the discovered results. If for example, the conclusion could be that event X led to event Y and that there is a casual relationship between X and Y. But if there is actually a third unaccounted for factor Z that caused Y, the research has failed to achieve internal validity. Yin (2009) argues that one technique to increase internal validity is to compare empirical

patterns with predicted ones, called pattern matching. This tactic was used in this thesis as well as for each casual relationship found analysing what other potential explanations could have led to the observed event.

External Validity

The external validity is to which degree the findings and conclusions in this study can be applied outside the context of this study. To increase this the author has chosen to make a second more shallow case study on ICA to make the conclusions more general.

Reliability

Reliability means that if another researcher would conduct the same case study that was conducted in this thesis, the same findings and conclusions would be reached. To increase this, a case study protocol was developed and every step of the case was documented in depth. The questions and answers to the interviews have also been documented, both the unstructured and the semi-structured interviews.

According to Modell (2005) it is also important to triangulate the findings in the literature to make sure the conclusions are well supported. This is done by using different methods and sources to analyse a specific phenomenon in order to get multiple perspectives and see if the same conclusion is reached.

2.5.3 Preparing to Collect Data

The preparation stage of the case study is to make sure the researcher has sufficient skills to carry out the case study. Desirable traits to have according to Yin (2009) is being comfortable with procedural uncertainties that may arise, being a good listener, having a firm grasp of the subjects being studied and having high ethical standards. It's also essential to prepare the development of a case study protocol and to take measures to avoid bias.

2.5.4 Collecting Case Data

According to Yin (2009) there are six types of data that can be collected in a case study, documents, archival records, interviews, direct observations, participant-observation and physical artifacts. Yin suggests using a multiple sources principle where two or more sources should point to the same conclusions or findings for the source to be relevant. In order to achieve this the author has conducted multiple interviews with multiple people at TC

discussing the same type of problems and combined this with multiple theoretical frameworks from different sources.

2.5.5 Analysing Case Data

The goal of the analysis stage in the case study is to produce empirically based findings, which according to Yin (2009) can be done with five different types of data analysis. These five data analysis methods are examining, categorizing, tabulating, testing and recombining evidence. To find similarities and discrepancies in the data the answers from the interviews with TC were mapped and then compared both to TC's internal data and the data from presentations TC gives to external entities. This data was then compared to theories on supplier evaluation to create what Yin (2009) refers to as explanation building.

A second case has been conducted at ICA to serve as a benchmark in the analysis. ICA was chosen since they have a subdivision that purchases the same products as TC does and have the resources of a larger corporation and more developed evaluation methods. The similarities and discrepancies between TC and ICA, together with the theories from the literature review, serve as foundation for analysis in chapter 5.

2.5.6 Share Results

According to Yin (2009) it is important to identify the audience of the report and to adjust the content and presentation accordingly. The main audience for this thesis is The Company and more specifically the purchasing and supply chain departments as well as other students and academics at Lund University. For this reason the thesis has a well balanced mix between theoretical frameworks and analysis as well as practical step by step actions to improve the supplier evaluation process. This was made possible through a close collaboration with the supervisors both at TC and Lund University and an iterative writing process to ensure high quality throughout the thesis.

2.6 Summary

As a summary of the methodology chapter the research method, research approach, research data and research strategy can be seen in table 2.2.

Type of Methodology	Chosen Methodology
Research method	● Exploratory for evaluation process ● Problem solving for IT-system
Research approach	● Spectrum between inductive and deductive
Research data	● Mix of quantitative and qualitative
Research strategy	● Case study

Table 2.2: Table of chosen methodologies

Chapter 3

Literature Review

This chapter describes the process of conducting a literature review on the topic of supplier evaluation. Each section is an area within supplier evaluation where a review of current knowledge and information has been conducted. Each section will explain why this area has been researched and a summary of the current knowledge and theories will be presented to create a frame of reference.

3.1 Reviewing Process

In a literature review it is important to have a structured approach of how the data should be examined and extracted. According to Hempel (2020) there are four key steps in data abstracting in a literature review, coding or charting, summarizing, organizing and prioritizing the different aspects of the material.

Available literature on the subject was found using academic search engines like Google Scholar, ResearchGate and LUBsearch, Lund University's own search engine. Material deemed relevant was reviewed and compiled in a summary with the key concepts, conclusions and take-aways from all the literature.

The findings were then analysed to find whether the different findings were at some point contradicting each other or where they could support each other to make even stronger conclusions. This was then organized into different sub-categories and the most applicable conclusions for TC were prioritized in this thesis.

These next sections are the different sub-categories in supplier evaluation on which the literature review was conducted on. In these sections it will be presented why these categories have been chosen, what questions this literature should answer and what information or knowledge was acquired.

3.2 Supplier Evaluation Process

The first part of the case study on The Company is the process around the supplier evaluation. The process is defined as everything around evaluating supplier from considering a new supplier to having a close relationship with continuous evaluation that spans over many years. This process include for example but are not limited to:

- Initial review of new suppliers
- Scoring and ranking suppliers
- Collecting certificates, questionnaires and sub-supplier mappings
- Visiting suppliers
- Evaluation attributes and performance measures
- Working methods and responsibility
- Supplier risk assessments
- Sustainability and environmental impact

In this section we can see broad subcategories on different parts of the supplier evaluation process.. In each category it will be explained why this category is relevant for the supplier evaluation process and what information or knowledge was gained from the literature review on this subject.

3.2.1 Evaluation Attributes and Performance Measures

When evaluating suppliers you need to have certain attributes and performance attributes to be able to compare between the suppliers. The most straightforward way of doing this is with quantifiable measurements that have a numerical value as its output that can be directly compared with other suppliers. But not all attributes are quantifiable and there are many ways to compare qualitative measurements. The literature in this section provides information on, for example, how to select relevant performance measurements, how to gather supplier data, and how to compare qualitative measurements.

Mohsen (2020) identifies that there are a large number of different criteria to evaluate suppliers depending on industry, product or individual factors. These criteria can however all be categorized under the following ten criteria headings, technological, quality, managerial, history & reputation, environmental, geographical, financial-economic, social, time and risk. From this Mohsen (2020) has created a framework and identified ten key attributes and five key performance measures when evaluating suppliers.

Mohsen (2020) expresses that it's important to define the differences between an attribute and a performance measure and defines it as the following:

- **Attribute:** Supplier characteristics or standing. The data from the attributes are possible to obtain without having previous experience with the supplier.
- **Performance measure:** Measuring the performance of a committed task against predetermined standards. The buyer must have experience with the supplier to obtain this.

Mohsen (2020) proposes the following framework for supplier evaluation that can be seen in figure 3.1. New suppliers are only evaluated on their attributes while suppliers in the current

supplier pool are evaluated both on the same attributes but also on their performance measures.

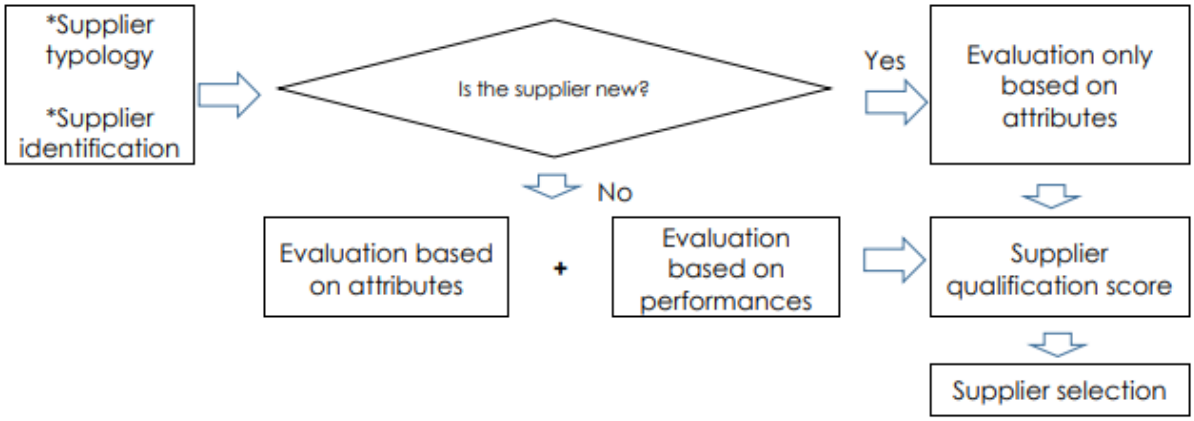


Figure 3.1: Framework for supplier evaluation based on attributes and performance measures (Mohsen, 2020)

The ten key attributes and five key performance measures that Mohsen (2020) recommends to be used in this framework can be found in table 3.1. The relevance of these attributes and performance measures are to be determined by the individual company to create the supplier typology that consists of the attributes and performance measures that the supplier should be evaluated on (Mohsen, 2020) (Hald & Ellegaard, 2011). This typology could contain different attributes and performance measures for different types of products, countries, purchasing volume, product groups or similar.

Attribute	Description
Supply	This attribute concerns supplier qualification in relation to the characteristics of supplying items, including the variety and supply risk (variety in items – parts, subassemblies, products, etc. - and services)
Technological	The attribute is related to hardware, software and humanware qualifications of supplier
Quality	The qualification of supplier's quality management (including quality assurance and quality control) is treated under this attribute heading
Organizational and managerial	The attribute considers supplier organizational and managerial competences including the structure, management systems, etc.
Economic-financial	The focal point under this attribute is the supplier's qualifications in terms of economic and financial

	competences.
History and Reputation	The attribute focuses on supplier competence in terms of reputation, historical records, and persistence probability in the long run and in critical situations, etc.
Social	Under this attribute, the social competences of suppliers, especially accomplishing social responsibilities are investigated.
Environmental	In this attribute, the supplier competence in protecting the environment is in focus.
Geographical	The supplier's qualification in terms of geographical location is explored under this attribute
Security	This attribute stresses supplier qualification for information security
Performance measure	**Description**
Innovation Performance	How well did the supplier perform during the execution of previous innovative contracts? Has it improved procedures/instruments/workflows or technical documentation in coordination with the organization?
Cost performance	How acceptable is the supplier's cost performance? Has it increased costs? Has it created hidden costs? Are there any new discounts?
Quality performance	How good is the quality of the supplier outputs? How many defective items has it produced? How many reworks and returns?
Delivery performance	How appropriate was the supplier's delivery in terms of time and place of delivery?
Flexibility performance	To what extent has the supplier responded to the changes in the organization's needs and demands?

Table 3.1: Key attributes and Performance measures (Mohsen, 2020)

Mohsen proposes determining the relevance of the attributes and performance measures by using a Content validity ratio (CVR) originally invented by C. H. Lawshe in 1975 (Ayre, C. & Scally, A. J., 2014). The method requires a panel of people that are answering the questions whether a certain attribute or performance measure is i) Essential, ii) Useful but not essential, or iii) Not necessary for the organisation. The formula for calculating the CVR is the following:

$$CVR = (n_e - n/2)/(n/2)$$

Where n is the total number of panel members and n_e is the number of panel members that deemed the attribute or performance measure to be essential. Whether or not an attribute or performance measure should be accepted depends on what P-value is assigned for the probability of falsely rejecting the null hypothesis that the attribute or performance measure is not significantly essential. An example of a table containing the minimum CVR-value for acceptance for different numbers of panelists given P=0,05 are shown in table 3.2.

No. of Panelists	Min. Value
5	.99
6	.99
7	.99
8	.75
9	.78
10	.62
11	.59
12	.56
13	.54
14	.51
15	.49
20	.42
25	.37
30	.33
35	.31
40	.29

Table 3.2: CVR minimum value for acceptance given P=0,05 (Mohsen, 2020)

The accepted attributes and performance measures will then make up the supplier typology which shows what criteria the supplier should be evaluated on.

Olhager (2019) argues that an important aspect to take into consideration when choosing suppliers is the balance between low cost and the flexibility of the supplier. It's common that if the product being bought is made to stock the supplier is competing on price, while if the product is made for the specific customer order it's more likely the supplier is more flexible. This is because if the product is made for the specific order the supplier can customize the product and sometimes create new product variants for the individual customer. The appropriate type of supplier in this regard can vary between industries, companies or individual products. It's common that products like raw materials are more suitable to make for stock while more complex products need more flexibility from the supplier (Olhager, 2019) (Lau et al, 2018).

Olhager also argues that the relative importance between the buyer and the supplier is important for the relationship between the two. If the buyer has a relatively strong position of power you can lose some of the advantages of economies of scale and essentially pay too much for the supplier innovation and technological improvements. If the supplier has a relatively strong position of power the buyer runs the risk of receiving bad service or not having the suppliers being incentivised enough to accommodate their needs. When the power distribution is relatively equal there is a basis for a good relationship where there is room for growth and changes in the purchasing volumes. This is illustrated in figure 3.2. This type of relationship is according to Olhager (2019) extra important when the buyer needs a lot of flexibility from its supplier. A good range for this is when the buyer stands for around 20-30% of the supplier total production volume, according to Olhager (2019).

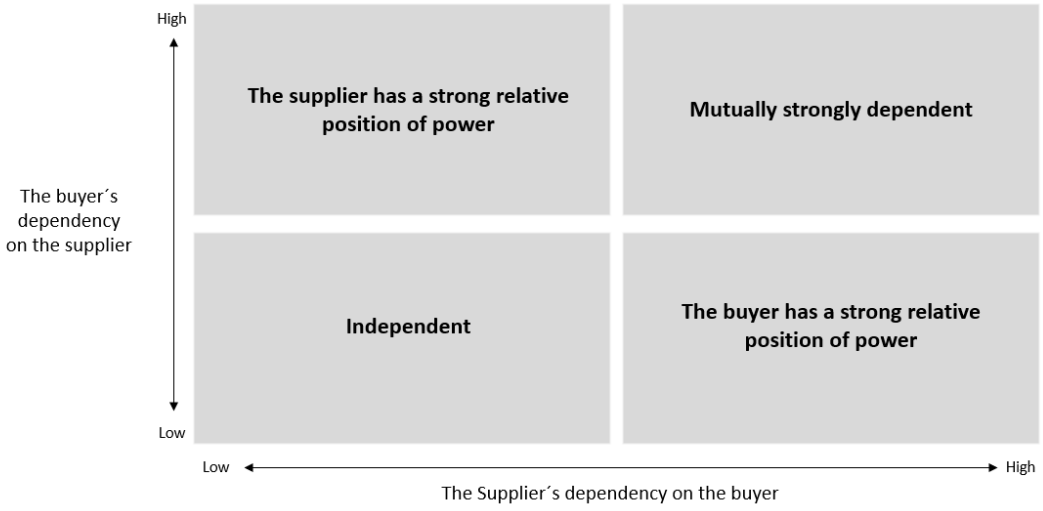


Figure 3.2: Perspective on supplier relationships (Olhager, 2019)

3.2.2 Sustainable Sourcing

An aspect of supplier evaluation that has become more and more important in corporations core strategy is sustainability (Zang et al, 2020). Therefore a relatively large portion of this literature review has been targeted at sustainability. This review provides information on how to measure sustainability, how to use sustainability attributes as performance measures and how to encourage and evaluate sustainability innovation throughout the supply chain.

Evaluating and selecting suppliers on the basis of sustainability can be viewed as a Multiple - criteria - decision - management process, from now on referenced as MCDM (Giannkis et al, 2020) (Ahmadi et al, 2020) (Fallahpour et al, 2017). MCDM is useful in complex decision making with many parameters where decision makers constantly have to weigh in trade-offs in a wide range of criteria that are affected by the decision. Giannkis et al (2020) argues that corporations often only measure attributes that are easily quantifiable and easy to calculate, for example transport distance and associated emissions, and often neglects other aspects that

are harder to quantify like working conditions. Ahmadi et al (2020) also argues that in the case of sustainability performance very few corporations actually look at the sustainability innovation of the supplier. This means looking also at the rate of improvements within the sustainability area instead of just looking at the current results. In a mathematical sense this could be viewed as looking at the derivative of a supplier's sustainability performance.

Giannkis et al (2020) argues that the Analytic Network Process (ANP) is the best way to determine the right sustainability performance measures and the weights between them. The steps in this process are illustrated in figure 3.3.

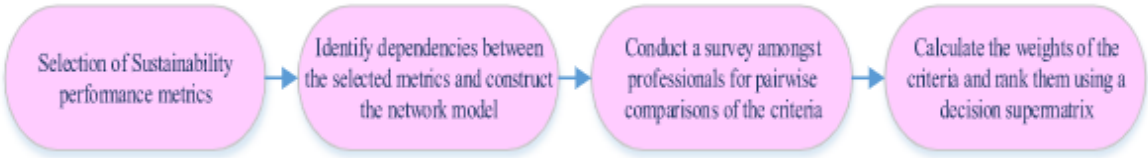


Figure 3.3: The Analytic Network Process, (Giannkis et al, 2020)

The second step in the ANP is looking at different performance measures to analyse the inner and outer depencies of different attributes when selecting suppliers. Inner dependencies are when changes within an area affect other attributes within the same area and out dependencies are when the changes affect other areas. This model can be seen in figure 3.4. To illustrate this concept a few examples of dependencies from Giannkis et al (2020) have been compiled in table 3.3. These dependencies are then compiled into a dependency mapping which is then used in the third step of the ANP.

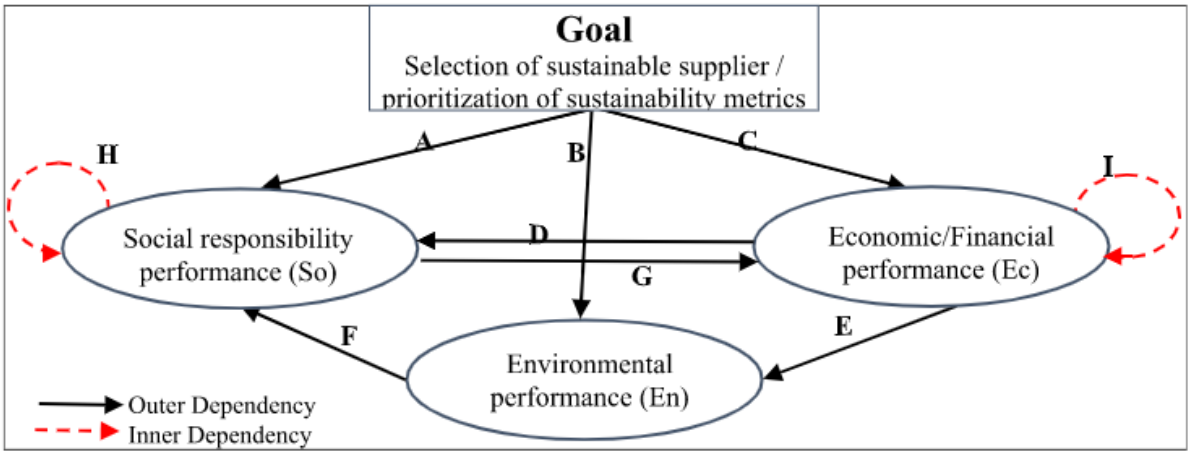


Figure 3.4: Mapping of inner & outer dependencies, (Giannkis et al, 2020)

Inner Dependency	Explanation
Social	It is possible that the company could reduce community complaints if they engage the communities in which they operate.
Economic	Joint investments in new processes or products could increase productivity and lower the price in the future.
Outer Dependency	**Explanation**
Environmental → Social	Selecting a foreign supplier with longer transport and more emissions might increase customer complaints.
Economic → Environmental	If the company invests in a new transport tracking system they might reduce emissions.

Table 3.3: Examples of inner and outer dependencies (Giannkis et al, 2020)

The third step in the ANP is to let experts or people with a lot of experience within the industry or the company make pairwise comparisons between the different attributes to analyse how important they are in relation to each other. These comparisons are made both on a high level between for example social responsibility and environmental performance but also between the individual attributes within each area. These comparisons are then compiled in the last step of the ANP where a decision supermatrix is created that shows the relevant attributes, how important they are in relation to each other and how suppliers are compared to each other.

Supplier selection on the basis of sustainability is a topic that has been getting a lot of attention the last couple years. Zang et al (2020) has analysed the interest and the amount of new research within the subject and concludes that there has been a significant increase of new methods, approaches and new articles being published between 2015-2020. Zang et al (2020) argues that this is a result of sustainability becoming more and more central in corporations strategy due to an increase in customer environmental awareness and government regulations. The research of Zang et al (2020) also shows that two of the most used approaches to assign weights to different performance measures within sustainability was the ANP method used in Giannkis et al (2020) or a pure expert judgement strategy which also is a part of the ANP method.

3.2.3 Comparing and Ranking Suppliers

To be able to compare suppliers on a large amount of different aspects and attributes there needs to be some sort of mathematical model in order to eliminate biases when scoring and ranking suppliers. The more quantifiable the attributes are the more use there is from using mathematical models. Therefore, this section will also cover how to quantify data that is normally qualitative, but there also needs to be models for comparison between attributes that are purely qualitative. The review has also been focusing on how different attributes should be weighed in different situations and with different products. There are a number of extensive and complex comparing and ranking models, but this review has focused on models that are more straightforward and easier to use.

To be able to more easily compare suppliers on certain attributes there needs to be some type of unified quantitative score that's going to be used on all suppliers, even on purely qualitative attributes (Segura et al, 2019) (Demir et al, 2018). Segura et al (2019) suggest quantifying the qualitative attributes by assigning them a score between 0-100 based on predetermined targets that have to be met. The possible scores that a supplier can achieve in a certain attribute can depend based on the nature of the attribute being evaluated. One attribute could for example generate a score of either 0 or 100 based on if a specific criteria is met, and another could, for example, generate the following scores (0, 20, 55, 85, 100) based on what criteria are met. The different scores that can be achieved between 0-100 within the attribute should be determined by the company based on the nature of the criteria and how the predetermined targets within the criteria relate to each other. Examples from Segura et al (2020) on how these scores can be distributed can be seen in table 3.4.

Attribute	Score
Food Safety	(0, 50, 100). 100 if the supplier has at least one food safety certification. 50 if a HACCP has been conducted. 0 otherwise.
Withdraw Volume	(0, 30, 75, 100). 100 if "none". 75 if "low". 30 if "medium". 0 if "high"
Environmental	(0, 100). 100 if the supplier has an environmental certificate. 0 otherwise.
Origin	(50, 75, 100) 100 if local. 75 if domestic. 50 if international.
Organic	(75, 100) 100 if organic. 75 otherwise.

Table 3.4: Examples of how qualitative attributes can be quantified (Segura et al, 2019)

To generate a more accurate total score for the supplier it is important that the scores on the different attributes are weighted according to their importance (Segura et al, 2019) (Olhager,

2019) (Taherdoost & Brard, 2019). Olhager suggest the following formula to calculate the total weighted score:

$$TWS = \Sigma(w_i \times s_i)$$

Where TWS = Total weighted score, w_i = weight for evaluation attribute i where $\Sigma w_i = 1$ and s_i is the score for evaluation attribute i.

Segura et al (2019) suggest a similar model for weighing attributes, but in two layers where scores in different categories are weighed into the total score, and each category contains a number of attributes which are weighed to produce the score within that category. Segura et al (2019) has also produced a suggested weighting for the different categories and attributes for the fresh fruit industry. This model and the suggested weightings can be seen in figure 3.5.

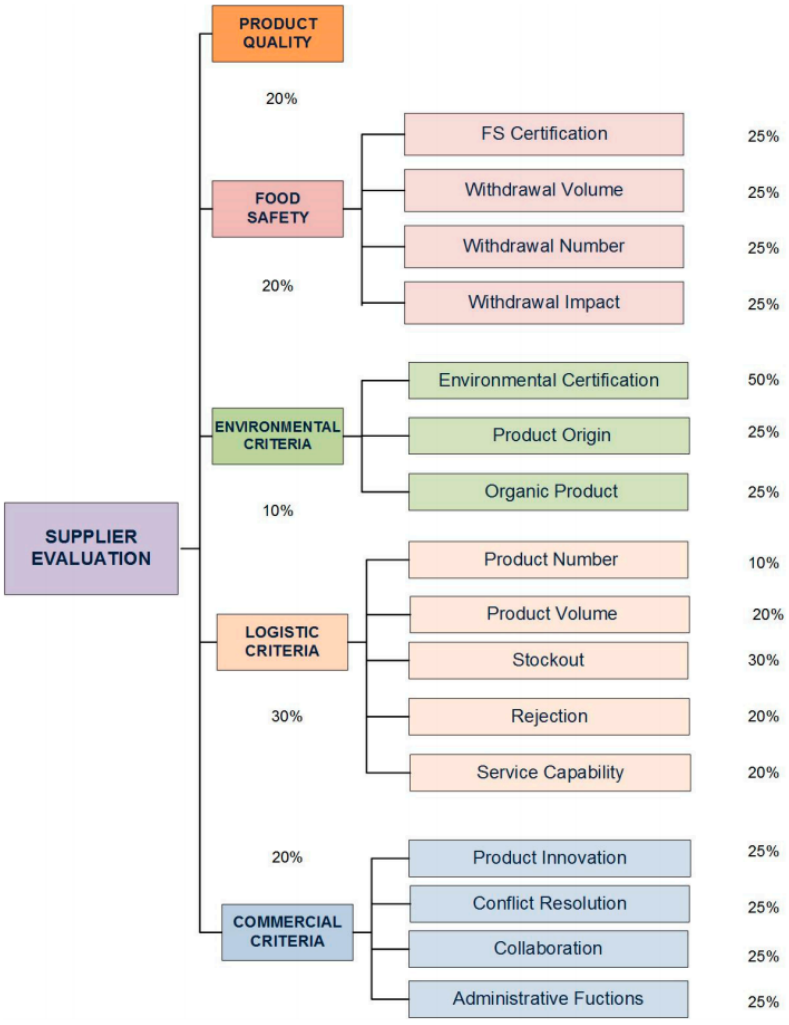


Figure 3.5: Weighting model and suggested weightings for the fresh fruit industry (Segura et al, 2019)

3.3 Supplier Evaluation IT-system

An important part of this thesis is enabling the supplier evaluation process to be incorporated into an integrated IT-system. To increase adaptability and productivity it's important that the system has a user friendly experience and a quick implementation phase. The goal of this system is to reduce resources spent on data entry, data analysis and data collection. The system will also provide decision makers with more relevant information in a more presentable way. This review has looked at how software can help display data in a more useful way, how to create a user friendly experience and how to integrate systems together. This review has also looked at the pros and cons of running such an IT-system on an internal server with only internal access, compared to a web based solution where the data could be accessed anywhere.

The IT-system for supplier evaluation is a tool for decision making that affects large parts of the supply chain (Effeny, 2019) (Omurca, 2013). Effeny (2019) defines it as a decision support system that uses and transforms data that the company possesses that enables decision makers to interpret the data in a way that helps them make better decisions. Effeny (2019) argues that a lot of companies evaluate their suppliers manually, which is very time and resource consuming and subsequently lead to many companies not taking as many factors about the supplier in consideration as they would have with a supplier evaluation IT-system. Effany further argues that using a supplier evaluation IT-system and having more meaningful data as a basis for decisions increases the competitiveness in the supply chain.

One of the most important aspects when developing an IT-system is the user experience (Talatappeh & Lakzi, 2019) (Effendy, 2019). Talatappeh & Lakzi (2019) identifies three key indicators that a system is user-friendly:

- The system is easy to understand for its users and the functionalities matches the expectations of the users
- The system can satisfy the users needs
- The system is efficient and effective for the users to carry out their work in

In order to combine these indicators there often needs to be many different functionalities in order to provide the users with all the tools needed to perform their work in an efficient way. However this increases the complexity of the system thus often making it harder to understand and more difficult to work in. Talatappeh & Lakzi (2019) argue that it's important that the different functionalities can be reached with as few steps as possible and what steps to take should be self-explanatory by the system. Further it's advantageous to have as few different views as possible as well as using a design where the functionalities to a great extent can be understood intuitively.

In terms of running the IT-system on an internal server or having a cloud based solution there are pros and cons with both solutions (Talatappeh & Lakzi, 2019) (Trovato, Sharp, & Siman,

2019). Running the system on an internal server lets you keep full control over the data and can protect companies from events like connection issues. However with a cloud based solution the accessibility is increased since the system can be reached anywhere, it doesn't require any own hardware like servers, is often cheaper and also often easier to implement. Talatappeh & Lakzi (2019) argues that with the current advances in cloud computing technology a cloud based solution is in most cases preferable when it's possible to have.

To ensure the system is of high quality Effendy suggests giving questionnaires to the users to evaluate different aspects of the system. The questions are divided into four categories and answered on a scale of 1-4 where 1 is "strongly disagree", 2 is "disagree", 3 is "agree" and 4 is "strongly agree". This allows the developers to identify improvement areas and specific identified problems. These areas could then be subject for improvement if deemed necessary and changes are possible to implement. The system should therefore also be built in a way that easily allows for updates and changes after the system has been implemented and is in use. The proposed categories and factors for the evaluation questionnaire can be seen in table 3.5.

Category	**Factor**
Usability	The system is easy to use
	The system is easy to understand
	The application is running well
	The language used by the system is easy to understand
Functional completeness	The input used is easy to enter and understand
Performance	The system provides a fast response
Overall	The output of the system built can help in evaluating the company's supplier
	The system is made good in its entirety

Table 3.5: Factors when evaluating the supplier evaluation IT-system (Effendy, 2020)

3.4 Summary

As a summary for this chapter table 3.6 was created that contains the different areas reviewed and what questions the conclusions from the review should answer. These questions could be seen as sub-questions under the two research questions.

Area Reviewed	Questions Answered
Evaluation Process	● What should the supplier evaluation process look like from a broad and general view?
Attributes & Performance Measures	● What attributes and performance measures should companies look at on their suppliers? ● How should these measures be designed? ● How can companies obtain the data needed for these measures?
Sustainable Sourcing	● How can companies measure sustainability in their suppliers? ● How should companies use sustainability in their evaluation?
Comparing & Ranking	● How can companies compare and rank their different suppliers? ● How can qualitative measures be quantified in a meaningful way to make it easier to compare and rank suppliers?
Supplier Evaluation IT-system	● What should an IT-system for supplier evaluation look like? ● Should this system be cloud-based or run on an internal server? ● How can the system be designed to create a user friendly experience?

Table 3.6: Summary of questions answered by the literature review

Chapter 4

Empirical Data

This chapter will go through all the available information about TC's current situation. The first part will give a view of TC's current supplier evaluation process. This will show what attributes TC is looking at today, how the reviewing process works and what determines what they are looking at in different situations at individual suppliers. The second part will show what systems TC uses to keep track of all supplier data and the workflow around working in this system. Lastly a more shallow case study on ICA has been conducted to serve as a benchmark for comparison.

4.1 Introduction to Empirical Data

The empirical data consist of all the available data that was accessed about TC's supplier evaluation process as well as a chapter about the more shallow case study on ICA. This is used to explain and describe TC's current situation from both a broader view as well as specific details about how the evaluation is conducted today. The data has been gathered from different interviews and presentations, but also from getting access to a lot of TC's actual internal supplier data. In this chapter TC's current situation around different aspects of supplier evaluation will be presented.

4.2 Current Evaluation Process

TC has two types of supplier evaluation, one initial evaluation before they use a supplier for the first time, and a continuous evaluation of the suppliers in the pool of existing suppliers. When conducting the initial evaluation the most central attribute is the suppliers market reputation and current customer base. This since TC has no current experience from the supplier where information can be drawn to evaluate the supplier. It is common in the initial evaluation that multiple departments within TC are involved to make sure that the supplier is a good fit for TC from multiple perspectives.

When the supplier becomes an existing supplier to TC the continuous evaluation is conducted, with a more thorough review being conducted at least every 3 years, but sometimes more often than that. This evaluation has certain elements that are mandatory for all suppliers and some that are individually customized. These supplier evaluation strategies are explained more thoroughly in 4.2.2.

TC also uses third parties for certain elements in the evaluation like issuing certificates and conducting visits with the intention of investigating a specific matter.

A model has been made by the author to illustrate TC's supplier evaluation process. A larger copy of this model can be found in the appendix.

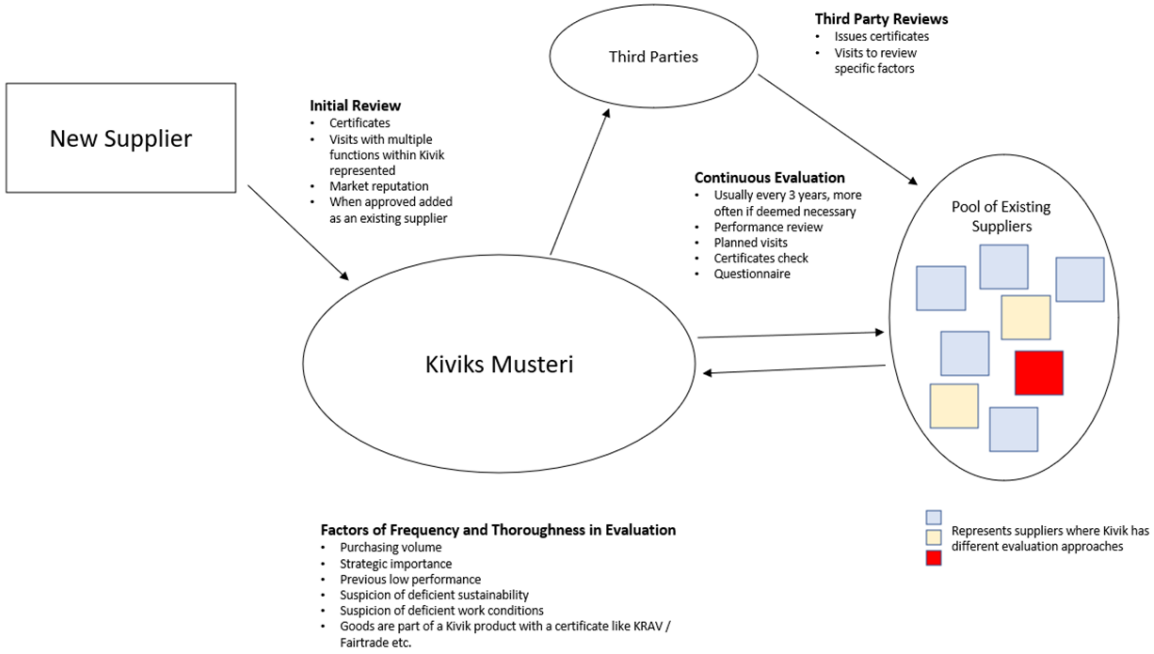


Figure 4.1: TC's Evaluation Process, figure made by the author.

4.2.1 Evaluation Attributes & Performance Measures

Today TC evaluates their suppliers on a few quantitative attributes, but the majority of the performance measures are today purely qualitative.

One of the most central performance measures in TC's evaluation is a supplier score based that is created from combining five different attributes. Each attribute gets a score from 1-3 and all scores are then multiplied to create a total score between 1-243. The five parameters are:

1. **Strategic importance:** The more critical the products from this supplier is to TC the higher the score in this parameter. If a supplier is more critical to TC the more likely TC is to make a more in depth evaluation. This score is not created from any quantitative measures but is set based on the experience and knowledge of the procurement department at TC.
2. **Value of purchased goods:** If the yearly value of the purchased goods are under 500.000 SEK the supplier gets a score of 1 in this parameter. 500.001-6.999.999 SEK generates a score of 2 and over 7.000.000 gets a score of 3. This means that the higher

the value of purchased goods from a supplier the more likely TC is to make a more in depth evaluation. As we can see this parameter is purely based on numerical values and doesn't have any qualitative aspects in it.

3. **Quality & product safety:** Here TC makes a qualitative assessment of both the quality of the product and the product safety. High quality and safety generates a score of 1 and vice versa which means that if quality has been good and the safety is deemed high TC is less likely to make a more in depth evaluation.

4. **CSR & environmental impact:** Here TC assesses the corporate social responsibility and environmental impact from the supplier with worse perceived performance generating a higher score. This is also a qualitative score based on a number of factors like certificates and pollution.

5. **Risk of cheating:** Here TC tries to assess the probability of any cheating or dishonesty from the supplier. This is another qualitative measure where country of origin and potential prior misconducts will be weighed in.

This supplier score is a numerical value that consists of both qualitative and quantitative measures and could be viewed as a measure of the combined importance and risk TC sees in the supplier. TC defines supplier score of <15 is considered to be low, 16-40 is medium and >40 is considered high. These scores don't have any fixed predetermined actions to them but rather serves as an indication to TC on the frequency and thoroughness in the evaluation of the individual supplier.

Every supplier has to provide TC with a mapping of their sub-suppliers which is then evaluated by TC on attributes like food safety and environmental impact. The basis of this evaluation is mainly the country of which the products are produced and the distance the products have to be transported.

TC sends questionnaires on the management system, product safety and environmental & social responsibility to all their suppliers. These answers are then evaluated by the purchasing department for potential risks or improvement areas for the supplier.

TC also uses visits as a performance measure. When TC themselves visit the supplier they are looking at an overall impression, and when they want a more specific matter investigated it is more common that TC contracts a third party to conduct the visit.

4.2.2 Different Evaluation Strategies

There are four different types of suppliers that TC uses today, manufacturer, agent, trader and customer-purchased goods. Manufacturer is the actual producer, agents is a middleman that doesn't handle the products themselves, traders are middlemen that also stores and ships the products and customer-purchased goods is when TC's customer already has decided what

products TC should buy to produce their product. There are a lot of steps in the evaluation process that are the same for every supplier, see table 4.1. Depending on the results from the evaluation attributes and performance measures combined with the type of supplier TC, sometimes deploys different evaluation strategies on individual suppliers. Examples of these kinds of extra measures can also be seen in table 4.1. These extra measurers includes, but are not limited to:

All suppliers	Extra measures
Sub-supplier mapping	More frequent evaluation
TC's code of conduct	TC demanding extra certificates
HACCP (risk assessment)	TC visiting the supplier
Certificates	The supplier has to show how they are working to solve a specific problem
Questionnaires	A third party will visit the supplier and conduct an investigation

Table 4.1: Evaluation strategies for all suppliers and extra measures

The main factors that determine this more thorough evaluation is according to TC the result from the Supplier Score from 4.2.1 and if there have been any problems or deviations with the supplier. According to TC, using this strategy of individual customized evaluations can save resources and allow more focus on evaluating and improving problem areas.

4.3 Current Evaluation IT-System

Today TC stores information about their suppliers in a number of different ways in different places. TC does not currently have an IT-system dedicated to supplier evaluation but instead stores and uses their data in traditional ways in Excel and folders. This can have the benefit of saving resources on development, maintenance and training but poses other difficulties that will be explored later in this thesis. This also means that the supplier has no way of submitting their data directly into TC's system, but TC instead has to enter all supplier data manually. This also means that the suppliers have no insight of what information TC has on them and if any of it is inaccurate or out of date. This section will show where TC currently stores their data and how they use it.

4.3.1 Supplier Information Folder

Each supplier that TC's is currently purchasing goods from or have purchased goods from in the past has its own folder on TC's server. Here all the information about the supplier is stored from certificates, notes from visits, answered questionnaires, risk analysis (HACCP), relevant correspondence and the supplier’s sub-supplier mapping. This information is used when TC is conducting the evaluation of the individual supplier.

4.3.2 Supplier Summary in Excel

TC has a summary of their suppliers where key information is stored. This contains basic information about the supplier and other key attributes used to get an overview of the suppliers and to make it easier to compare them to one another. This summary contains the following information:

- Basic information about the supplier, what product they supply and if they are currently an active supplier.
- Date for the latest evaluation and a date for the next planned evaluation
- If TC has visited the supplier and in that case date of last visit.
- Supplier score from 4.2.1
- Box for general comments
- Supplier general performance score from 1-5

This Excel is today the main tool for comparison between suppliers and for getting an overview of the status of the supplier. When the evaluation is conducted TC mainly uses other sources to gather information like the supplier folder, and the key results from the evaluation are then added to the Excel.

4.3.3 Other Information Sources

TC logs every delivery in a database and can keep track of each supplier's performance regarding both quality and delivering on time. This information is today stored but not used by the purchasing department since the current system has no way of presenting this data in a useful way to the decision makers. According to TC, delivery accuracy and quality logs are still a part of the supplier evaluation, but from the perspective of how the people conducting the evaluation have experienced the supplier’s performance on these attributes.

4.4 Comparison With ICA

The ICA Group is the largest supermarket chain in Sweden with a market share of slightly over 50%. ICA's business main business model is franchising and collecting a part of the revenue from the different stores. ICA is mainly finding their franchisees internally and often helps them with loans and education to start a new store. By being incorporated as an ICA store owner the individual store owners can gain advantages from representing a recognised brand and various marketing activities. Store owners are also part of ICA's centralized purchasing strategy where ICA purchases goods to their central warehouses and then resells the products to the store owners. This centralized purchasing strategy leads to ICA being one of the largest purchasers of fresh fruit and associated products in Sweden, which leads to them being a very interesting subject for a comparative case study for The Company.

In this chapter we will explore what ICA's supplier evaluation process looks like and how they have incorporated this into their IT-system. Key differences between ICA and TC will be highlighted but the analysis of what TC can learn from this will be discussed in the analysis in the next chapter. In order to get this information the purchasing manager for fruit and vegetables at ICA's central warehouse in Helsingborg, Marcus Welin Sandgren, was interviewed.

ICA has a larger supplier base and a higher purchasing volume per year than TC does today. Even though the exact numbers are confidential Marcus estimated that a small supplier has a purchase value of a couple million SEK/year while a larger supplier can have a purchasing value of over 100 million SEK/year. This compared to TC which defines their large suppliers as over 7 million SEK/year. ICA is today using a purely continuous evaluation strategy compared to TC that partly evaluates continuously but also conducts a more thorough review of the supplier at least every 3 years.

Similar to TC, ICA purchases their products either directly from the manufacturer, from an agent or from a trader. ICA has an internal goal that they want to purchase as much as possible directly from the manufacturer as this increases ICA's control over the product. Only when this is not feasible ICA will use agents or traders. ICA visits all their suppliers unlike TC that only visits some, according to Marcus ICA visits their European suppliers every 1-2 years and suppliers outside the EU every 2-3 years. Similar to TC, when buying from a supplier for the first time ICA's main evaluation aspects are the supplier's market reputation and current customer base.

Similar to TC, ICA identifies which countries are deemed risky and collects certificates from all suppliers on food safety and sustainability. In addition to these certificates ICA also demand a social certificate from a third party from countries they have identified as risky. This compared to TC that has created their own Code of Conduct document that the suppliers need to sign. According to Marcus, ICA is planning to collect these social certificates from all suppliers in the coming years.

Looking at the sustainability aspect ICA has been focusing a lot on pollution from transportation of the products as well as the UN's 17 Sustainable Development Goals. One demand from ICA to their suppliers is that they chose 5 of the 17 Sustainable Development Goals and show ICA how they are actively working towards those goals. Very recently ICA has decided to start working with Science Based Targets developed by World Resources Institute and according to Marcus this is going to be ICA's primary focus of development in the sustainability area over the coming years.

ICA has an IT-system dedicated to supplier evaluation where suppliers themselves can contribute with necessary information or documents. This system also handles logs over quality, delivery accuracy and other deviations and presents it to decision makers. This compared to TC that stores this data in a different system and is not able to present this data to the decision makers in the purchasing department. According to Marcus, ICA has recently been exploring how this system could be updated to a cloud based solution.

Key similarities	Key differences
Purchases from manufacturers, agents and traders	ICA has a larger purchasing volume and more suppliers
Tries to spread risk by buying the same product from multiple suppliers	ICA visits all their suppliers and more often
Prioritize and values long term relationships with their suppliers	Suppliers can contribute documents like certificates and sub-supplier mappings themselves into ICA's IT-system
Identifies risky countries	ICA's IT-system can present relevant data over quality logs and delivery accuracy
Market reputation and current supplier base is the main evaluation attribute when considering new suppliers	ICA is looking into having their IT-system cloud based
	ICA's sustainability efforts are mainly focused around the UN 71 Sustainable Development Goals and Science Based Targets while The Company mainly uses different certificates
	ICA is using a purely continuous evaluation strategy compared to The Company that partly evaluates continuously but also has a more thorough review at least every 3 years

Table 4.2: Key similarities and differences between The Company and ICA's supplier evaluation process

Chapter 5

Analysis

This chapter will cover the analysis that has been made on TC's supplier evaluation process and IT-system. This means that the findings in the literature review has been applied to the empirical data in an effort to find gaps and improvement areas. The first part of the analysis is mainly a gap-analysis between TC's current supplier evaluation process and the findings in the literature. The second part consists of a game theory based model for supplier monitoring and the third and final part is a proposed new IT-system for the evaluation process. This chapter will be the basis of the suggested recommendation for The Company in chapter 6.

5.1 Introduction to Analysis

This thesis will mainly use a Gap analysis to look at differences between the empirical data of The Company and what current literature, theories and knowledge suggests. Section 5.2 will show the gaps between the literature and TC's current supplier evaluation process. Section 5.3 analyses how suppliers cheating can be mitigated without excessive resources and controls being made. This is done using a game theory based approach based on finding the mixed strategy Nash-equilibrium for how much control and monitoring should be made on suppliers. The final section 5.4 will show a suggestion of a supplier evaluation IT-system using the findings in section 5.2. This will be presented using an interactive mock-up of what the system could look like alongside its functionalities and design.

5.2 Evaluation Process Gap Analysis

Looking at what TC uses as evaluation attributes and performance measures today the literature supports that these are relevant and important, however there are too few measures which means too few aspects of the supplier are being evaluated. The attributes are also not optimally structured and designed in a way that will present the most accurate overview and the comparisons and rankings can potentially be misrepresented.

Firstly TC should divide the evaluation attributes and performance measures into different categories (Segura et al, 2019). Each category has a certain number of attributes and performance measures under it, each is assigned its own score and then a category score is then calculated based on the weights of the different attributes and performance measure for that category. Segura et al (2019) suggests the following categories for supplier evaluation of suppliers in the fresh fruit industry:

- Product quality
- Food safety
- Environmental
- Logistic
- Commercial

Segura et al (2019) suggests having around 4-5 attributes and performance measures in each category, however notes that what attributes and the amount of attributes that are relevant can vary greatly between companies and products being purchased. The amount of data points and attributes that TC uses should be increased with additional measures, however as Mohsen (2020) agrees, it is important to determine what attributes are relevant in the given situation. Measuring unimportant attributes and performance measures additionally counterproductive since it wastes resources and redirects attention from other measures that are more relevant. Therefore TC should consider what measurements are relevant for different types of suppliers in different product categories. Mohsen suggests using a Content Validity Ratio model where experienced employees at TC, and perhaps other experts within the field, rate each potential attribute on how relevant this attribute is in this situation. Only the attributes and performance measures that pass a certain predetermined ratio of being deemed relevant are then to be used in the actual evaluation. This model is more closely described in the literature review on evaluation attributes and performance measures in section 3.2.1.

Another improvement area for TC in regards to the attributes and performance measures is designing them to be more quantifiable (Segura et al, 2019) (Mohsen, 2020) (Shin, H., Benton, W. C. & Jun, M, 2009) (Demir et al, 2018). The current method TC is using today with the scoring of the five attributes in the supplier score from 4.2.1 is a first try of quantifying some of the qualitative attributes, but several problems arise in the current method. The first major issue with the current situation is that there are no clearly predetermined activities or performance metrics that indicates what score is to be given between 1-3 for each supplier for the qualitative attributes. The only attribute in supplier score that has predetermined metrics is the only of the five that already is fully quantitative, namely purchasing volume. Purchasing volume has monetary values where if TC buys for over a specific amount from a supplier that supplier gets a higher score, while the qualitative attributes have no such markers. This can lead to inconsistent scores over time and in between employees at TC determining the scores. TC should set predetermined activities or performance metrics on all qualitative attributes on what should be done by the supplier to get a specific score (Segura et al, 2019). Segura et al (2019) suggest using a scoring range between 0-100 where the company themselves can determine how many different possible scores are available and what should be done to get these scores, depending on the nature of the attribute. An example of how this model works can be found in table 3.4. This is also the model being used in the proposed IT-system in 5.4.

Regarding the quantitative attributes TC can score suppliers by using a linear scaling model to score suppliers even more accurately in regards to each other. This would work as giving the supplier with the highest quantitative measurement a score of 100, the lowest a score of 0

and all suppliers scores linear to the difference between these two base scores. For example, let's say TC were to score suppliers on purchasing volume and the lowest purchasing volume was 1 MSEK and the largest was 2 MSEK. The supplier with the purchasing volume of 1 MSEK would get the score 0, the supplier with 2 MSEK would get the score 100, a supplier with the purchasing volume of 1,5 MSEK would get the score 50 and a supplier with 1,7 MESK would get the score 70 and so on. By doing this the scores given to the suppliers would be even more differentiated and more accurately representing how the suppliers measurements relate to each other (Grimheden, 2020). This scaling model is only applicable to attributes and performance measures that are purely quantitative in nature because of the ability to measure the exact differences between the suppliers. In qualitative attributes and performance measures the differences are often more unclear and therefore the scaling model should not be implemented on these attributes and performance measures.

Kvik should be using quality and delivery accuracy as performance measures in their evaluation. Mohsen (2020) considers these two performance measures to be two of the five most important performance measures in supplier evaluation. This claim is further supported by the comparative case study on ICA where purchasing manager Marcus Welin Sandgren explains that ICA uses both of these performance measures and views these are important measures, which are also automatically imported to the supplier evaluation IT-system. This information exists today in TC's business system, however not in a format that can present it in a meaningful way that can be used for supplier evaluation. TC should develop this system so that the data that goes into the system is compiled in a way where users can easily access delivery accuracy as a percentage over a given time period, as well as the quality results as a score, both at a specific quality check and as a mean score over a given time. If this was done it would be easy to use these performance measures as any other quantitative performance measure due to the data output being numerical. The optimal solution for this would be if TC's business system was integrated with the supplier evaluation system and these scores could automatically be updated continuously, however this would further complicate the development and increase resources needed to develop a new supplier evaluation IT-system. Therefore the suggested design for the new supplier evaluation system in section 5.4 does not have this functionality, but rather suggests the previously mentioned solution where the scores on these performance measures are manually entered into the supplier evaluation system, but clear and easily accessible data points are being generated by TC's current business system.

The next gap found between TC's current evaluation process and the literature is the compilation and weighing of the category and attribute scores. TC's current solution of weighing each attribute with equal weight is not coherent with current literature (Olhager, 2019) (Taherdoost & Brard, 2019) (Segura et al, 2019). There are several problems that arise regarding the current procedures. Firstly the current scoring system with possible scores between 1-3 gives too little nuance and doesn't give the opportunity to differentiate enough between scores and relatively different performances will get the same score due to it only being 3 different possible scores. TC needs to increase the possible scores that suppliers can receive in different attributes and performance measures. Olhager (2019) suggests using at

least 1-5 and Segura et al (2019) prefers as previously mentioned a scale of 0-100. In the suggested IT-system in 5.4 the latter has been used. Secondly the method of multiplying the scores to generate a possible score between 1-243 can be misleading since it can give a very skewed perception of how the performance of the suppliers actually relate to each other. TC should be using a method where the score total score is a reflection of the scores in the attributes and performance measures (Olhager 2019) (Segura et al, 2019) (Demir et al, 2018). This means that the total score represents the average score given in the different attributes and performance measures. This is done by having the total score of the supplier in the same format as the attributes and weighing the scores into and average score. This will both represent the performance more accurately in relation to the attribute scores as well as the comparisons between suppliers becoming more perceivable and understandable. By weighing the attributes by level of importance the total score for the supplier becomes even more accurate in regards to the performance of the supplier on the grounds of what TC values. TC should also alter the weights based on, for example, type of supplier and product group in order to be able to get a supplier score based on the level of importance of different attributes or performance measures for this supplier type or in this product group (Olhager, 2020) (Mohsen, 2020). This concept is illustrated with the term “Weighing profiles” in the suggested supplier evaluation IT-system in 5.4. Similar to what attributes to use the weighing profiles are highly individual depending on company and product category. However Segura et al (2019) has made a suggestion for weights on suppliers in the fresh fruit industry for the previously mentioned categories from where TC can draw inspiration. The weights that Segura et al (2019) suggest are the following:

- Product quality: 20 %
- Food safety: 20 %
- Environmental: 10 %
- Logistic: 30 %
- Commercial: 10 %

To increase flexibility these weights and weight profiles do not have to be static, but can be updated after different needs. Therefore it’s important that the evaluation process is designed to easily allow updates and tweaks without demanding a lot of time and effort to implement these changes. A suggestion of how this can be managed easily can be seen in the suggested IT-system in 5.4, in figure 5.2 with weighing profiles that are easily edited and assigned to different suppliers.

TC values strong relationships with their suppliers today but has no clear predetermined way of incorporating this into their supplier evaluation. Complications arise when TC is a relatively small buyer for the supplier and not given enough attention, priority or have enough power to make impacts and changes that would be beneficial for TC and their relationship with the supplier. Other problems also arise when the supplier is small relative to TC's purchasing volume where it can be hard to quickly increase product volume bought and TC frankly contributing too much for the supplier's innovative efforts and technological improvements compared to if the supplier was larger and had a larger percentage of their

revenue coming from other buyers as well. Olhager (2019) suggests analysing the relative importance between the buyer and the supplier to be able to more accurately be able to identify suppliers where there is a possibility of a mutual strong dependence where the likelihood of a strong relationship is the highest. TC should incorporate this as an evaluation attribute in the supplier evaluation. As previously described with quantifying qualitative attributes TC should set a predetermined range of scores possible in this attribute where TC's purchasing volume as a percentage of the supplier's total revenue could be the underlying measure for assigning the score in this attribute.

Sustainability is a factor that is important for TC throughout their supply chain. An important factor in this that TC is not looking at today in their supplier evaluation is the sustainability innovation from the supplier. By working closer together with the supplier on sustainability improvements and not only looking at the current situation, but also using the changes in the sustainability measures in the evaluation companies get a more long-term valid sustainability plan as well as closer relationships with their suppliers (Ahmadi et al, 2020). TC should therefore start to incorporate improvement measures in the attributes connected to sustainability both for more accurate evaluation, but also for further improving the relationships with their suppliers.

Evaluating sustainability in suppliers is often complex with multiple variables involved. When making decisions that will change variables it's important to analyse the dependencies of the variables changed i.e. how changes in these variables changes other variables (Giannkis et al, 2020) . This is important when considering changing suppliers, when engaging in efforts or investments or when choosing new suppliers. When deciding to make these changes not only the current measures should be considered but also what effects these changes could have in the future or in other areas (Giannkis et al, 2020). For example, maybe the right decision is to accept a price increase from a supplier instead of switching if this can lead to the supplier being able to afford investments that could increase productivity or reduce environmental impact in the future. Dependencies vary greatly between individual companies and dependencies should therefore be analysed internally from experienced employees or experts and be taken in consideration when evaluating suppliers or making decisions that will afflict change throughout the supply chain (Giannkis et al, 2020).

A summary of the gaps found between the literature and TC's current supplier evaluation process can be found in table 5.1.

Area	Gaps
Attributes & performance measures	Not enough attributes and performance measures are taken into account to give a nuanced comparisons between suppliers
	Current model of assigning scores between 1-3 does not provide the opportunity do make accurate differentiations between suppliers
	Qualitative attributes and performance measures does not have clear predetermined activities or performance metrics for what qualifies as a certain score
	Logs on quality controls and delivery accuracy is not actively part of the evaluation
Weighing scores	The method of multiplying the supplier scores does not give meaningful understanding of the supplier's performance and it's hard to relate suppliers performances against each other when comparing and ranking
	Weighing supplier attribute scores on the basis of importance is not being performed
Supplier relationships	The use of supplier relationship and relative importance between TC and the supplier is not being used actively in the evaluation
Sustainability	Inner and outer dependencies of how different areas affect each other are not being analysed
	Sustainability innovation as a performance measure is not being used in the evaluation

Table 5.1: Summary of gaps found in the supplier evaluation process

5.3 Supplier Monitoring Using a Game Theory Based Approach

Monitoring suppliers and conducting meticulous controls of products is something that is often not done enough by companies in the food industry, according to Lau et al (2019). This is often due to monetary reasons since close monitoring is often expensive, and by companies trusting their suppliers too much. TC has expressed in interviews that this area is something that they are focusing on right now and that they want to improve. They have also expressed that their analysis of the market is that companies in general are not monitoring enough, as well as there being more organic products sold to consumers than are actually being produced. This lack of monitoring gives incentives for suppliers to cheat since their expected monetary payoff can sometimes be higher by cheating than not cheating (Lau et al, 2019).

To counter these incentives companies can do two things, monitor the suppliers more or enforce harder punishments on suppliers that are caught cheating by, for example, immediately terminating the contract. However these actions are costly for the companies, either by paying for monitoring or by incurring supplier switching costs or not being able to acquire adequate products. Because of this, a method of controlling enough to eliminate suppliers incentives to cheat by using the least amount of resources possible is what will generate the highest expected monetary payoff for the company.

The author has created an interactive model in Excel for TC that can illustrate different scenarios of what the incentives for supplier fraud or cheating could be, and what action TC has to take to remove these incentives using the minimal amount of resources. This Excel has also been given to TC as a part of this thesis. A screenshot from the suggested model can be seen in figure 5.3. A larger copy of this model can be seen in the appendix.

The model is based on the finding the Nash equilibrium created by the mathematician John Nash. The definition of a Nash equilibrium is the strategy where no agent has the incentive to deviate from the current strategy. The strategies used to find the Nash equilibrium can either be pure or mixed. A pure strategy means that an agent chooses the same option every time since that strategy is strictly better for the agent regardless of the choices by the other agent (Nash, 1953). In this model it's intuitively assumed that the best strategies for TC and the supplier depends on the choices of the other in the following way:

1. If the supplier chooses to cheat TC should to conduct a control
2. If TC is going to conduct a control the supplier doesn't want to cheat
3. If the supplier chooses not to cheat TC doesn't want to conduct controls since this is costly
4. If TC doesn't conduct controls the supplier has incentives to cheat

The reasoning goes into a circle and it's impossible to derive a pure strategy for either TC or the supplier since their best choice always depends on the choice of the other. This means the Nash-equilibrium from this model is going to be derived from a mixed strategy (Nash, 1953).

The results from this model is a percentage for TC for how often TC should conduct controls for the supplier to be indifferent to cheating and a percentage of how often the supplier should not cheat for TC to be indifferent to conducting controls. In the example seen in figure 5.3, based of hypothetical input variables, the model gives the result that TC should conduct controls at least 1,96% of the time to disincentivize suppliers from cheating and TC themselves would be indifferent to conducting controls is the supplier is not cheating 96,72% of the time. This solution is defined as the mixed strategy Nash equilibrium.

The results given by the model depend fully on the input variables that describe the monetary cost or payoff from the different possible events that can occur related to cheating versus not cheating. In this model this is exemplified by a situation where a product is labeled organically produced and the supplier can choose to not produce it organically and save money. The model consists of nine input variables, these along with a description of each variable can be seen in table 5.2.

Variable	Description
Organic production cost	The cost for the supplier of producing the product organically
Non-organic production cost	The cost for the supplier of producing the product non-organically
Product price	The price that TC pays the supplier for the product
Controlling cost	The cost TC incurs for conducting a control of the product
Supplier punishment in case of detection	The monetary value the supplier has to pay TC in the case of detecting cheating
Damage from detecting fraud	The cost TC incurs when detecting cheating from a supplier. Could be viewed as supplier switching cost or the cost of not being able to acquire the adequate products
Market price	The price the market pays to TC for the product
Market controlling rate	How often the market will detect a non-organically produced product in the case that it’s non-organically produced
TC punishment when market detects cheating	The monetary punishment that TC incurs in the case that the market has detected a non-organically produced product

Table 5.2: Input variables in the suggested Nash equilibrium model

The values of these input variables can be extremely hard to estimate due to the nature of the events used (Lau et al, 2019). The assumption is also made that TC will never detect cheating

if they don't conduct a control and will always detect cheating when a control is conducted. Due to the uncertainty of these variables this model should not be viewed as an exact course of action but rather serve as a source of information about the potential incentives in the supply chain, and that can support decisions about monitoring and product controls. The model is a rough simplification of reality and should be treated as such.

To use this model TC has to start by trying to evaluate the values of the input variables and enter them in the cells C6 through C14. Thereafter to receive the results the solver-extension in Excel has to be used in two cells, see figure 5.3, "Solver cell". The first solver operation should have the following input:

- Set objective: F21
- To: Value of: 0
- By changing variable cells: F18

The result will then be presented in cell F18 and this represents the frequency of which TC has to conduct controls in order for the supplier to be indifferent to cheating.

The second solver operation should have the following input:

- Set objective: F27
- To: Value of: 0
- By changing variable cells: F24

The result will then be presented in cell F24 and this represents the frequency of which the supplier is not cheating for TC to be indifferent to making controls.

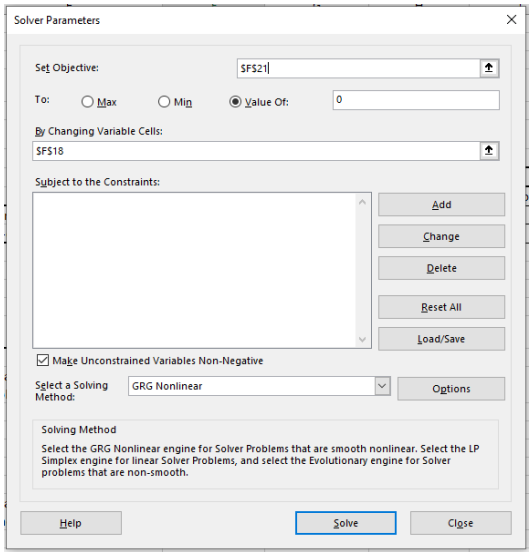


Figure 5.1: Settings first solver operation

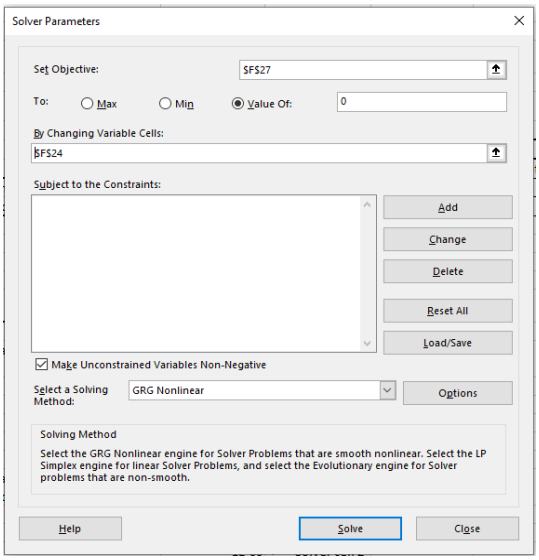
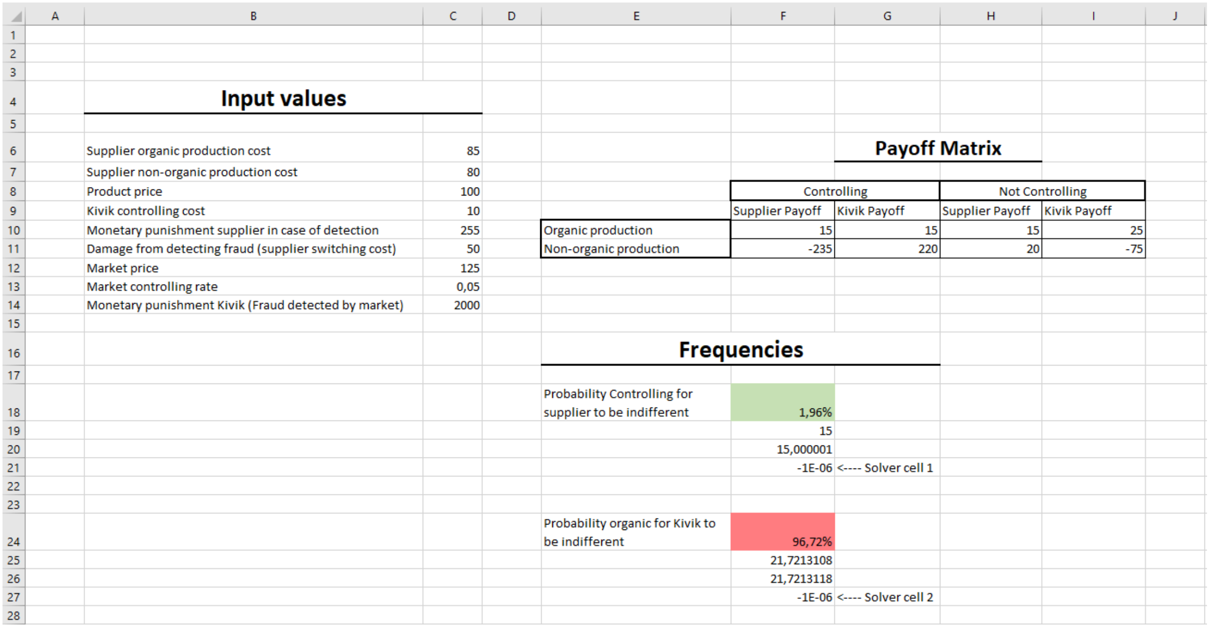


Figure 5.2: Settings second solver operation



Input values

Supplier organic production cost	85
Supplier non-organic production cost	80
Product price	100
Kivik controlling cost	10
Monetary punishment supplier in case of detection	255
Damage from detecting fraud (supplier switching cost)	50
Market price	125
Market controlling rate	0,05
Monetary punishment Kivik (Fraud detected by market)	2000

Payoff Matrix

	Controlling		Not Controlling	
	Supplier Payoff	Kivik Payoff	Supplier Payoff	Kivik Payoff
Organic production	15	15	15	25
Non-organic production	-235	220	20	-75

Frequencies

Probability Controlling for supplier to be indifferent	1,96%	
	15	
	15,000001	
	-1E-06	<---- Solver cell 1
Probability organic for Kivik to be indifferent	96,72%	
	21,7213108	
	21,7213118	
	-1E-06	<---- Solver cell 2

Figure 5.3: Mixed strategy Nash equilibrium model for supplier monitoring and product control frequencies

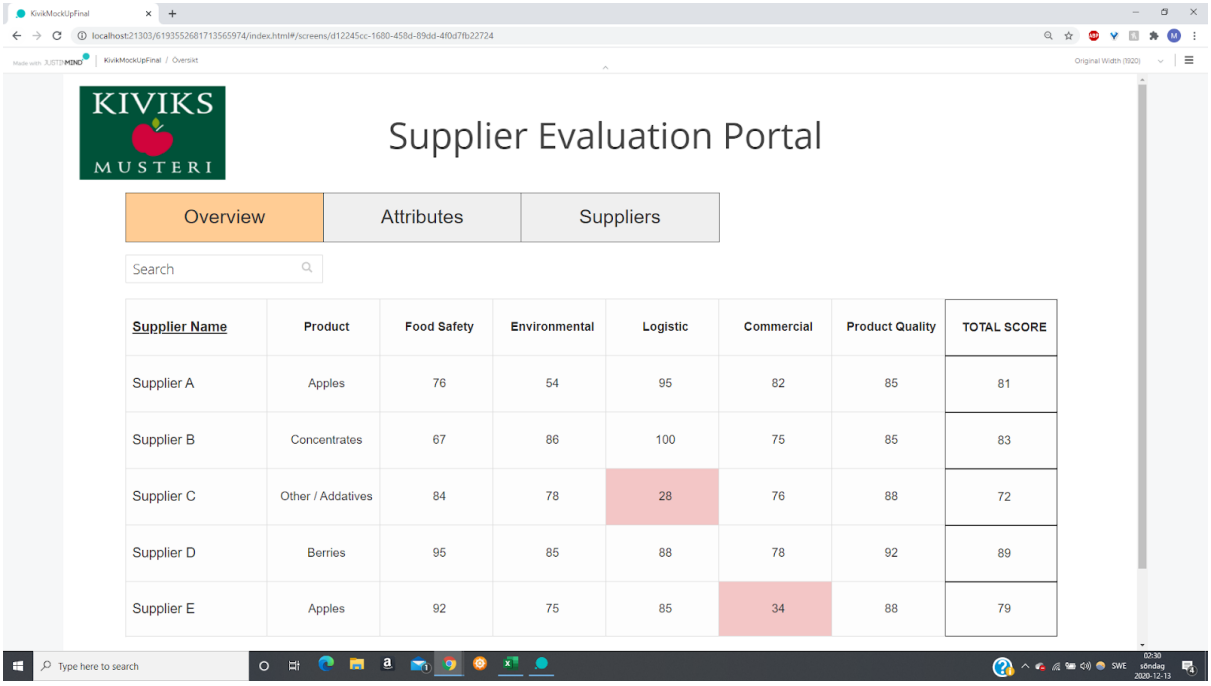
5.4 Supplier Evaluation IT-System

Based on the findings in the analysis of the supplier evaluation process a suggestion for an IT-system for supplier evaluation has been produced. This section will describe how this system would work and what it could look like. An interactive mock-up of this system has also been created as a part of this thesis in Justinmind Prototyper. Screenshots of this mock-up have been taken to highlight and show the different functionalities and design of the proposed system. This mock-up has also been given to The Company as a part of the thesis on the day of the presentation.

This mock-up has been made as a cloud-based solution as this has many benefits with accessibility, not requiring internal servers and often being easier to implement (Talatappeh & Lakzi, 2019). As found in the comparative case study, ICA is also in the process of making their supplier evaluation system cloud-based. In the ICA case study it was also found that ICA's suppliers can enter data into ICA's supplier evaluation system themselves. But in line with Effeny (2019) and Talatappeh & Lakzi (2019) that the system should be easy to use, implement and update this feature will not be a part of the suggested IT-system for The Company. This since Kvik has a large number of suppliers from around the globe, with many of them being relatively small, and it wouldn't be justifiable to use a lot of time, effort and resources to teach all of TC's suppliers how to use the IT-system. Especially since the workload for TC to enter the data once they have gathered it would be very small in the proposed IT-system. An effort based on Talatappeh & Lakzi's (2019) points on

user-friendliness has been made by having as few views as possible as well as having all functionalities as self explanatory as possible.

This system has been divided into 3 main parts. The first one called Overview is where you can see the suppliers' different category scores, the total weighted score and where the suppliers are compared and ranked against each other. This page compiles all the data about the supplier based on the chosen attributes and gives the supplier a score between 0-100 in each category. The supplier has also been given a weighing profile which in turn determines how much weight each category score contributes to the supplier total score. The table can be sorted by each column by clicking on the header of that column. This means that suppliers can be sorted by name in alphabetical order or reversed alphabetical order. The same logic with alphabetical order also applies to the next column with the different product groups that the suppliers are in. Suppliers can also be sorted by score in each category and for the total score, from highest to lowest or lowest to highest. It is also possible to search for a specific supplier or product group in the search bar above the table. By clicking on the supplier name the user will be redirected to that supplier's profile in the view Suppliers. Finally it will be possible to get a red marker as a warning on certain supplier category scores when it's below a predetermined threshold to make it easier to detect inadequate supplier scores. A screenshot from the overview can be seen in figure 5.4.



Supplier Name	Product	Food Safety	Environmental	Logistic	Commercial	Product Quality	TOTAL SCORE
Supplier A	Apples	76	54	95	82	85	81
Supplier B	Concentrates	67	86	100	75	85	83
Supplier C	Other / Addatives	84	78	28	76	88	72
Supplier D	Berries	95	85	88	78	92	89
Supplier E	Apples	92	75	85	34	88	79

Figure 5.4: Evaluation portal overview page

The second part of the system is the section called Attributes. This is where Kvik can manage everything around the attributes and performance measures that the suppliers are evaluated on.

The first part of this is determining the different evaluation categories under which the attributes and performance measures are located. This is done to be able to give the suppliers different scores in different areas to make it easier to understand the suppliers' current situation and to make it easier to identify improvement areas. In this mock-up the five suggested evaluation categories on suppliers in the fresh fruit industry from Segura et al (2019), product quality, food safety, environmental, logistics and commercial are used.

The scores from these categories are then going to be weighed into a total score, but the importance of the supplier's performance in different categories can vary greatly between different types of suppliers and product groups. For example, suppliers dealing with chemicals and additives could be more heavily weighted on food safety while suppliers dealing with high volume products like apples could be more weighted on their performance in the logistics category. To solve this, different category weighing profiles can be created. For each supplier a weighing profile is chosen when the supplier is added, or edited later on, and this is then going to determine how the scores in the different categories weigh into the total score of this supplier. In this weighing profile it will also be possible to assign a cutoff score for a specific category. This means that if a supplier scores under the cutoff score the supplier will get a red marker in the overview on this score to make it easier for the users to spot category scores that are unsatisfactory. See figure 5.5 for the view where users can create weight profiles.

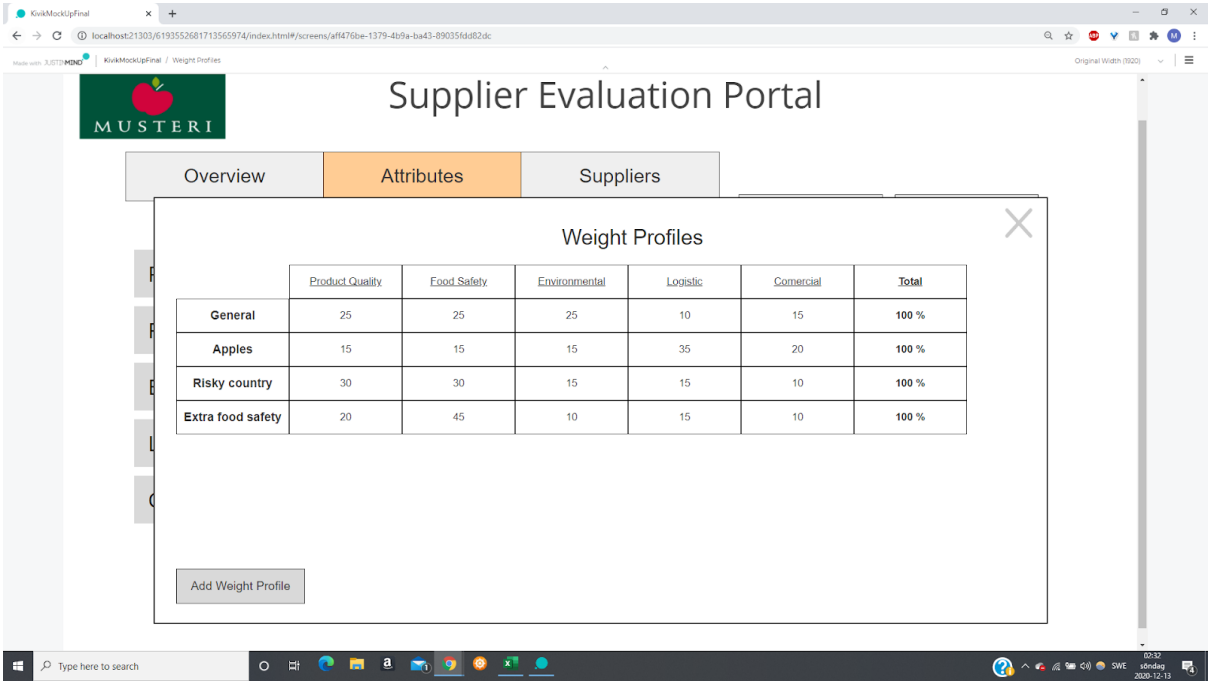


Figure 5.5: Managing weight profiles

Under each category are the attributes and performance measures that determine the category score. Categories can have any number of attributes and attributes can be added, edited or removed whenever necessary. Each attribute is also weighed into the category score with an individual weight. These weights are seen directly under each category and edited by the

users of the system. These weights translate directly into the category score and thus also to the supplier total score, which means by editing these weights the scores viewed in overview will be updated. See figure 5.6 for the view where a category has been chosen and the user can edit the weights of each attribute.

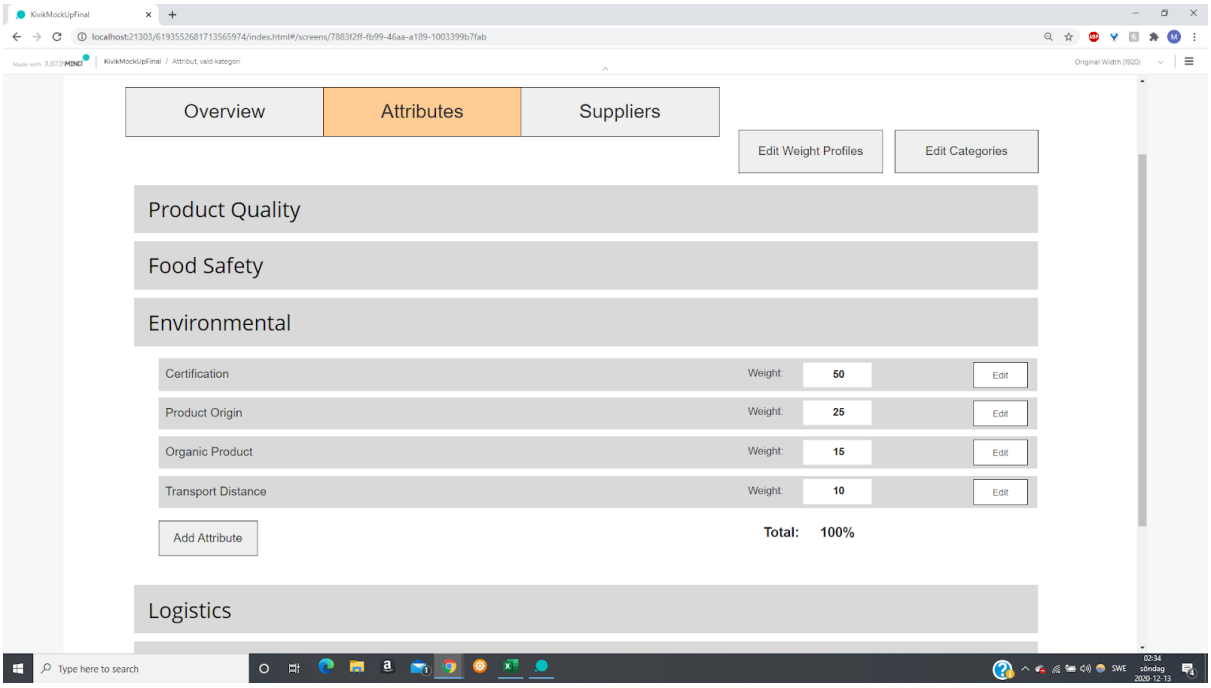


Figure 5.6: Manage attribute weights

Supplier will get a score between 0-100 on each attribute but to do this it has to be determined what the supplier needs to achieve to get different possible scores. In each attribute there can be a range of possible scores suppliers can reach in this attribute. The possible score and an explanation to each score are set by the users. These explanations and possible scores will then show up when scoring the suppliers in the view Suppliers where the users clicks the appropriate checkbox to assign the supplier a score on the specified attribute. Users also chose how long the score is going to be relevant before it needs to be checked again. When this time has passed the supplier will get a marker in the view Suppliers that some info is missing and the users can then easily find what attribute score needs to be updated. See figure 5.7 for an example of the attribute Product Origin under the category environmental being edited. The functionality requirements for the view Attributes has been compiled in table 5.3.

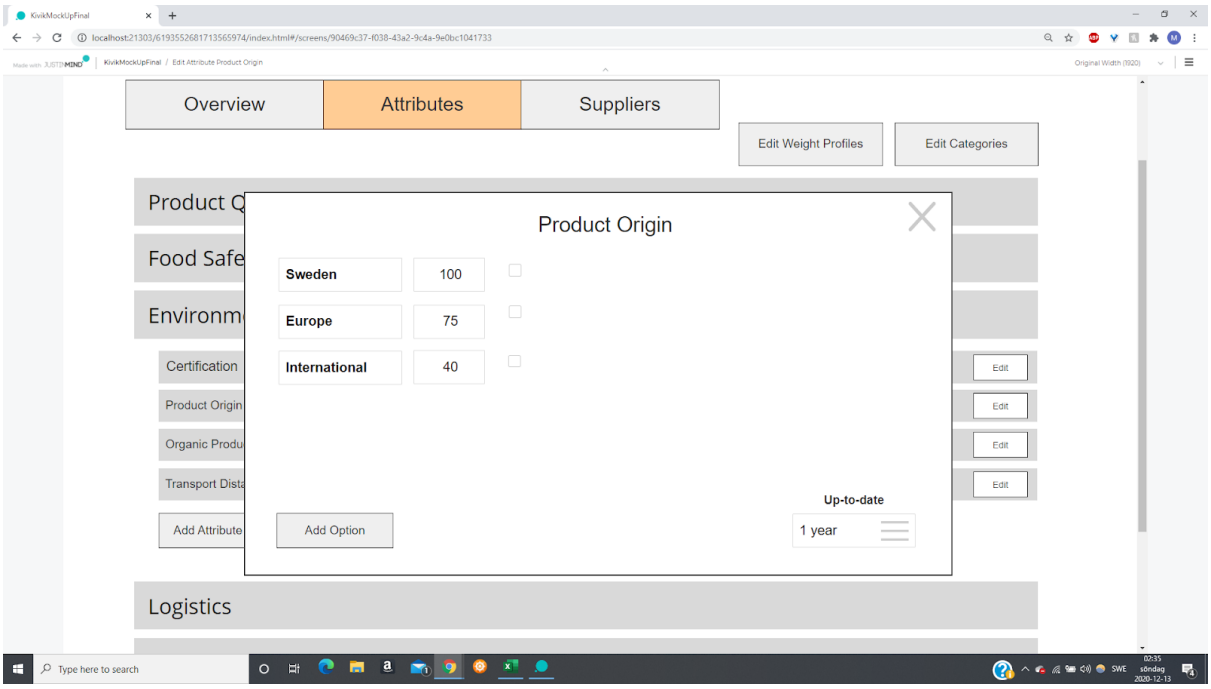


Figure 5.7: Edit attribute Product Origin

Data	What	Where
Evaluation categories	Add and edit the evaluation categories	Attributes / edit categories
Category weight profiles	Add and edit the weight profiles of the category scores that determines the total score	Attributs / edit weight profiles
Category attributes	Add and edit attributes and performance measures in the different categories	Attributes / chosen category / add attribute or Attributes / chosen category/ edit attribute
Attribute weights	Add and edit the weights of the attribute scores that determines the category score	Attributes / chosen category
Attribute score requirements	Edit what activities or requirements that the supplier needs to meet for a specific attribute score 0-100.	Attributes / chosen category / edit attribute
Up-to-date time	Edit when the attribute score will be out-of-date and will subsequently trigger a marker for “info missing” for the supplier	Attributes / chosen category / edit attribute
Edit cutoff score for	Edit what the cutoff is for the score in a	Attributes / edit

varning in overview	specific category to generate a red marking in the overview	categories

Table 5.3: Functionality requirements for evaluation attributes

The third part of the system is the section called Suppliers. This is where Kvik can manage all their suppliers with associated notes, documents and assigned attribute scores.

All suppliers can be managed in the Supplier view where new suppliers are added and existing suppliers are edited with new information or updated attribute scores. The individual supplier page can also be reached by clicking on the supplier's name in the overview.

When a specific supplier is selected the user can assign attribute scores for the supplier on all attributes. As previously mentioned the possible scores will be determined in the view Attributes where the attribute is constructed. The score will be selected by clicking a checkbox on the appropriate description. There will also be an option for the user to assign an individual score manually if the supplier doesn't easily fit in to the predetermined scores. If a score has not been assigned to all attributes, or if the up-to-date date has passed a red marker in the Supplier view will signal that at least one attribute needs to be updated. See figure 5.8 for the supplier view where Supplier C and Supplier E is missing a score in at least one attribute.

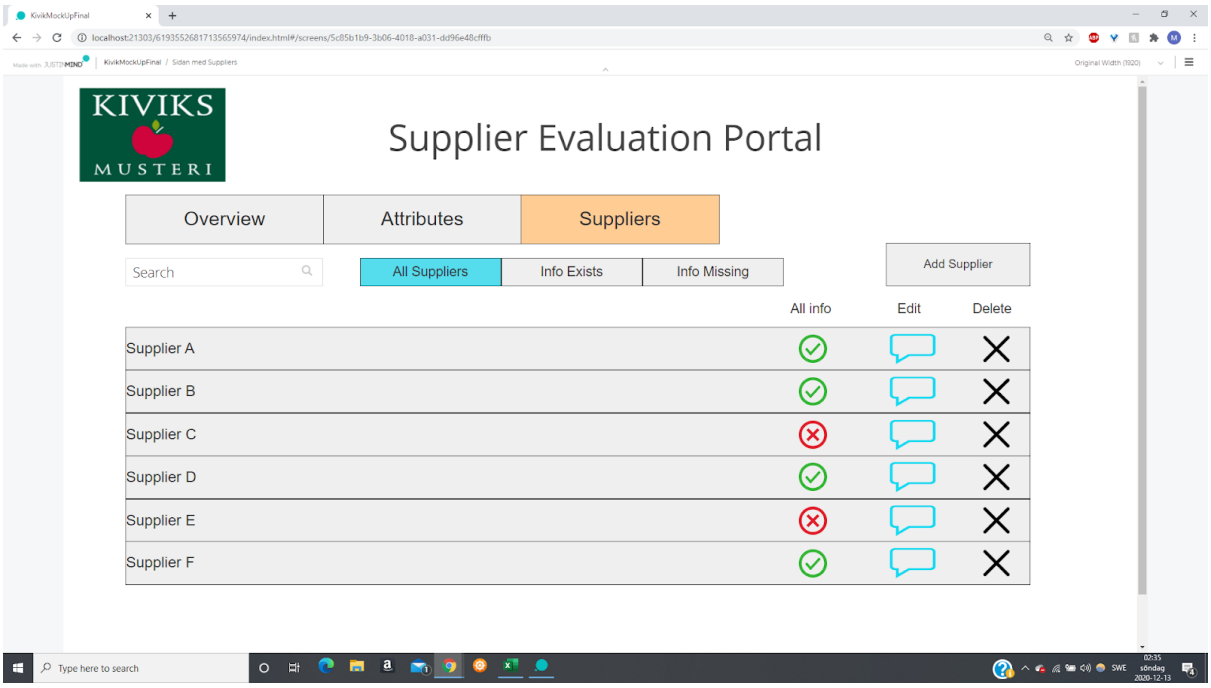


Figure 5.8: The Suppliers view

Users can also attach relevant documents for each attribute that are relevant for the scoring of the attribute. The users can also write general notes under each attribute. The same logic goes

for the supplier as a whole where users can attach documents or write notes on the supplier in general without it being assigned to a specific attribute. When the user has selected the supplier, all attached documents for this supplier should also be shown and viewable to avoid users having to search through attributes to find the desired document. See figure 5.9 for the supplier profile for Supplier C and figure 5.10 for Supplier C's attribute score on Product Origin being updated.

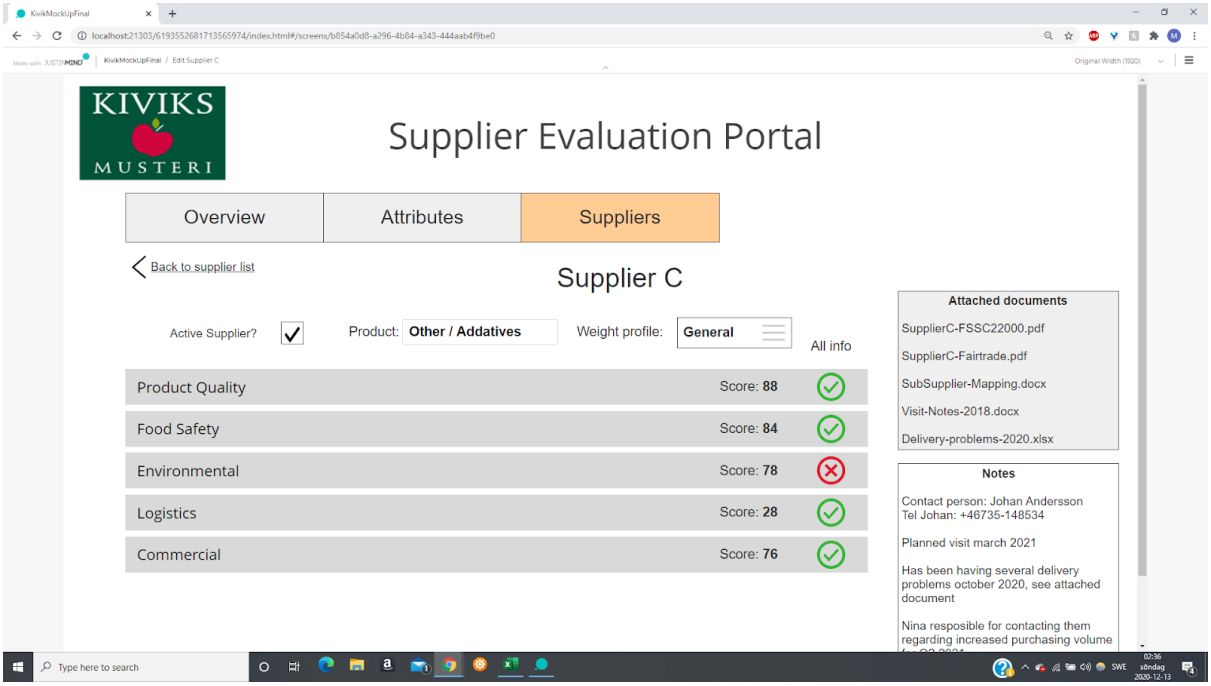


Figure 5.9: Supplier profile for Supplier C

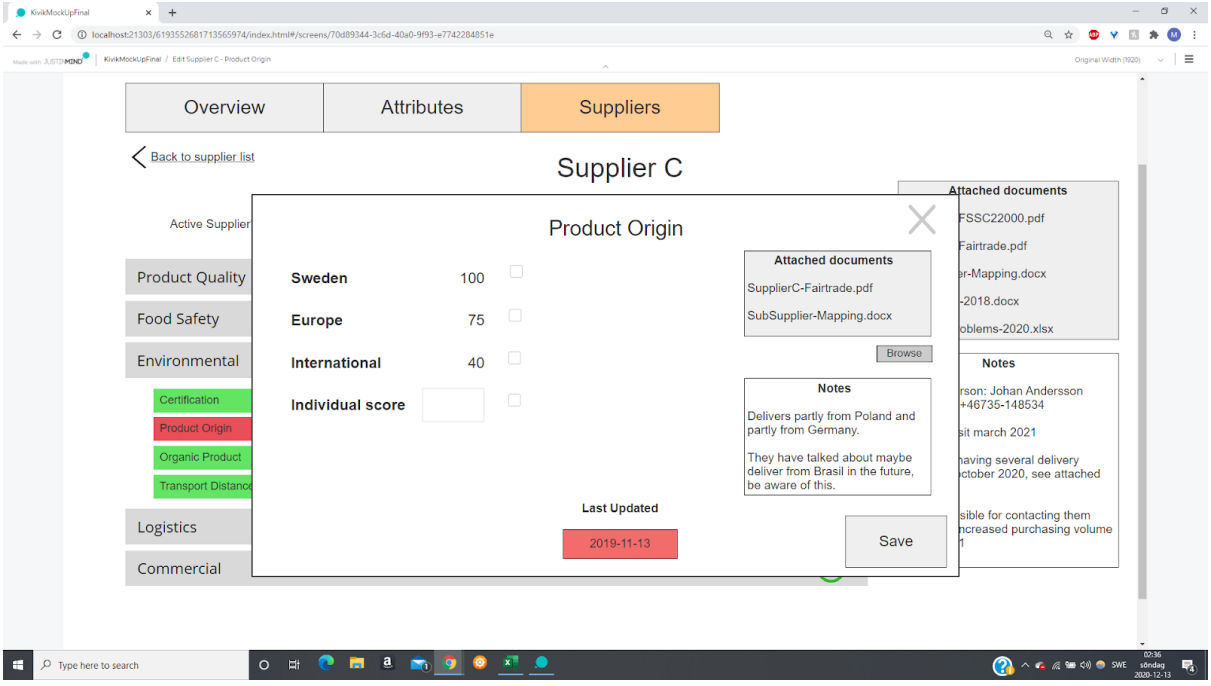


Figure 5.10: Updating Supplier C's attribute score on the attribute Product Origin

A weight profile is also selected for each supplier based on the ones created in the Attribute view. The selected weight profile will determine the weight from the scores in the different categories into the supplier total score. The users will also select if the supplier is currently active or no by clicking a checkbox. If the supplier is not active it will still be shown in the list of suppliers, but it will no longer be shown in the overview. The functionality requirements for the view Suppliers has been compiled in table 5.4.

Data	What	Where
Supplier name	Add and edit suppliers and product categories	Suppliers / add supplier or Suppliers / chosen supplier / edit supplier
Select attribute score	Select what score the supplier meets in the specific category	Suppliers / chosen supplier / chosen category / edit attribute
Attach documents	Attach documents related to the supplier and the evaluation. Can be done both under specific attribute or generally for the supplier	Suppliers / chosen supplier or Suppliers / chosen supplier / chosen category / edit attribute
Supplier notes	Write notes related to the supplier and the evaluation. Can be done both under specific attribute or generally for the supplier	Suppliers / chosen supplier or Suppliers / chosen supplier / chosen category / edit attribute
Select weighing profile	Select category weighing profile for the supplier	Suppliers / chosen supplier
Select active	Select whether the supplier is active or not	Supplier / chosen supplier

Table 5.4: Functionality requirements for supplier data

In addition to what has been shown in this mock-up there needs to be functionalities for administering users and accounts. This has not been done in the mock-up due to the reason that it wasn't relevant for the research in this thesis since it's a common functionality in almost all IT-systems. Here an administrator can create new accounts for users with email and password. The administrator can also set what rights and functionalities different users can have. For example, only the manager can change and delete categories, attributes and weight

profiles but all users can work with the supplier data, write notes, attach documents and update attribute scores. The system is reached through a web browser via a link and can be accessed anywhere with the username and password. The formation of the link depends on where and how the system is hosted.

Chapter 6

Recommendation

This chapter will go through the recommended actions for TC to improve their supplier evaluation. This includes problems or improvement areas that have been identified in the analysis and the suggested actions that TC should take. This chapter has been divided into two parts. The first part consists of improvements that are deemed important and essential or easily implemented. The second part consists of areas that are harder and going to take longer to implement or that have been determined as less urgent in the current situation.

6.1 Short Term Recommendations

The short term recommendations are steps and improvements that are either easily implementable and that TC can do today, or that are deemed essential and urgent for improving the supplier evaluation process. This section will cover these improvements areas and what actions should be taken.

Firstly, TC's current scoring model of their suppliers using scores between 1-3 needs to be changed to another model that has a broader range of scores to increase the differentiation between supplier performances. The recommended model is to change this to a scoring of 0-100. Instead of just having a supplier scoring with five different measures TC should break out all the underlying data that comprises the current supplier scores and score them individually as their own attributes or performance measures. TC should also increase the amount of attributes and performance measures used in the evaluation to further increase the nuance in the comparisons and more clearly be able to distinguish the right supplier for the right product. What attributes and performance measures to use in a given situation is highly individual and should be determined by TC employees with experience and experts, but suggestions for new attributes and performance measures can be seen in table 3.1.

The attributes and performance measures should be divided into categories and each category is to be given a score that is composed of the attributes and performance measures that belong to that category. This category score is the weighted average of these attributes and performance measures where the weight is assigned by the relative importance of the individual attribute in that category. Instead of the current method of multiplying these scores into the total score the category scores should be weighed into a total score that has the same scale as the category-, attribute- and performance measure scores. By keeping the scores in the same scale it’s easier to interpret the meaning of the scores and what they represent at the same time as the relation between the suppliers’ scores become more accurate and

descriptive. See figure 3.5 for a suggested weight distribution for category weight for companies in the fresh fruit industry by Sergura et al (2019).

To be able to assign consistent scores throughout the evaluation it's essential that the qualitative attributes and performance measures have clearly defined activities or performance metrics that have to be fulfilled to be assigned a certain score between 0-100. This is referred to as quantifying the qualitative attributes and performance measures. Depending on the nature of the attribute the amount of possible scores and the numerical difference between the scores may differ. This concept is best illustrated in table 3.4 along with examples of qualitative attributes being quantified.

The final short-term recommendation for TC has to do with supplier relationships. TC has expressed that they highly value having strong relationships with their suppliers, however they do not include the potential relationships as an attribute in the evaluation. This should be included as an attribute in the evaluation through level of relative importance explained in figure 3.4 where the score is based on TC's purchasing volume as a percentage of the supplier's total revenue.

6.2 Long Term Recommendations

When the changes from the last section have been made, or at least decided on but not yet implemented, it's time for TC to start developing their new supplier evaluation IT-system. The reasoning behind waiting with the IT-system is that the design of the new process needs to be decided as much as possible to simplify the development of the IT-system. The suggested system is constructed in a way that it's possible to make changes even after the system has been implemented, but it's more resource effective to get it right the first time. To do this TC should thoroughly go through the suggested process and the mock-up of the IT-system and decide if it's anything they want to add, change or remove from the suggestion.

When the suggested IT-system is in place it's also possible to make two upgrades with regards to scoring attributes and weighing category scores. The weights to be used for the category scores into the total score should be able to differ between different types of suppliers and different product groups. This concept is best illustrated in figure 5.5 "Managing weight profiles" from the mock-up of the suggested IT-system. When using an IT-system it's also possible to further increase the accuracy of the scoring of the quantitative attributes by using the linear scaling model described in 5.2.

In addition to developing the new IT-system for supplier evaluation TC needs to improve their current business system so that the data on quality logs and delivery accuracy is retrievable and presented in a useful way to be able to use it in the evaluation. The literature and the comparative case study agree that this data is among the most crucial in the evaluation of suppliers. Therefore this improvement is critical, however it has been placed in

long-term goals since it often requires a certain amount of time to conduct a functionality change to this proportion in a business system.

To increase the information of which decisions are made TC should start to analyse the inner and outer dependencies of changes in different areas. Changes can have spiraling impacts that affect completely other areas within the supply chain than intended in the first place. Therefore the potential impacts should be analysed and considered when making such decisions. This concept is important for TC in the long term to improve their decision basis, however this improvement is not the most crucial right now for TC to improve their evaluation process.

To further increase their sustainability efforts and supplier relationships TC should begin evaluating sustainability innovation in their suppliers as well as the current sustainability performance. To do this TC should construct a new performance measure that considers the change in sustainability performance for suppliers as well as the supplier's sustainability goals and planned efforts.

The final long-term recommendation to TC is to work more structured with supplier monitoring and product control. TC should conduct this in a way that disincentivizes suppliers to cheat using as little resources as possible. This is done by having good insight into possible events and outcomes throughout the supply chain as well as being well balanced in the punishments for suppliers caught cheating and in the controlling frequencies. To do this the mixed strategy Nash equilibrium model from 5.3 can be used and experimented with. Here TC can see the possible incentives for suppliers to cheat and to what degree TC has to conduct monitoring or product controls to make the supplier disincentivized to cheat. In addition to this TC can see how these frequencies change with different input variables in order to be able to construct a fitting strategy.

A summary of the gaps found in 5.2 and associated recommendations can be seen in table 6.1.

Gap	Recommendation	Type
Not enough attributes and performance measures are taken into account to give a nuanced comparisons between suppliers	Break out all the underlying data that comprises the current supplier scoring model and score them as individual attributes, as well as analysing internally which new attributes and performance measures should be included	Short-term
Current model of assigning scores between 1-3 does not provide the opportunity do make accurate differentiations between suppliers	New model where scores are assigned from 0-100 in each attribute and performance measure	Short-term

Qualitative attributes and performance measures does not have clear predetermined activities or performance metrics for what qualifies as a certain score	Set predetermined activities or performance metrics of what qualifies as a certain score between 0-100 for all qualitative attributes	Short-term
Logs on quality controls and delivery accuracy is not actively part of the evaluation	Improve the current business system so the data can be presented in a useful and meaningful way	Long-term
The method of multiplying the supplier scores does not give a meaningful understanding of the supplier's performance and it's hard to relate suppliers' performances against each other when comparing and ranking	Start weighing the category into a total score that has the same format as all the scores from the attributes and performance measures. This way the total score will give a more meaningful representation in of itself and have a more accurate and descriptive relationship with the scores of the other suppliers	Short-term
Weighing supplier attribute scores on the basis of importance is not being performed	Weigh the scores after the relative importance of that attribute in relation to other attributes in the same category	Short-term
The use of supplier relationship and relative importance between TC and the supplier is not being used actively in the evaluation	Use supplier relationship and relative importance as a evaluation attribute	Short-term
Inner and outer dependencies of how different areas affect each other are not being analysed	Analyse what dependencies exist when evaluating suppliers and making decisions that inflicts changes in the supply chain	Long-term
Sustainability innovation as a performance measure is not being used in the evaluation	Work together with suppliers to improve sustainability and use changes and improvements in sustainability as a evaluation performance measure	Long-term
-	Develop a supplier evaluation IT-system based on the suggestion in 5.4	Long-term
-	Start using suggested model based on Nash equilibrium from 5.3 for supplier monitoring and product control frequencies	Long-term

Table 6.1: Summary of recommendations

Chapter 7

Conclusion

This chapter will summarize the whole thesis by compiling what the current situation is, what the literature says and how TC can improve their supplier evaluation. There will also be an analysis of how well the research questions were answered. Lastly a section of suggested future research within the area will be presented.

7.1 Conclusion

The purpose of this thesis was to analyse what The Company supplier evaluation process should look like and how this process could be integrated into a new supplier evaluation IT-system. To fulfill this purpose the thesis was constructed in the following fashion. After an appropriate methodology was selected in chapter 2, a literature review was performed on four areas within supplier evaluation, attributes and performance measures, sustainable sourcing, comparing and ranking suppliers and finally on supplier evaluation IT-system.

After the literature review in chapter 3, a thorough case study on TC's current supplier evaluation methods and processes was conducted which resulted in chapter 4, empirical data. Accompanied by this, another case study on ICA’s evaluation methods and processes was conducted to serve as a comparison and benchmark against TC.

The analysis in chapter 5 combined the knowledge acquired from the literature review with the data collected in the empirical data. The goal of this was to find gaps between the literature and TC's current methods and processes. These gaps were then analysed to identify and suggest improvement areas throughout the process. The analysis also included two new frameworks produced by the author. The first one being a game theory based model in supplier monitoring and product control frequencies. The second framework is a suggested design and functionality of a new supplier evaluation system illustrated by an interactive mock-up.

The last chapter, recommendation, summarizes the improvement areas found in the analysis, and suggested actions are presented. These improvements are divided into short-term or long-term recommendations based on urgency and complexity of the actions needed.

When the thesis was initiated two research questions were formed that has served as a basis of the research conducted throughout the thesis. The goal of this research has been to answer

these research questions as accurately and thoroughly as possible to fulfill the purpose of the thesis. The answers to the research questions have been summarized as follows.

RQ1: *How should The Company evaluate their suppliers and what should this process look like?*

A thorough and meticulous case study of TC's current supplier evaluation process was conducted and continues to serve as the basis of the new suggested process. An associated comprehensive literature review was conducted on the subject to identify improvement areas and needed changes to the current process. The most important improvements identified was related to the evaluation attributes and performance measures and how the evaluation, scoring and weighting of these attributes was conducted. Underlying data that today comprises the supplier's score should be broken out and be scored individually as their own attributes, and more attributes and performance measures should be incorporated in the evaluation. The attributes should be scored on a more differentiated scale than the current one of 1-3, suggestively from 0-100 instead. The attributes and performance measures should be weighed by their importance depending on the type of supplier or products group and the total score should also be a weighted aggregate of the other scores instead of the current method of multiplying the scores. Finally all the qualitative attributes and performance measures need to be properly quantified by assigning clear activities and measures that need to be met in order to get a certain score.

Suggested improvements that should be viewed as more long term include incorporating quality and delivery logs in the evaluation, analysing inner and outer dependencies when making changes, incorporating sustainability innovation as a performance measure and start working actively and structured with supplier monitoring with the help of the suggested model in 5.3.

RQ2: *How could this process be integrated in an effective and easy-to-use IT-system?*

To provide a comprehensive answer to this question, a suggestion for a new IT-system, based on the process from RQ1, was produced including functionalities, design and data requirements. A literature review of how systems like this can be developed and how to make it user-friendly was conducted and key takeaways from this review was incorporated into the suggested system.

To illustrate the functionalities and design of the IT-system, a mock-up of the system was made. To also be able to demonstrate the user-friendliness of the suggested system this mock-up was converted into being interactive to enable users to get an idéa of what the workflow of the system would be like.

7.2 Future Research

Looking at potential suggestions for future research there are a number of areas where efforts could be made to further increase the amount of data on the suppliers and the accuracy and flexibility of the evaluation. This will however most likely further complicate the process and these following suggestions are not suitable for TC to try to investigate right now since they have other major changes in their process that are more urgent. However these suggestions could become interesting for TC in the future to further increase the quality of their evaluation.

To further increase the flexibility and variability between suppliers and product groups more distinctions can be made in regards to the attributes and performance measures. The suggested model in this thesis is that attribute and performance measure, and their associated weights, are fixed and the same for all suppliers. The weighing between different types of suppliers and product groups using weighing profiles is only from weighing category scores to the total score of the supplier. The differentiation could instead be made in two levels where attributes are weighted differently in regards to the category score for different suppliers. The attributes and performance measures used in a category could also vary depending on the type of supplier or product group. Research about how accurate comparisons can be made when different attributes and performance measures are used would be useful, as well as how this could be done in an effective and resource-efficient manner without complicating the process too much.

The IT-system could be more automated and retrieve attribute data and score these attributes automatically. This could be done with data that is quantitative and exists in another system, for example, quality logs, delivery accuracy logs and purchasing volume could be retrieved automatically from TC's business system. Research would be needed on how the systems could be configured to perform these tasks, as well as the amount of resources that could be saved versus the resources that needs to be spent on development of these features and thus in what situation it would be beneficial to implement these configurations. The same logic goes for when it could be beneficial to enable suppliers to enter their own data into the system when this would require resources spent on training suppliers to use the IT-system.

Further research could be made on the Nash equilibrium model on supplier monitoring and product control frequencies. Many of the input variables are extremely hard to estimate whereas extensive research could be made to try to more accurately predict these variables in order to increase the accuracy and usefulness of the model. This model could also become more advanced and accurate by including probabilities for finding cheating without controls, not finding cheating despite control, as well as including different scenarios and associated payoffs, and the associated probabilities for these scenarios to occur.

A summary of suggestions for future research can be seen in table 7.1.

Area	Suggested research
Attribute and performance measures	How can the evaluation become even more customized by differentiating the chosen attributes and performance measures by individual suppliers, and how can meaningful comparisons be made between suppliers when different attributes are used?
Weighing profiles	How can weighing profiles be done in two levels by using the same concept by weighing the attribute and performance measure scores into the category score without making the process too complicated? How should these weights be determined and what should the weighing profiles be based upon?
IT-system	How can the IT-system be more automated and require less manual input? When would developing and implementing these features be beneficial from a resource perspective?
Supplier monitoring model	How can the input variables in the Nash equilibrium model be more accurately estimated?

Table 7.1: Summary of suggested future research

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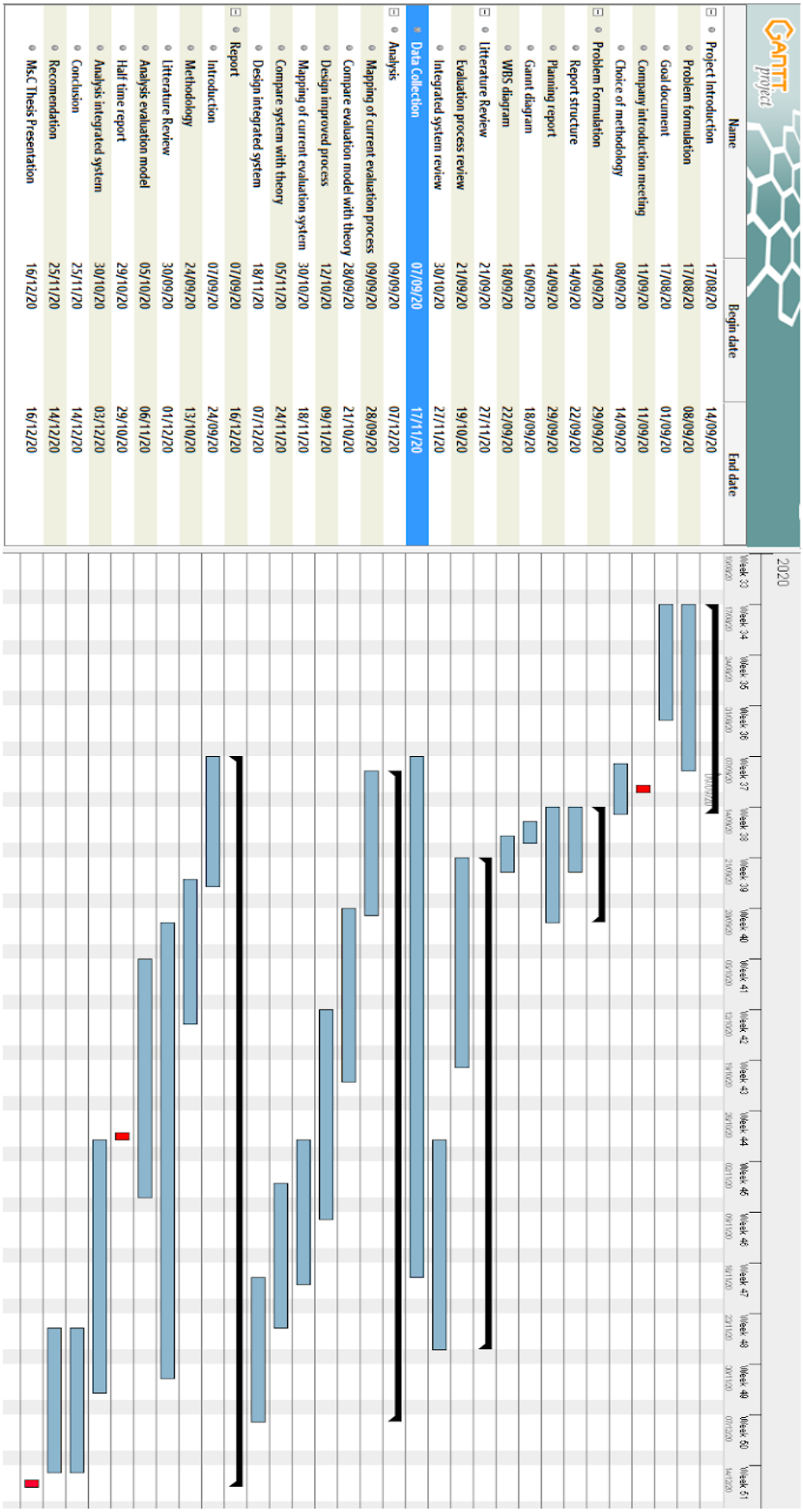
Appendix

A.1: Work breakdown structure for the thesis

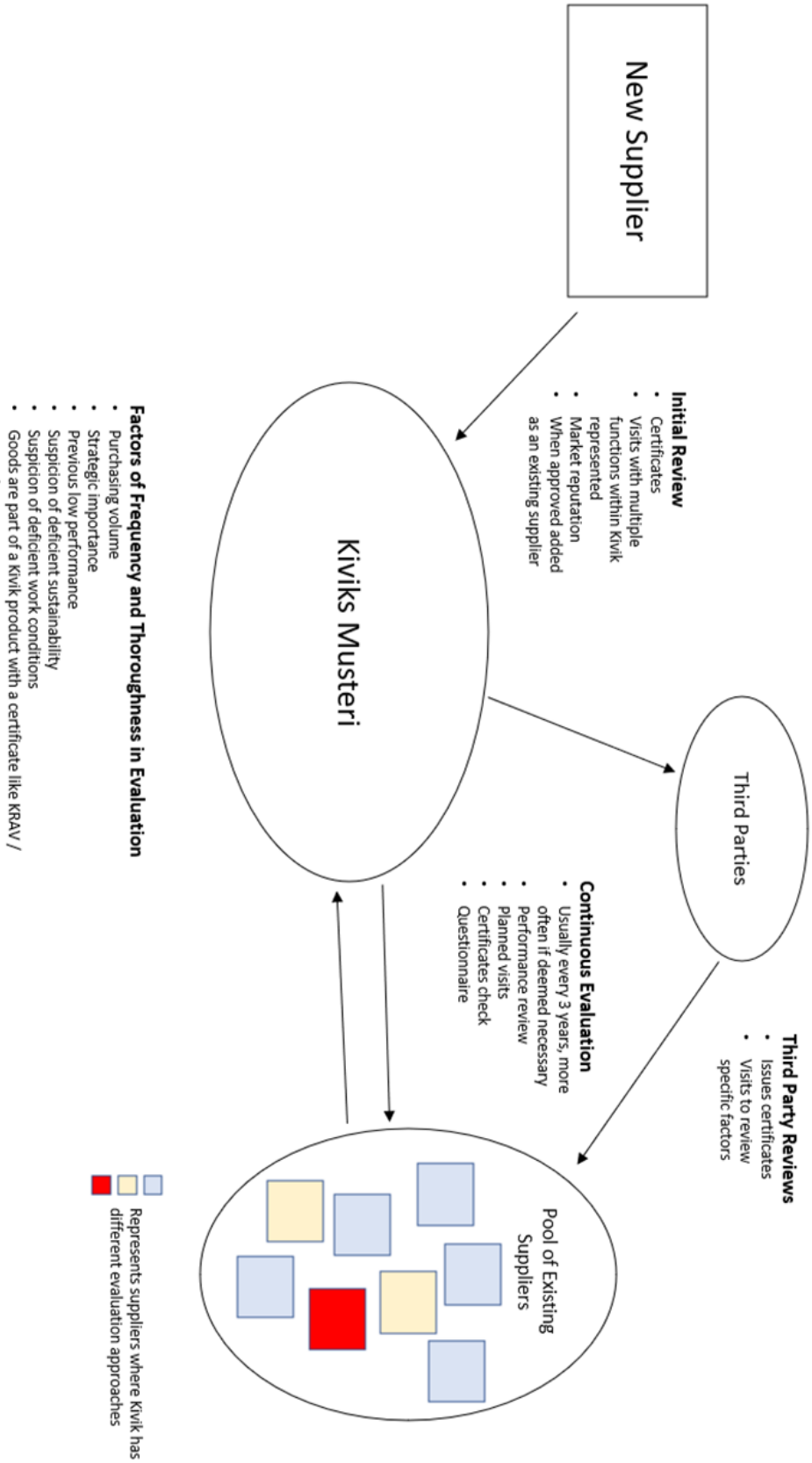
A.2: Gantt chart for the thesis



A.3: Interview guide ICA

- What does the current supplier evaluation process look like at ICA?
- Is ICA looking at the same attributes for all suppliers or are the choice of attributes more individually customized?
    - How often does ICA conduct evaluations?
    - What factors matter when ICA decides how to conduct the evaluation?
- What attributes and performance measures is ICA using when evaluating their suppliers?
    - How many of these are quantitative and how does ICA quantify their attributes and performance measures?
    - How does ICA compare and rank their suppliers?
- What measures are taken if:
    - Problems arise?
    - ICA suspects / discovers cheating?
- To what degree is sustainability a factor in the evaluation and how is this measured?
- What type of IT-system does ICA use today for supplier evaluation?
    - Can suppliers add their own data into the system?
    - What data does the system contain and how is it presented?
    - Is the system collecting data automatically from other systems?
- Is there anything other that you think is relevant in this context that we haven't discussed?

A.4: TC's current evaluation process



A.5: Mixed strategy Nash equilibrium model for supplier monitoring and product control frequencies

Input values	
Supplier organic production cost	85
Supplier non-organic production cost	80
Product price	100
Kivik controlling cost	10
Monetary punishment supplier in case of detection	255
Damage from detecting fraud (supplier switching cost)	50
Market price	125
Market controlling rate	0,05
Monetary punishment Kivik (Fraud detected by market)	2000

Payoff Matrix				
		Controlling		Not Controlling
		Supplier Payoff	Kivik Payoff	Supplier Payoff	Kivik Payoff
Organic production		15	15	15	25
Non-organic production		-235	220	20	-75

Frequencies	
Probability Controlling for supplier to be indifferent	1,96%
	15
	15,000001
	-1E-06 <---- Solver cell 1
Probability organic for Kivik to be indifferent	96,72%
	21,7213108
	21,7213118
	-1E-06 <---- Solver cell 2

System för Leverantörsutvärdering i Livsmedelsindustrin

Populärvetenskaplig sammanfattning av **Marcus Wuttke**

Leverantörsutvärdering är något som väldigt många företag måste genomföra och som ofta är ett komplext problem med många parametrar och variabler inblandade. Detta arbete har tagit fram ett framework för hur attribut och prestandamått bör vara konstruerade för att ge en så representativ poängsättning som möjligt, samt en modell för övervakning och kontroll av leverantörens produkter baserat på spelteori.

När man inom leverantörsutvärdering poängsätter leverantörer inom olika områden är det viktigt att poängen är representativa till leverantörens prestanda samt att poängen sätts på ett konsekvent sätt. För att poängen skall vara representativa är det viktigt att skalan är tillräckligt differentierad samt att den totala poängen leverantören får är en sammanvägning av de olika attributen som har poängsätts. I detta arbete föreslås en poängskala från 0-100 samt att vikten från attributen som utvärderats till totalpoängen varierar beroende på vilken typ av leverantör det gäller eller vilken produktgrupp leverantören tillhör.

För att poängen skall sättas på ett konsekvent sätt är det viktigt att poängen bestäms på ett sätt som undviker partiskhet och som blir samma över tid. Det finns tre nivåer i hur noggrant poäng kan sättas, det första är datatolkning, det andra är kvantifierade attribut och den tredje och mest noggranna är en linjär skalningsmetod.

På den första nivån tittar användaren på data och skapar sin egen uppfattning om vilket poäng detta motsvarar. På den andra nivån det finns tydliga och fördefinierade aktiviteter eller mål för vad som skall uppfyllas för att få en viss poäng. På den tredje nivån används de leverantörerna med sämst och bäst prestation inom ett attribut som basvärden och alla andra leverantörer får en poäng i skalenlig relation till dessa två basvärden. Denna metod kan dock endast användas på attribut som är helt kvantitativ karaktär.

Att genomföra noggranna kontroller på leverantörernas produkter är ofta mycket kostsamt samtidigt som det ofta finns monetära incitament för leverantörerna att fuska med sina produkter. Med hjälp av 9 variabler över situationer som kan uppstå i samband med fusk och motsvarande monetära utfall har en modell skapats med hjälp av Nash equilibrium som visar hur ofta företag minst måste utföra kontroller för att ta bort incitamentet för leverantörer att fuska

Slutsaterna från detta arbete är att företag måste se till att ha en tydlig, konsekvent och representativ poängsättning, samt använda en tydlig modell för hur ofta kontroller skall utföras på leverantörernas produkter.

Examensarbete: Supplier Evaluation System in the Food Industry
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Handledare: Jan Olhager
Examinator: Louise Bildsten
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