Efficient Information Flow in a Supply Chain of Raw Materials

JOHN STEINKELLER
Abstract

The Study aims to evaluate what kind of systems buyers of raw materials use for handling the flow of information in their supply chain of raw materials. Due to the complexity of the topic, the Study is only examining the continuous exchange of information between suppliers and buyers of raw materials. The purpose of the Study is to provide recommendations to Boliden on which system is suitable for implementation at the company.

The Study’s results were achieved by collecting both primary and secondary data. The primary data was collected through interviews with raw materials buyers and trade organisations. A total of fifteen interviews were conducted in the Study. The secondary data was collected through a literature study.

The results of the Study indicate that there exists four different solutions for managing the flow of information in a supply chain of raw materials. The most common solution among buyers of raw materials is to use the so-called “traditional” systems, i.e. e-mail, telephone and physical meetings. The second most common solution is to use an external information handling system provided by a trade organisation. The third most common solution is to use a commercial information handling system, i.e. a system provided by a commercial provider. Lastly, the least common solution is to develop an information handling system on its own, i.e. a proprietary information handling system.

The conclusion of the Study is that Boliden should use two information handling system simultaneously, i.e. an external information handling system and the traditional information handling systems. However, Boliden should also look into the option of developing a proprietary information handling system.

Key words

Delivery scheduling, flow of information, forest products, information handling systems, paper and pulp, production planning, raw materials, scrap, steel, supply chain of raw materials
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1 Introduction

This chapter provides a brief introduction to the Study, which is named “Efficient Information Flow in a Supply Chain of Raw Materials”. The chapter begins with a brief description of the academic background behind the Study and the purpose of the Report. These two subchapters are then followed by a description of the Study’s two research questions. The chapter finishes with an explanation of the Study’s delimitations and a short description of the disposition of the Report.

1.1 Introduction to the Study

This master’s thesis project (the “Study” or the “Report”) is named “Efficient Information Flow in a Supply Chain of Raw Materials” and it is a part of the university course MH200X, which is offered by the Department of Materials Science and Engineering at KTH Royal Institute of Technology in Stockholm, Sweden. The Study is a collaboration between KTH and Boliden Commercial AB.

1.2 Purpose

The main objective of the Study is to thoroughly examine what kind of systems companies present in the process industry use for handling the flow of information in a supply chain of raw materials, i.e. what kind of information handling systems are currently in use in the process industry. The Study will mainly focus on buyers of secondary raw materials, i.e. companies that purchase scrap products for the purpose of extracting raw materials from the scrap. Three different process industries will be evaluated in the Study, i.e. the steel production industry, the base metals industry and the paper and pulp industry. The Study will mainly focus on the steel production industry, while the base metals industry and the paper and pulp industry will be used as reference industries.

The purpose of the Study is to provide recommendations to Boliden on which information handling system is suitable for implementation at the company. Boliden is looking for a system that streamlines its procurement process as well as reduces its administrative burden.

1.3 Research Questions

The objective and purpose of the Study will be achieved by assessing the following two research questions. These questions serve as the main pillars of the Study.

RQ1: What system is used for handling the flow of information in a supply chain of raw materials?

RQ2: Which information handling system is suitable for implementation at Boliden?
1.4 Delimitations

Due to the complexity of the research topic, different delimitations will be applied to the Study. First of all, the Study will only evaluate the exchange of information between suppliers and buyers of raw materials. Secondly, the Study will solely focus on the exchange of information during the following steps of a procurement process:

(i) Notification of amount and quality of raw materials by the supplier
(ii) Discussions regarding terms and conditions of the specific delivery
(iii) Booking of delivery time frame and method
(iv) Continuous exchange of information regarding the delivery of the raw materials
(v) Delivery of the raw materials to the buyer
(vi) Quality analysis of the raw materials by the buyer and follow-up with the supplier

Lastly, the final delimitation is that the Study will only examine buyers and suppliers of raw materials that are mainly present in Sweden. The reason for this is that the purpose of the Study is to thoroughly examine how companies handle the flow of information in their supply chains. Hence, the ambition of the Study is to conduct both face-to-face and telephone interviews with the investigated companies as well as conducting field trips to the companies’ plants in order to directly see how the companies handle the flow of information in their supply chains. Since these examinations require a lot of time, the number of companies evaluated will have to be limited. Hence, only companies in Sweden will be examined.

1.5 Disposition

The remaining part of the Report is divided into six chapters. Chapter 2 is named “Background” and it provides a description of the underlying background behind the Study. The chapter outlines common issues encountered in the process industry and the effect these issues have on companies present in the process industry. Chapter 3 is called “Methodology” and this chapter discusses the methodology that was used in the Study for investigating the research questions and for achieving results. In addition, this chapter outlines the characteristics of the selected methodology and the reasons for why the methodology was chosen. The results of the Study are presented and described in chapter 4 of the Report, which is named “Results”. Chapter 5 is called “Discussion and Conclusions” and this chapter analyses and scrutinises the achieved results from chapter 4. The research questions of the Study are answered in this section of the Report. Moreover, chapter 6 is named “Acknowledgements” and this chapter outlines the people that have supported and contributed to the study. Lastly, chapter 7 is called “List of References” and this chapter lists the references that were used in the Study.
2 Background

This chapter provides an overview of the theoretical background behind the Study. The chapter is divided into three sections. The first part of the chapter discusses the importance of scrap to the process industry. The second section describes the inconsistent availability of scrap. The final part of the chapter discusses the variability of incoming scrap, the reason for the variability and why this is an issue for companies present in the process industry.

2.1 Importance of Scrap in the Process Industry

The process industry is one of the largest industries in the world. It comprises of a large number subindustries, including the steel production industry, the base metals production industry, the paper and pulp production industry and the chemicals industry. (Van Donk & Fransoo, 2006; Crama, et al., 2001)

Companies present in the process industry are often highly dependent on the availability of secondary raw materials, i.e. waste materials and products which can be able to be recycled or reused (Crama, et al., 2001; European Commission, 2017; Zbořil & Gibellieri, 2011). Secondary raw materials covers a wide number of product classes. One of the largest classes is scrap products consisting of ferrous, non-ferrous and precious metals, e.g. electronics and building leftovers. Other important classes are waste paper and plastic scrap products. (Hagelüken & Corti, 2010; Schwarzkopp & Drescher, 2016; Zbořil & Gibellieri, 2011)

The steel production industry is an example of an industry that is highly dependent on the availability of scrap. A total of 1,621 million tonnes of crude steel were produced in the world in 2015 (World Steel Association, 2016). It required approximately 3,520 million tonnes of raw materials to produce this amount, of which 520 million tonnes consisted of scrap steel, which corresponds to 15%. The remaining amount consisted of iron ore and metallurgical coal, which accounted for 57% and 28%, respectively (World Steel Association, 2017).

The copper production industry is another industry that heavily rely on the availability of scrap. For example, a total of 23.4 million metric tonnes of refined copper were produced in 2016, of which 3.9 million metric tonnes were produced from secondary raw materials, corresponding to 17% of the total production output. (International Copper Study Group, 2017)

In conclusion, access to scrap is vital to the process industry, since many companies present in the industry use scrap products and materials as raw materials. However, using scrap in manufacturing processes can be problematic. For example, the access to scrap materials is inconsistent and it is often
difficult to accurately verify the quality of scrap. These issues are further described in the following subchapters.

2.2 Availability of Scrap

Many companies present in the process industry are dependent on buying scrap from scrap collectors. However, their access to scrap depends on the suppliers’ ability to collect and deliver products and materials. A common issue that causes incoming raw material shortages for manufacturing companies is that some suppliers of scrap do not provide reliable and accurate information about the materials and the shipments before delivering the goods to the buyers. This includes information relating to the quality and quantity of the materials as well as the delivery time frame of the goods. This issue is a problem for buyers of scrap since it increases the buyers’ uncertainties. Buyers of scrap need to know how much they can order, what quality they can order and when the shipments will be delivered, as these parameters are crucial for the companies’ ability to plan and schedule their planning. (Gunnarsdóttir & Valdimarsdóttir, 2012)

One reason for the suppliers’ inability to provide reliable and accurate information is that scrap is a diversified raw material category, in regard to both physical and chemical characteristics, i.e. the definition of scrap covers a wide number of products and materials. For example, there exists ferrous scrap, non-ferrous scrap, precious metals scrap, waste paper scrap, plastic scrap, etc. In addition, scrap comes in various forms and dimensions, e.g. used machines, equipment, industrial components and electronics could be reused and recycled as scrap. (Jernkontoret, 2015; European Commission, 2017; Zbořil & Gibellieri, 2011)

To cope with this issue, some process industries have established rules and guidelines for classification of scrap products and materials. For example, the Swedish steel industry and steel scrap industry have put together a document named “The Swedish Scrap Book” (Sw. “Skrotboken”), which outlines how stainless steel scrap and unalloyed metal scrap should be classified, depending on the origin, shape and characteristics of the scrap. The document also describe how the scrap should be transported and delivered from the suppliers to the buyers. The European steel association EUROFER has developed a similar document named “European Steel Scrap Specification”, which outlines how different scrap products and materials should be graded within the European Union. (AB Järnbruksförnödenheter, 2000; EUROFER, 2008; Jernkontoret, 2015)

Despite established rules and guidelines, the process of classifying scrap products and materials is complex and often problematic for the suppliers. One of the main reasons is that secondary raw materials are heterogeneous.
2.3 Variability of Incoming Scrap

Most secondary raw materials are heterogeneous, i.e. they have non-uniform characteristics. This means that the characteristics can vary a lot within a specific material. This is an issue for companies operating in the process industry, since the heterogeneity makes it very difficult to fully determine the characteristics of raw materials. As a result, many suppliers of raw materials are not able to accurately measure and verify the quality of the raw materials before delivering the goods to the buyer, including important characteristics such as composition, weight and moisture content. Many suppliers solve this issue by testing the characteristics of a few samples of a shipment and then apply the test results to the entire shipment. However, this is not a fully reliable method since there is an imminent risk that the characteristics of the tested samples do not accurately represent the entire shipment. This uncertainty is often a problem for buyers of raw materials, as they cannot fully rely on suppliers’ specifications. Most buyers handle this problem by carrying out their own tests after receiving the goods. External third parties are also used for verifying the quality. This is especially common when the buyer’s test results differ from the agreed specification or the supplier’s test results. The neutral third party will then analyse some samples of the delivery and provide the buyer and the supplier with a report summarising the results.

The process of testing and verifying the quality is often costly, as it requires experienced and qualified personnel. In addition, it increases lead times for companies, as the process is often time-consuming, especially if a third party verification is needed. Minimising lead times is highly important for companies operating in the process industry, as a reduction in lead times can improve productivity, production output and profits. Longer lead times will in most cases have a negative effect on the operations of a company, as it causes delays in the production work flow. Companies present in the process industry are especially vulnerable to unnecessary lead times, as they are highly dependent on the availability of raw materials, and a shortfall in quality-verified raw materials can constrain production output and thereby limit profits.

However, the costs and lead times can often be minimised with delivery scheduling and production planning. Delivery scheduling is defined as follows:

“The timing or rate of delivery as required by a buyer, or as agreed between a buyer and a seller, for goods or services purchased for a future delivery period.” (Toroitich & Iravo, 2015, p. 20)

Production planning is defined as:

“Production planning is the process of determining a tentative plan for how much production will occur in the next several time periods, during an interval of time called the planning
horizon. Production planning also determines expected inventory levels, as well as the workforce and other resources necessary to implement the production plans.” (Saharidis, et al., 2006, p. 114)

However, for the production planning and delivery scheduling to be efficient, buyers of raw materials depend on information provided by their suppliers, e.g. information relating to delivery volumes, methods and time frames.
3 Methodology

This chapter provides an overview of the methodology that was used in the Study to achieve the results. The chapter is divided into three sections. The first section discusses how the scientific approach was selected for the Study and why this approach was selected, while the second part outlines the characteristics of the selected approach. The final section of this chapter provides an overview of how the primary data and secondary data were collected in the Study.

3.1 Selection of Scientific Approach

Yin’s (2003) research on scientific research strategies was considered when selecting the scientific approach for the Study. According to Yin, one need to consider three questions when determining the appropriate approach for a study:

(i) What is the character of the research questions?

(ii) Has the researcher control over the results?

(iii) Is the Study concentrated on contemporary events?

The questions are arranged in hierarchical order, meaning that the first question is the most important one to answer. Hence, this question needs to be considered before the other two questions, as the answer on this question determines the overall research approach. The second question is to some extent more important than the third one. There are mainly five different approaches when researching a scientific subject and the most appropriate approach for a specific study depends on the answers on the aforementioned questions. The five approaches are; (i) experimental study, (ii) survey, (iii) archival study, (iv) historical study, and (v) case study. Figure 1 illustrates the process for selecting a scientific approach according to Yin. (Yin, 2003)

Although the Study has two research questions, the first research question is the most important one to the Study, as the second research question is dependent on the first one, i.e. it cannot be examined without investigating the first research question first. Hence, the first question has a higher priority than the second one and it should therefore determine the selected approach for the Study.
The first research question of the Study is a “what” question, which suggests that the most appropriate approach for examining the first research question of the Study could either be; (i) archival study or (ii) survey. Furthermore, the researcher of the Study has no influence or control over the results or the events in the Study, which means that the answer on Yin’s (2003) second question is “no”. Lastly, since the Study focuses on contemporary events, the answer on Yin’s third question is “yes”. This suggests that the most optimal scientific approach for the Study is to do a survey. The process for deriving at this approach has been highlighted with orange in Figure 1.

### 3.2 Characteristics of Scientific Approach

The survey approach was selected as the scientific approach of the Study. Survey research is defined as:

> [...] a specific type of field study that involves the collection of data from a sample of elements drawn systematically to be representative of a well-defined, large, and geographically diverse population often, though not necessarily, through the use of a questionnaire.” (Reis & Judd, 2014, p. 406)
However, even though surveys are commonly used for investigating groups of people, surveys are also used for examining organisations and companies. Hence, the survey approach is well-suited for the purpose of the Study. (Reis & Judd, 2014)

Surveys can be conducted in various ways. The most common survey types are: (i) mailed questionnaires, (ii) telephone questionnaires, (iii) personal interviews, and (iv) online questionnaires. There are several advantages and disadvantages with each type, and several variables need to be considered when selecting the most appropriate method for a specific study, such as the size of the investigated population, the goal of the survey, budget, allocated time frame, and etcetera. (Diem, 2002; FAO, 2017; Rutgers-Cook College, 2002)

The main advantages and disadvantages with each survey type are outlined in Table 1:

Table 1: Advantage and Disadvantages with Different Survey Methods
(based on FAO, 2017 and Rutgers-Cook College, 2002)

<table>
<thead>
<tr>
<th>Survey type</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Mail        | • Easy and cost efficient  
• No interviewer, respondents may be more willing to share information | • Response rates are typically low  
• Not appropriate for low literacy audiences  
• No interviewer, respondents cannot be probed |
| Telephone   | • Large scale accessibility  
• Rapid data collection  
• Quality control  
• Anonymity  
• Flexibility | • Lack of visual materials  
• Call screening is common  
• Limited open-end questions  
• Wariness  
• Inattentiveness |
| Personal    | • Quick response possible  
• Interviews can be done in one location  
• Face-to-face contact offers personal element and trust  
• Can interview groups of people at one time  
• Can reach inaccessible audiences | • Time consuming if interviews are conducted at subjects’ locations  
• Respondents may be more likely to give socially acceptable answers |
| Online      | • Low costs  
• Automation and real-time access  
• Less time needed  
• Convenience for respondents  
• Design flexibility  
• No interviewer, respondents may be more willing to share information | • Limited sampling and respondent availability.  
• Possible cooperation problems  
• No interviewer, respondents cannot be probed |
Personal and telephone interviews were selected as the most appropriate approaches for the Study. The reason for this is that the objective of the Study is to thoroughly examine what kind of systems companies use for handling the flow of information. As seen in Table 1, face-to-face interviews offers the interviewer and the interviewee the opportunity to interact and create trust to each other. In addition, personal interviews enable the interviewer to reach inaccessible interviewees, which is advantage when interviewing employees and representatives from companies and organisations. Telephone interviews were also selected as an approach in the Study since telephone interviews offer the interviewer the possibility reach a large group of interviewees in a flexible manner.

Lastly, the Report is characterised as an exploratory study and the reason for this is that the goal of an exploratory study is to examine a subject that has not been researched before (Collis & Hussey, 2003) or a subject that has not been fully investigated (Shields & Rangarajan, 2013). The subject and research questions of the Study have not been investigated earlier, i.e. no precedent research report has investigated what kind of systems companies present in the process industry use for handling the flow of information in a supply chain of raw materials. Hence, the characteristics of the Study corresponds well with the goal of an exploratory study.

3.3 Data Collection

The Study, including the Study’s results and analysis, is based on both primary and secondary data. Primary and secondary data are defined as:

“Primary data is collected with the aim of being foundation for the analyses in your investigation. Secondary data is collected for other purposes” (Safsten, 2004, p. 1)

The primary data of the Study was collected in two ways; (i) interviews with raw materials buyers, and (ii) interviews with trade organisations. The secondary data was gathered through a literature review. Books, journal articles, articles in periodicals and scientific reports were used when conducting the literature review.

The primary data was used for answering both of the research questions, while the secondary data of the Study was solely used for examining the first research question. Additionally, the findings concluded when researching the first research question were used as a foundation when examining the second research question. An overview of the data collection categories and how the categories were used is illustrated in Figure 2.
3.3.1 Primary Data Collection

The primary data collection method consisted of interviews. Throughout the Study, a total of fifteen interviews were held with eleven different companies and organisations. Two categories of interviews were conducted:

(i) Interviews with raw materials buyers (twelve interviews)
   a. Steel production industry: Seven interviews with five companies (these five buyers account for c. 80% of all the steel scrap that is purchased annually in Sweden (Högberg, 2017))
   b. Base metals production industry: Three interviews with two companies
   c. Paper and pulp production industry: Two interviews with two companies

(ii) Interviews with trade organisations (three interviews)
   a. Recycling and steel scrap industry: Two interviews with one organisation
   b. Forestry industry: One interview with one organisation

The reason for the categorisation is that the two categories had different purposes and interview questions. However, both of the categories have been considered as primary data collection sources in the Study, as the findings from the interviews were essential when exploring what kind of systems
companies present in the process industry use for handling the flow of information in a supply chain of raw materials.

The interviewees for the interviews were chosen in two different ways; (i) the supervisors of the Study provided contact details to employees at relevant companies, and (ii) the interviewees recommended acquaintances and partners at other companies and trade organisations, e.g. an interviewee at “Company A” suggested a specific person at “Company B” and this person suggested a person at “Company C”, etcetera. This is known as snowball sampling and it is a common method in qualitative research for finding relevant interviewees and for collecting data (Biernacki & Waldorf, 1981; Collis & Hussey, 2003). Even though there are many ways for finding interviewees for research purposes, snowball sampling was chosen as the most appropriate method for the Study. The reason for this is that snowball sampling is an effective approach when it is difficult to find relevant interviewees and when the research concerns a sensitive subject (Biernacki & Waldorf, 1981). This was the case when examining the research questions of the Study, as the largest buyers of raw materials in the Sweden are multinational companies with several thousand employees, making it difficult to pinpoint the most relevant employees for the Study, and since many companies are hesitant to disclose information relating to their operations and procurement processes. The snowball sampling approach was also useful as several interviewees provided contact details to people at both engineering and management positions. This was valuable since it enabled the group of interviewees to become more diversified.

All meetings were conducted as semi-structured interviews. A semi-structured interview is defined as:

“In a typical semi-structured interview the researcher has a list of questions or series of topics they want to cover in the interview, an interview guide, but there is flexibility in how and when the questions are put and how the interviewee can respond” (Edwards & Holland, 2013, p. 29)

This approach was selected for the interviews, as it allows the interviewee to be spontaneous and it encourages discussions, while it at the same time provides guidance for the interviewer. Although there are several advantages with fully structured interviews (e.g. a higher degree of objectivity), the purpose of the Study is to understand and analyse a specific subject, and the semi-structured approach is a better alternative for this, as it allows the interviewer to ask follow-up questions. In addition, as previously mentioned, the Study is structured as a qualitative case study and semi-structured interviews are common when conducting qualitative research and smaller case studies. (Edwards & Holland, 2013; Drever, 1995)

All of the interviews were held in Swedish, except for one which was conducted in English. Three of the interviews occurred in person, ten over telephone, one over e-mail and the remaining one occurred via a video conference. The reason for why only three interviews were conducted face-to-face is that most of the examined companies have located their production facilities in Northern Sweden.
Prior to each interview, the interviewee was asked if the interview could be recorded. A majority of the interviewees accepted it. In addition to recording most of the interviews, notes were written down during the interviews. This approach was used as it efficiently allowed the researcher to take an active role during the interviews, e.g. participate in discussions with the interviewee and ask follow-up questions. All of the recordings and the notes from the interviews were scrutinised and analysed when answering the research questions of the Study.

**Interviews with Raw Materials Buyers**

Twelve interviews were conducted with employees from nine different raw materials buyers located in Sweden. The main purpose of interviewing these raw materials buyers were to (i) examine how the buyers handle the flow of information in their supply chain of raw materials, and (ii) why are they using their information handling systems. The buyers were asked detailed questions about the information handling systems they currently use, how and why they use these systems, how the systems were developed and if they are planning to implement other systems. In addition to these questions, a various number of follow-up questions were asked and several discussions took place during the interviews. The findings derived from these interviews were used to answer the first and second research question of the Study.

All of the nine interviewed companies are raw materials buyers, i.e. they buy raw materials from suppliers in order to process the materials and later manufacture their own products from the processed materials. Five of the buyers manufacture stainless steel and/or alloyed steel products, and these five buyers purchase together approximately 80% of all the steel scrap in Sweden every year. In addition to these companies, two producers of base metal products and two producers of paper and pulp products were interviewed in the Study. Eight of the interviewed companies are headquartered in Sweden and the remaining company is based in Finland.

Most of the interviews lasted for 45 to 75 minutes. Nine of the interviews were held over telephone, two in person and one over a video conference.

**Interviews with Trade Organisations**

Three interviews were conducted with representatives from two different trade organisations in Sweden. One of the trade organisations is involved in the recycling and steel scrap industry and the organisation is involved in approximately 80% of the trades conducted in the Swedish steel scrap market every year. The second trade organisation is present in the Swedish forestry industry, and the organisation represents over 20,000 forest owners in Sweden.
The objectives of these two interviews were to; (i) derive an industry-wide understanding of what kind of information handling systems are used in the steel scrap industry and the paper and pulp industry, (ii) understand if there exists a common practice system among the organisations’ partners, and (iii) understand if the trade organisations have developed any proprietary systems for information handling. The findings from the interviews were used to answer the first research question of the Study.

One of the interviews was conducted via telephone, one was conducted face-to-face in Stockholm and the final was held over e-mail. The face-to-face and telephone interviews lasted for approximately 60 to 75 minutes.

### 3.3.2 Secondary Data Collection

In addition to the primary data, secondary data was gathered for examining the research questions of the Study. The secondary data was gathered through a literature review, in which books, journal articles, articles in periodicals and scientific reports were reviewed.

The main purpose of gathering the secondary data was not to explicitly answer the Study’s research questions. Instead, the secondary data was collected for research purposes, i.e. the secondary data was used to provide the researcher of the Study with information on how companies present in the process industry handle delivery scheduling and production planning. In addition to providing the researcher with information on supply chain management in the process industry, the collected data was used as a theoretical foundation when examining the first research question of the Study.

The secondary data was collected in two different ways; (i) through recommendations provided by the interviewees and the supervisors of the Study, and (ii) by reviewing references provided in relevant articles and reports.
4 Results

The results of the Study are presented in this chapter. The chapter begins with a short presentation of the findings from the data collection as well as the numerical results. This part is then followed by detailed descriptions of each information handling system, including how each system works, the characteristics of each system as well as what the systems achieves for their users.

4.1 Numerical Results

A total of fifteen interviews were conducted in the Study. The results from the interviews indicate that there exists four different solutions for handling the flow of information in a supply chain of raw materials. The results from the Study indicate that the most common solution was to use the so-called Traditional Information Handling Systems, i.e. e-mail, telephone and physical meetings. The second most common solution was to use an External Information Handling System, i.e. a system provided by a trade organisation. The third most common solution was to use a Commercial Information Handling System, i.e. a system provided by a commercial provider, typically a business software company. Lastly, the results indicate that the least common solution was to develop an information handling system on its own, i.e. a Proprietary Information Handling System.

Nine buyers of raw materials were examined in the Study and the numerical results from the examinations are presented in Table 2:

Table 2: Distribution of Information Handling Systems among the Examined Companies

<table>
<thead>
<tr>
<th>Industry</th>
<th>Traditional Systems</th>
<th>Proprietary Systems</th>
<th>External Systems</th>
<th>Commercial Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company 1</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
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<td>Company 2</td>
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As seen in Table 2, all of the companies that participated in the Study use the traditional information handling systems when buying raw materials, however, six of the companies combine the traditional systems with another system. Five of the companies use external information handling systems, i.e. systems provided by trade organisations, two companies use commercial systems, and only one company has developed a proprietary information handling system.

A clear majority of the examined companies use multiple information handling systems simultaneously when buying raw materials. Four companies use two systems at the same time, while two companies use three systems simultaneously. Only three buyers of raw materials use one system, and no company uses all four systems.

4.2 Traditional Information Handling Systems

The results of the Study indicate that the most common systems for handling the flow of information in a supply chain of raw materials are: (i) e-mail, (ii) telephone, and (iii) physical meetings. These communication methods have been named the “traditional information handling systems” in the Report. The reason for this is that several interviewees described the aforementioned systems as either “traditional” or “old-fashioned”, due to the fact that the communication methods have been established and used for several decades for purchasing raw materials and other kinds of goods.

It became evident during the interviews that all of the participating companies in the Study use the traditional information handling systems, i.e. nine out of nine raw materials buyers use a mix of e-mail, telephone and physical meetings when communicating with their suppliers of raw materials. However, only three companies use the traditional information handling systems exclusively when buying raw materials, while a clear majority of the companies combine the traditional systems with other systems.

4.2.1 How It Works

All of the investigated companies incorporate the traditional systems into their procurement processes in a similar way. The common denominator is that all exchanges of information during the procurement processes occur over either telephone, e-mail or in person, i.e. through physical meetings.

The typical process starts as follows. The supplier of raw materials contacts the buyer and notifies the buyer of its current stock levels, i.e. what kind of materials it has access to and the quality and volumes of these materials. It is also common for the buyer of raw materials to actively seek raw materials, i.e. to contact suppliers to see what kind of materials they have access to. This step of the process is often done over either telephone, e-mail or face-to-face. The buyer will then examine if the supplier’s raw materials are need and suitable for its operations.
The buyer will then contact the supplier to discuss terms and conditions relating to that specific shipment. This is often done over e-mail or in person, but it could also be done over telephone, especially if the buyer and the supplier have a long history of making transactions. Most suppliers have already established relationships and contracts with their buyers, making this step of the procurement process relatively uncomplicated.

The next step of the process is that the supplier sends the buyer a specification. The buyer will then review the specification and send back an order placement. This is always done over e-mail. However, some buyers do not send order placements, but rather verify the suppliers’ specifications directly.

The supplier will then start to deliver the purchased goods to the buyer. This is often done by trains or by trucks in Sweden, the Nordics and Northern Europe. However, some deliveries are conducted via cargo shipments, e.g. if the buyer has access to a harbour or if the delivery is extensive or needs to be transported over long distances.

The final step of the process is that the buyer receives the delivery. The buyer will then examine and analyse the received goods to verify if the delivery corresponded to the supplier’s initial specification, e.g. measure the composition, weight and moisture content of the goods. The buyer will then contact the supplier to deliver the results from the examination. This is mostly done over either telephone or e-mail.

*Figure 3* displays how the buyers use the traditional information handling systems to manage the flow of information in a typical procurement process. The steps in which the traditional systems are used in are highlighted with colours in the figure.
4.2.2 Characteristics

Most of the interviewees highlighted different characteristics with the traditional information handling systems. However, there were many similarities in their reviews, and most interviewees emphasised three main characteristics with the traditional information handling systems.

**Bi-directional Communication**

The traditional information handling systems offers bi-directional communication, meaning that the supplier of raw materials can contact the buyer of the products, and the buyer can contact the supplier. The bi-directional communication is possible since most people are constantly available over e-mail or
telephone. Four interviewees highlighted this feature as the main characteristic with the traditional information handling systems.

**Transparent**

The traditional information handling systems are highly transparent. Several interviewees highlighted this feature as a main characteristic with the systems. The high transparency is mainly due to the fact that it is very easy for both the supplier and the buyer in a transaction to discuss issues and details over the telephone, e-mail and via physical meetings. One of the interviewees emphasised that the high transparency is one of the main reasons for why the interviewee’s company is still committed to conduct procurement through the traditional systems.

**Cost-effective**

Most interviewees described the traditional systems as “cheap” or “cost-effective” solutions for handling the flow of information during procurement processes. The reason for this is that all established companies have already invested in e-mail and telephone systems as these systems are necessary when operating a business. Companies can limit their procurement costs by utilising these already established systems when communicating with suppliers, instead of investing in additional information handling systems. In addition, many interviewees highlighted that the cost for physical meetings is often limited since most Swedish buyers of secondary raw materials source their goods from Swedish suppliers. Hence, travelling costs are often limited since most travelling occur domestically.

### 4.2.3 What It Achieves

The interviews of the Study indicate that the traditional information handling systems achieve three results for the companies that use them.

**Strengthens Relationships with Suppliers**

Four interviewees highlighted that the traditional information handling systems improve and strengthen the buyers’ relationships with their suppliers. The reason for this is that continuous meetings and phone calls provide opportunities to deepen partnerships and collaborations with suppliers. Many interviewees emphasised that traditional information handling system are deliberately used as a tool for preserving good and withstanding partnerships with suppliers.

**Increases the Administrative Burden**

Several interviewees highlighted that the traditional information handling systems are inefficient and that they create a lot of unnecessary work, i.e. they increase the administrative burden for the companies.
There is mainly one reason for this. Most documents that are being used in a procurement process (e.g. term agreements, specifications and order placements) need to be reviewed and approved, both internally and externally. As a result, a lot of documents need to be sent back and forth over e-mail between different people and departments. The constant exchange of e-mails is a time-consuming and inefficient process and it increases the administrative burden for the buyer.

**Increases the Risk for Human Errors**

As previously mentioned, several documents need to be reviewed and processed when organising a transaction of raw materials, e.g. term agreements, specifications and order placements need to be reviewed and approved by several parties before a transaction can be made. Most of the documents are transferred back and forth over e-mail between different people and departments. Hence, there is a risk that a document gets “lost” during an e-mail exchange, e.g. gets forgotten in someone’s e-mail inbox or gets deleted by mistake, and this could have a damaging effect on the transaction of the goods. For example, if someone forgets to forward an e-mail containing an updated delivery date, there risk is that the buyer will not be able to receive or process the delivery when it arrives.

In addition, since a lot of correspondence occurs over e-mail, there is also a risk that someone sends an unfinished or classified e-mail by mistake to the wrong person. If the document is sent to someone within the same company, the consequences are usually not damaging, but the consequences could be serious if an e-mail or a document is sent by mistake to an external party.

**4.3 Proprietary Information Handling Systems**

All of the interviewed companies use traditional information handling systems for handling the flow of information. However, multiple companies combine the traditional systems with other information handling systems. Most of the companies use systems that have been developed by external parties, but one of the investigated buyers of forest products has developed an information handling system on its own, a so-called “proprietary information handling system”. This was the least most common solution for handling the flow of information in a supply chain of raw materials.

The buyer’s proprietary information handling system consists of both a website and a mobile application. The mobile application is offered to both Android and iPhone users. The information handling system was launched in several stages during a twelve month period between 2013 and 2014. However, the company has made several changes and updates to the system since the launch to simplify the system and to make it more efficient to its suppliers.

The company’s proprietary system is only used by the company and its suppliers, i.e. suppliers that are not directly supplying products to the company are not able to use or log in to the information handling
system. Although the proprietary system is offered to all of the company’s suppliers, a minority of its suppliers use it frequently. Most of the non-users are smaller companies with limited raw materials reserves. These suppliers do not sell products frequently, and thus, do not need to use the system on a regular basis. However, the percentage of users increases every year.

The company decided to develop the system due to competitive reasons. It had noticed that some of its competitors had similar systems in place or were developing comparable systems. It took approximately two years to develop the information handling system.

Most of the proprietary information handling system was built internally within the company, i.e. by the company’s IT architects. The IT architects created the website, while the mobile application was developed by an external technology company based on the website’s functionalities. The proprietary information handling system is today solely managed by the company’s IT department.

4.3.1 How It Works

The company’s proprietary information handling system is customised for the needs of the company and its suppliers. The system contains four main functions; (i) it serves as a communication channel and database during procurement processes, (ii) it contains contact details, (iii) it contains information on how the suppliers can take care of their raw materials reserves, and lastly (iv) it acts as a news website.

However, the main purpose of the proprietary information handling system is to serve as a communication channel and database when buying raw materials. In fact, most exchanges of information occur through the system in a typical procurement process.

The proprietary information handling system offers suppliers the possibility to catalogue and map their current raw materials reserves on the platform, i.e. register current volumes, classes and qualities. The company’s raw materials buyers have access to the provided information and can therefore reach out to certain suppliers when they want to buy certain materials. However, they usually do this manually, i.e. over telephone, e-mail or in person. Discussions regarding terms and conditions take place outside of the proprietary system as well.

Once the terms and conditions have been stipulated, the suppliers have the possibility to upload specifications to the IT platform. The buyer can then access and approve these documents by logging in to the system. It is also possible to book delivery dates and methods via the platform.

Lastly, when the goods have been delivered and quality tested, the buyer has the possibility to upload the quality results and write comments about them. The suppliers can then access these results and respond to the provided remarks, either through the system or externally.
Figure 4 provides an overview of how the company’s proprietary information handling system is used to manage the flow of information in a typical procurement process. The relevant steps in which the proprietary information handling system is used are highlighted with colours.

Figure 4: Overview of How the Proprietary Information Handling System is Used When Purchasing Raw Materials

However, even if the main purpose of the proprietary information handling system is to serve as a communication channel and database, the system offers other services as well. These functions are presented in the sections below.
Contact Details
One key function of the proprietary system is that it contains contact details to employees at the company. I.e., the company’s suppliers have the possibility to search for relevant employees on the platform. The provided contact details are regularly updated by the company.

Information on Raw Materials Management
Another function of the proprietary system is that the suppliers have access to information on how different kinds of raw materials should be managed. The information consists of instructions and recommendations made by experts. This function is especially used by smaller suppliers of raw materials.

News Feed
The company has also added a news site to the proprietary system. The suppliers have access to the site, which lists relevant articles about the company as well as press releases made by the company. The articles are written by the company, i.e. the site does not include any articles written by professional journalists.

4.3.2 Characteristics
The main characteristics of the company’s proprietary information system are presented below.

Customisation
One of the main characteristics with the proprietary information handling system is that the system is customised for the needs of the company and its suppliers. The reason for this is that the system was built internally within the company. When developing the system, the company put together different reference groups consisting of the company’s IT architects, sales personnel and raw materials buyers. Each group had the task to determine useful functions and services to incorporate into the system. As a result, the system is tailored for the company and it includes features and services that benefit all of its users.

Marketing Tool
The proprietary information handling system is used as a marketing tool by the company. In fact, the system is included in the company’s marketing material towards potential suppliers. As a result, the company has been able to attract suppliers from its competitors. This has been possible to do since the system offers a wide number of functions that create value for suppliers, such as contact details and instructions on how to manage raw materials reserves in an effective way.
In addition, the company has added a news site to the system. This site works as a marketing tool towards the company’s existing suppliers, since most articles concern the company and its operations.

**Demanding Development**

Another characteristic that was highlighted by the company was that the process of developing a proprietary information handling system is slow and demanding, and requires a lot of resources. For example, the company started to develop the system in 2011 and was not able to fully launch it until 2014. Also, the company is still making changes to the information handling system since it is not fully functioning yet. The company has spent a lot of resources on the system over the years, in the form of both working hours and capital.

**4.3.3 What It Achieves**

According to the company, the proprietary information handling system achieves three effects for the company.

**Reduces the Administrative Burden**

The proprietary information handling system reduces the company’s administrative burden. The reason for this is that procurement documents such as term agreements, specifications and order placements can be uploaded to the system’s IT platform. Since all of the documents are stored within the system, it is possible for the company to review previous agreements and documents when organising new transactions. This is a useful tool since it effectively reduces the administrative burden for the company.

**Streamlines the Procurement**

One of the main things that the proprietary information handling system achieves for the company is that it has made the company’s procurement processes more efficient, i.e. it has streamlined the processes. Since most exchanges of information occur via the proprietary system, the company has been able to reduce the amount of time it used to spend on gathering information from the suppliers. For example, instead of arranging calls and meetings with the suppliers to find out their availability of raw materials, the company can nowadays log in to the proprietary system and review the suppliers’ raw materials reserves.

**Reduces Relationships with Suppliers**

The company’s proprietary information handling system acts as a communication channel during procurement processes, since most exchanges of information occur via the system. As a result, the company is not interacting with its suppliers as often as it used to do, i.e. before the system was
established. The number of meetings and phone calls has reduced, and this has had a negative effect on some of the company’s relationships.

4.4 External Information Handling Systems

The results of the Study indicate that the second most common solution for handling the flow of information in a supply chain of raw materials is to use an external IT platform provided by a trade organisation, a so-called "external information handling system”.

One of the interviews in the Study was held with a trade organisation involved in the steel scrap industry and this organisation is currently developing an external information handling system for its partners. A beta version of the system has already been released and a fully equipped version of the system will be launched in 2017. In fact, five of the buyers that participated in the Study use already the beta version.

The trade organisation started to develop the external information handling system in 2015. The system consists of a web-based platform, which can be accessed by the organisation’s partners. The trade organisation covers c. 80% of the Swedish steel scrap market and has partnerships with the largest buyers and sellers of steel scrap in Sweden. All the organisation’s partners use the system frequently.

The external information handling system is not commercially driven and it is only offered to companies present in the steel scrap industry. The trade organisation is open to the idea of licensing the concept to companies present in other scrap industries. However, the organisation is has no interest of running the system as a commercial service, i.e. as a subscription service offered to non-partners.

There were mainly two reasons for why the trade organisation decided to develop an external information handling system for its partners. First of all, the organisation had previously in place an enterprise resource planning system (“ERP”) which managed some aspects of the partners’ delivery scheduling. However, this system had many flaws and it was considered highly inefficient, both from a technical and an administrative perspective. Hence, the organisation decided that the ERP system needed to be replaced with a newer and more customised system. Secondly, the trade organisation had noticed that some of its suppliers did not send proper notifications before delivering the goods, and this had caused some problems for the buyers of the goods. As a result, the organisation realised that it needed to standardise the notification process and that this could be done with an external information handling system. The platform of the external information handling system was built externally, i.e. by an external technology company. The maintenance of the system is also administrated externally.
4.4.1 How It Works

One of the investigated trade organisation has developed an external information handling system for its partners. The partners consist of both buyers and sellers of raw materials, and the system is customised for the needs of both groups. The main purpose of the system is to serve as a communication platform between the groups during transactions. In fact, the system has many similarities with the earlier discussed proprietary information handling system.

The external information handling system works as follows. The organisation’s suppliers register their available volumes in the system every month. They list what kind of raw materials they have in stock, as well as the quality and the characteristics of these materials. It is also possible for the suppliers to list different “special offers” in the system, e.g. if they have access to any unique or unusual materials. The registration of available materials is usually done during the first few days of every month. The organisation’s buyers have also the possibility to register their estimated needs for the next month in the system. They can register what kind of materials they want, the quality of these materials, and the needed volumes. The buyers usually do this at the same time as the suppliers register their stocks, i.e. during the beginning of every month.

The next step of the process is that the trade organisation will download a summary of what the suppliers and the buyers have registered in the system. The trade organisation will then match the available stock levels with the needs of each buyer. This is usually done manually via Microsoft Office. The trade organisation take into account a long list of parameters when doing this, including the buyers’ proximity to the suppliers, logistical capabilities and expertise. The trade organisation will then reach out to each supplier and buyer with suggested delivery schedules and conditions. This is done externally, i.e. over telephone, e-mail or in person. Discussions regarding the conditions and the terms take place outside of the information handling system as well.

The suppliers will then send specifications to the buyers via the external information handling system, i.e. upload the specifications to the system’s IT platform. The buyers can access and review these documents by logging into the system. The buyers will then send order placements to the suppliers via the system. Both parties can write comments or attach pictures when doing this.

A key feature of the external information handling system is that it is possible for the suppliers and the buyers to track the deliveries. This is possible to do since there is a tool in the system where the suppliers and buyers can register their progress. For example, the suppliers can confirm via the system if they have prepared the deliveries and if they have started to ship the goods. The buyers can at the same time confirm if they have received the goods and if they have started to analyse the materials.

Lastly, once the buyers have tested the quality of the received goods, it is possible for the buyers to upload the results on the platform. It is also possible for the buyers to write comments about the goods
and attach pictures. The suppliers can then see these results and respond to them through the system. Figure 5 displays how the trade organisation’s external information handling system is used.

**Figure 5: Overview of How the External Information Handling Systems is Used When Purchasing Raw Materials**

### 4.4.2 Characteristics

The interviews of the Study indicate that the external information handling system has three main characteristics. The characteristics are presented in the sections below.
Straightforward

Many of the interviewed companies highlighted in their interviews that the external information handling system is straightforward and easy to use. The interface of the system was often described as “uncomplicated”, “transparent” and “clean” by the interviewees. In addition, several interviewees highlighted that it was easy to learn how the system works and how and when the different features of the system should be used. Moreover, several companies mentioned that no internal or external training were required for their employees when launching the system. This was described as a highly positive characteristic, since both internal and external training often require resources, such as time and money.

Transparent

One of the main characteristics with the external information handling system is that the system is transparent. The reason for this is that it is possible for the buyers of the raw materials to track their goods via the IT platform, since the suppliers are required to register their progress in the system. Several of the interviewees highlighted this a key feature, since it helps them to prepare for the arrival of the goods, both from an administrative perspective and a delivery scheduling and operational perspective.

Poor Follow-up Capabilities

It is possible for the buyers to upload their test results on the platform and it is also possible for them to write comments about the results and add pictures. However, two of the interviewees highlighted in their interviews that the external information handling system is not very efficient when it comes to discussing test results with suppliers, since it is difficult to discuss complex matters over an IT platform. Both of them highlighted that the traditional information handling systems are better suited for this and that the external information handling system needs to be improved when it comes to this feature.

4.4.3 What It Achieves

Most interviewees highlighted three effects the system has had on their operations and specifically on their procurement processes. The effects are presented in the sections below.

Streamlines the Procurement

One of the main effects the system has had is that it has helped the buyers of raw materials to streamline their procurement processes and thereby improve the efficiency in their supply chains. The reason for this is that most exchanges of information occur via the external system. Hence, the buyers do not have to spend time and/or monetary resources on gathering information from the suppliers, which was a problem before the system was launched.
Reduces the Administrative Burden
Another effect with the external information handling system is that the system has reduced the administrative burden for both the buyers and the suppliers. The reason for this is that most documents that get uploaded to the platform get stored within the system after the transactions have closed. This means that the suppliers and the buyers of raw materials can access the system at a later date to review previous documents, such as term agreements, specifications and quality reviews. I.e. the companies are no longer required to store and catalogue their own documents, since the system is taken care of this, resulting in a reduced administrative burden for the companies.

Standardises the Procurement
The external information handling system has standardised the procurement process for the buyers of raw materials. The main reason for this is that the system and its features are easy to use and straightforward and an effect of this is that both the suppliers and the buyers use the system frequently. As a result, more and more information is shared through the system today. One issue that was common before the beta version of the system was launched was that some of the suppliers did not send proper notifications before delivering the goods and caused problems for the buyers. However, this issue has been resolved through the external information handling system since the suppliers of the raw materials have the possibility to easily and effectively send notifications to the buyers via the system before delivering the raw materials.

4.5 Commercial Information Handling Systems
A “commercial information handling system” is defined as an information handling system that is provided by an external and commercial party. Most commercial information handling systems are provided by business software companies. It became evident during the interviews that two of the companies that participated in the Study use commercial information handling systems for managing the flow of information in their supply chains. In fact, the two companies use the same commercial provider for their systems. One of the companies started to use its commercial information handling system in 2016, while the other company has used its system for two years, i.e. since 2015.

However, the two companies had different reasons for beginning to use the commercial systems. One of the companies wanted to replace its former ERP system, which managed some aspects of its production planning. This company conducted a market investigation which concluded that the selected commercial information handling system would be the best option for its needs. The other company wanted to optimise its production planning and delivery scheduling capabilities. The company was recommended by a consulting firm to use the commercial system.
The provider of the commercial information handling systems is a global software company based in Europe. The company’s offers a wide range of services and software solutions, including solutions for production planning and supply chain planning. The software solutions are offered via modules on the provider’s IT platform, i.e. it is possible for the customers to add different modules to the platform depending on what they want to achieve. The platform can be accessed from either a computer or a smart phone. The maintenance of the platform is administrated by the provider.

Both of the companies that participated in the Study declined to comment on what kind of modules they use in their commercial information handling systems. One of the companies declined to comment since the company had not fully decided on what kind of modules it will use on its platform, while the other company declined due to confidentiality reasons. In addition, since none of the companies have fully launched their systems, it was not possible for any of them to comment on the characteristics of their systems and what the systems have achieved for the companies.

4.6 Characteristics and Achievements of Each Information Handling System

Table 3 lists the characteristics of each investigated information handling system and what the systems achieves for the companies that use them.

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<th>Characteristics</th>
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5 Discussion and Conclusions

The results of the Study are scrutinised and analysed in this chapter. The chapter is divided into four sections. The first section of the chapter evaluates the results presented in Chapter 5, in regard to the first research question of the Study, i.e. this section focuses on the question “How are companies handling the flow of information in their supply chain of raw materials?”. The second part of the chapter examines the results in regard to the second research question of the Report, i.e. “Which information handling system is suitable for implementation at Boliden?”. The conclusions are then presented in the third section of the chapter. The final section of the chapter focuses on some areas that needs to be further investigated in the future.

5.1 Discussion

The objective of the Study was to thoroughly examine what kind of systems companies present in the process industry use for handling the flow of information in a supply chain of raw materials. By examining this topic, the Study aimed to provide recommendations to Boliden on which information handling system is suitable for implementation at the company. As a result, two research questions were investigated in the Study.

5.1.1 Research Question 1

The first research question was What system is used for handling the flow of information in a supply chain of raw materials? The results of the Study indicate that there exists four different solutions for managing the flow of information in a supply chain of raw materials. The most common solution among buyers of raw materials is to use the so-called traditional systems, i.e. e-mail, telephone and physical meetings. The second most common solution is to use an external information handling system provided by a trade organisation. The third most common solution is to use a commercial system, i.e. a system provided by a commercial provider. Lastly, the least common solution is to develop an information handling system on its own, i.e. a proprietary information handling system.

Nine buyers of raw materials from three different commodity industries were investigated in the Study and all of the companies use the traditional systems for managing the flow of information in their supply chains. Hence, it is possible to conclude that it is common practise among buyers of raw materials in Sweden to use mix of e-mail, telephone and physical meetings when buying raw materials from suppliers.
However, a majority of the investigated companies use either two or three information handling systems simultaneously. In addition, the Study’s results indicate that there are several differences between the three investigated industries when it comes to selected systems. It is possible to make the following three observations from the Study’s results:

(i) Both buyers of base metals scrap use the traditional systems exclusively
(ii) All buyers of steel scrap use at least two systems, and two of them use even three systems
(iii) Both buyers of forest products use the traditional systems, but one of the buyers uses also a proprietary information handling system

As only two buyers of forest products were investigated in the Study, it is not possible to conclude what is common practise among buyers of forest products. This also applies to buyers of base metals scrap, even though the results indicate that it is common practise among these buyers to use the traditional information handling systems exclusively.

However, it is possible to draw conclusions for Swedish buyers of steel scrap. The reason for this is that the five investigated buyers account for c. 80% of all the steel scrap that is purchased annually in Sweden, i.e. these companies represent a vast majority of the Swedish steel scrap industry. Since all of these companies combine the traditional systems with an external information handling system, it is possible to conclude that this kind of setup is common practise among buyers of steel scrap in Sweden. This conclusion is of interest as it indicates that the setup of combining the traditional systems with an external system is the most optimal setup for handling the flow of information among buyers of steel scrap. The five investigated buyers of steel scrap have extensive experience of buying scrap and handling the associated information flow. Hence, if all of them use the same setup, this is an indication that the used setup has been proven to be the most optimal one.

An interesting observation from the Study is that two buyers of steel scrap have recently partnered with a commercial provider of information handling systems. However, both of the companies declined to provide details on their collaboration with the provider, since none of the companies have fully launched their commercial systems. Hence, the potential of using a commercial system for handling the flow of information in a supply chain of raw materials is an area that needs to be further investigated in the future.

**5.1.2 Research Question 2**

The second research question of the Study was *Which information handling system is suitable for implementation at Boliden?* After meeting representatives at Boliden on several occasions, it became evident that Boliden is looking for a solution that fulfil two criteria:
(i) Criteria 1: The system should streamline the company’s procurement process

(ii) Criteria 2: The system should reduce the company’s administrative burden

Hence, an appropriate information handling system for Boliden needs to achieve these two criteria. The results of the Study indicate that there are significant differences between the systems in regard to what they achieve for the companies that use them.

The results of the Study indicate that two of the information handling systems fulfil the two desired criteria, i.e. proprietary information handling system and external information handling system, as both of these systems have reduced the administrative burden for its users and also streamlined the buyers’ procurement processes.

As earlier mentioned when answering the first research question of the Study, a majority of the investigated buyers combine the traditional systems with an additional information handling system. By doing this, the companies are able to take advantage of the effects from two systems. If Boliden would combine the traditional information handling systems with a proprietary system, the company would attain the following positive effects:

(i) Strengthen relationships with suppliers (via the traditional systems)

(ii) Reduce the administrative burden (via the proprietary system)

(iii) Streamline the procurement (via the proprietary system)

However, at the same time, Boliden would attain the following negative effects

(i) Increase the administrative burden (via the traditional systems)

(ii) Increase the risk for human errors (via the traditional systems)

(iv) Reduce relationships with suppliers (via the proprietary system)

If the company would instead combine the traditional system with the external information handling system that was investigated in the Study, Boliden would attain the following positive effects:

(i) Strengthen relationships with suppliers (via the traditional systems)

(ii) Streamline the procurement (via the external system)

(iii) Reduce the administrative burden (via the external system)

(iv) Standardise the procurement (via the external system)

The negative effects of combining the two systems would however be:
(i) Increase the administrative burden (via the traditional systems)

(ii) Increase the risk for human errors (via the traditional systems)

This points in the direction that the combination of traditional and external information handling systems would achieve more positive effects for Boliden and it would be easy to suggest that Boliden should use this solution, but one also needs to consider if this solution is appropriate for Boliden.

The main issue with the external information handling system that was investigated in the Study is that the trade organisation that provides the system is specialised on the steel scrap market and the organisation is only partnering with companies present in the steel scrap industry. This is an issue since Boliden is engaged in the base metals industry and not the steel scrap industry. However, the trade organisation mentioned during one of the interviews that the organisation is open to the idea of licensing the external system, but the organisation has no interest of running the system as a commercial service, i.e. as a subscription service offered to non-partners. Hence, Boliden should reach out to the trade organisation and examine if it is possible to collaborate in any way.

Combining the traditional systems with a proprietary information handling system would be a good second option for Boliden if the trade organisation is not interested in a collaboration. However, the main issue with this solution is that the process of developing a proprietary information handling system is slow and demanding and it requires a lot of resources. Hence, this is something that Boliden need to consider when selecting a solution.

Another option would be to look into the possibility of using a commercial information handling system. However, the Study has not been able to examine this system in an extensive way, since both of the examined companies that use the system declined to comment on what kind of modules they use in their commercial information handling systems. Hence, the potential of using a commercial system needs to further investigated.

### 5.2 Conclusions

The results from the Study indicate that there exists four different solutions for handling the flow of information in a supply chain of raw materials:

(i) Traditional Information Handling Systems

(ii) Proprietary Information Handling Systems

(iii) External Information Handling Systems

(iv) Commercial Information Handling Systems
The Study’s result indicate that it is common practise among buyers of raw materials in Sweden to use mix of e-mail, telephone and physical meetings when buying raw materials from suppliers. However, a majority of the investigated companies use either two or three information handling systems simultaneously.

Boliden should combine the traditional information handling systems with either a proprietary system or an external system. The Study’s results indicate that the combination of traditional and external information handling systems would achieve more positive effects for Boliden. However, if Boliden is not able to use the trade organisation’s external information handling system, the Study’s recommendation is that the company should look into the option of developing a proprietary information handling system.

5.3 Future Research

It is worth noticing that the Study only investigated companies that mainly operate in Sweden. The reason for the delimitation was that the ambition of the Study was to investigate buyers of raw materials through both interviews and field trips. However, no field trips were conducted in the Study due to time constraints. As a result, only face-to-face and telephone interviews were conducted. If the time constraints had been known prior to the Study, more interviews would have been conducted with companies from other regions than Sweden, e.g. companies from Northern or Western Europe. The results might be different if someone would investigate a larger geographical area. Hence, if someone would investigate this research area in the future, the researcher should either allocate more time for field trips or investigate several geographical regions.

In addition, since two of the companies declined to provide details on their commercial information handling systems, the potential of using a commercial system for handling the flow of information in a supply chain of raw materials is an area that needs to be further investigated in the future.
6 Acknowledgements

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Xavier University Library, Qualitative versus Quantitative Research. *Qual*, Cincinnati: Xavier University Library.


## Appendix: List of Interviews

*Table A: List of Interviews*

<table>
<thead>
<tr>
<th>Industry</th>
<th>Interviewee</th>
<th>Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company 1 Base Metals Scrap</td>
<td>Manager Contract Administration, Raw Materials</td>
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</tr>
<tr>
<td>Company 1 Base Metals Scrap</td>
<td>Quality Engineer, Strategy and Planning</td>
<td>1</td>
</tr>
<tr>
<td>Company 2 Base Metals Scrap</td>
<td>Supply Chain Manager</td>
<td>1</td>
</tr>
<tr>
<td>Company 3 Steel Scrap</td>
<td>Raw Materials Manager</td>
<td>1</td>
</tr>
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<td>Company 3 Steel Scrap</td>
<td>General Manager, Supply Chain</td>
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</tr>
<tr>
<td>Company 4 Steel Scrap</td>
<td>Procurement manager</td>
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</tr>
<tr>
<td>Company 5 Steel Scrap</td>
<td>General Manager, Manufacturing</td>
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</tr>
<tr>
<td>Company 5 Steel Scrap</td>
<td>Category Manager, Raw Materials</td>
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<tr>
<td>Company 6 Steel Scrap</td>
<td>Vice President, Raw Materials</td>
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<td>Company 7 Steel Scrap</td>
<td>Raw Materials Manager</td>
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<tr>
<td>Company 8 Forest Products</td>
<td>Manager Process Technology, Development Department</td>
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</tr>
<tr>
<td>Company 9 Forest Products</td>
<td>Timber Buyer</td>
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</tr>
<tr>
<td>Organisation 1 Steel Scrap</td>
<td>CEO</td>
<td>2</td>
</tr>
<tr>
<td>Organisation 2 Forest Products</td>
<td>Business Development Manager</td>
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