

Satakunnan ammattikorkeakoulu Satakunta University of Applied Sciences

TOPI MAANAVILJA

Effects of Covid-19 to the supply chain of Boliden Harjavalta Oy

DEGREE PROGRAMME IN INTERNATIONAL BUSINESS 2020

ABSTRACT

Maanavilja, Topi: Effects of Covid-19 to the supply chain of Boliden Harjavalta Oy Bachelor's thesis International Business November 2023 Number of pages: 44

In this thesis I describe the effects of the pandemic caused by COVID-19 to supply chain of Boliden Harjavalta Oy.

The pandemic caused by the COVID-19 virus was something that has never happened in 21st century. The effects it caused to the global economy were almost catastrophic and changed the perspective of the global supply chains.

Different industries were affected differently, and this thesis covers the effects in the metal refining company. Base metals are key materials to every major product either in electronics or mechanical industry.

The research was conducted with qualitative method and in the form of a questionnaire. There were 15 questions to which participants were free to answer, the questionnaire was conducted anonymously. The answers were analysed, and the results listed accordingly.

The core result from the research was that Boliden Harjavalta Oy did not suffer from the COVID-19 pandemic in a large scale. The company's supply chains were affected of course, but no major impact was detected. All the problems that raised from the pandemic were solvable within the resources that the company was able to deploy.

The solution to clearing out of the pandemic was fast decision making and thorough usage of the available resources, this combined with a committed personnel and company's stable financial situation created a solid base to operate.

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1 INTRODUCTION

The covid-19 pandemic changed the perspective of the way the world's supply chains work. The pandemic caused a near total shutdown of international supply chain and forced the companies to rethink and reroute their supply chains to maintain business and production.

Metal refining industry was no exception to the effects of the COVID-19 pandemic. The industry is heavily dependent on their supply chains for materials, spare parts services etc. Supply chains are the veins of the global economy.

Supply chains consists of multiple different variations of transport methods and service providers. A metal refining company has a large-scale network of suppliers and service providers. The COVID-19 pandemic caused problems that needed instant clarifications and tested the company's resilience to deal with these.

The main purpose of this thesis is to clarify what kind of problems if any did the pandemic cause to the supply chain of Boliden Harjavalta Oy. In this process there are questions that need answers and with these the goal is to provide a wider perspective to what happened and how the decision-making process handled the fast-pacing events.

It is also important to reflect the financial situation of the company during the pandemic and how it reacted to the supply chain problems. Well balanced financial status creates more options for a company to manoeuvre with sudden cost increases and other financial difficulties that the pandemic created.

2 BOLIDEN HARJAVALTA OY

Boliden Harjavalta Oy is a smelting and metal refining company based in Harjavalta and Pori. The company is part of the New Boliden group, which is a Swedish company that operates in smelting and mining. New Boliden has operations in Sweden, Finland, Norway and Ireland and the group employs over 6000 people.

Boliden Harjavalta produces copper, nickel, gold, silver, sulphuric acid as main products. The company's turnover is 420 MEUR in the year 2022. Boliden Harjavalta employs 570 people. Boliden Harjavalta Oy is based in two locations, the main part of the company is in Harjavalta where the smeltery and the acid plants are, copper refinery is in Pori. The company also has premises in Mäntyluoto harbor.

"Boliden Harjavalta Oy focuses on sustainable metal production and the company's vision is to be the forerunner in the metal industry in terms of development, productivity, and responsibility" (Boliden, 2023).



Picture 1. Arial picture of the Harjavalta heavy industry park. (Boliden Harjavalta Oy, picture archive. 2023).

2.1 History

Long traditions of Boliden Harjavalta Oy

- 1936 Outokumpu copper smeltery started in Imatra.
- 1941 Copper cell house started in Pori.
- 1945 First copper cast in Harjavalta.
- 1949 Beginning of copper concentrate flash smelting.
- 1959 Beginning of nickel concentrate flash smelting.
- 1960 Nickel cathode production started.
- 1987 Purchase of sulphuric acid plants.
- 1990 Incorporation of Outokumpu.
- 1995 Expansion of production (copper +60 %, nickel +200%).
- 1999 Outsourcing of support functions.
- 2000 Sale of nickel business.
- 2004 Unification of the Boliden Group.
- 2007 Expansion of copper production.
- (Boliden archive material. 2023.).

The copper smeltery was started in 1936 in Imatra by Outokumpu. During the second world war the smeltery was forced to move to Harjavalta in 1944, because of the order of the military officials. Harjavalta was selected because there was a hydro power plant and railway in the city. The plant was built and operational in 1945.

Flash smelting process of copper concentrates is a major technological innovation developed in Harjavalta. The process first operated in 1949. similar process model for the nickel concentrates was developed in 1959. Boliden Harjavalta has been a major developer of flash smelting process and has steadily developed its processes and production over the course of the company's history.

In the year 2004 Outokumpu sold the copper and zinc business to Boliden and thus the New Boliden group was formed.

Years after the change in ownership have been focused on investments and the enhancement of the processes.



Picture 2. Workers and builders of the copper smeltery in 1945. (Boliden Harjavalta Oy, picture archives, 2023).

2.2 Sourcing and supply organization

Sourcing and supply organization in Boliden Harjavalta employs 10 people. Addition to this there are 4 others involved in sourcing in other departments. Company invests in sourcing approx. 160 MEUR on a yearly basis. Most of the products and services are bought locally.

The main objective for the sourcing and supply organization is to maintain the groups goals for procurement with rightly timed and cost-efficient deliveries, thus making their part on continuous production.

The organization is divided into two different sections, sourcing, and supply. All the acquisitions that involve material or services to production or projects has a person from those organizations working as a counterpart for support. The value of the selected purchase defines the level where the decision is made. Ground rule is that the more the item or service will cost the higher in the organization the decision is made.



Picture 3. Boliden Harjavalta Oy, organization chart (Boliden, 2023).

2.2.1 Sourcing

Sourcing involves in supplier mapping, supplier evaluation, putting out tenders for suppliers, just to mention few points. Sourcing operates with group level functions and is responsible for the sourcing strategy.

2.2.2 Supply.

Supply section is responsible for the local part of the purchasing process. Its role involves material acquisitions, billing, reclamation handling, warehousing, inventory management, co-operation with local suppliers and production.

3 COVID-19

Covid-19 is a disease caused by SARS-CoV-2 virus. The disease first started to spread in the end of the year 2019. With a fast pace the disease covered almost the whole globe. since the disease was fast spreading the countermeasures were locking down the airports, train stations and harbours. This was done to prevent the infected people from spreading the disease further. Stopping the transportation of people and goods worldwide disrupted the global supply chains, this forced companies to either adjusted their supply chain networks by remodelling them.

The COVID-19 pandemic was not the first disaster to cause damage to GSCs. Three other natural catastrophes, the 2011 earthquake in Japan, the 2003 SARS outbreak in China, and the 2004 tsunami in Indonesia, have caused shortages of parts and products. It is notable that the

production has recovered from these disasters in a relatively short time. However, as shown in Picture 4, based on the scope and magnitude, the impacts of COVID-19 vary from those of previous events.(Xu & Kerbache, n.d.)



Picture 4. Ali and O. M. Alharbi, "COVID-19: Disease management treatment and social impact", Science of the Total Environment, vol. 728, (2020).

The global nature of the crisis states that companies engaged in international trade were exposed to international disruptions to deal with the domestic ones,

with drop in foreign demand for exporting firms, and a reduction in supply translating effected the importing firms through the intermediates.(*Understanding the Impact of COVID-19 Supply Disruptions on Exporters in Global Value Chains*, n.d.)

3.1 The effects on the global supply chain

Supply chains are dependent on the continuous movement of goods and when this is limited it creates problems. Pandemic diseases cause huge problems not only because manufacturing plants are shut down of certain supply routes are closed. The main problem arises when people operating in the supply chain are not able to work due to illness or restrictions from preventing the illness. When nobody is working the rerouting the material flows becomes difficult.

"The pandemic disrupted many supply chains when the outbreak occurred, and the subsequent economic recovery, being the strongest on record, caused significant continuous strain on the global supply system" (Szczepański, n.d.).

The flows of the pandemic caused more damage to the companies in the end of the supply chain. The changes the pandemic caused tended to multiply during the supply chain, thus the destination received the hardest blows.



Picture 5. (How COVID-19 Impacted Supply Chains and What Comes next | EY Finland, n.d.)

"The COVID-19 pandemic was a global disruption across several fields both economy and societal, including trade, finance, health and education systems, having only few comprising occurrences in the past 100 years)" (*How COVID-19 Impacted Supply Chains and What Comes next* | *EY Finland*, n.d.)

Basically, the only companies coming out of the pandemic with profits were the pharmaceutical companies. The main reason for this was the development of the COVID-19 vaccine. Companies that had their supply chains integrated more digitally took more damage from the pandemic than companies that had less digital supply chains. Companies seldom have full visibility of their value chains, and this makes them vulnerable to radical changes like the pandemic.

3.2 Resilience in the global supply chain

"Supply chain professionals have measured success for years on how well they have been able to downsize costs and maximize efficiency. Just-in-time (JIT) became an optimization point and those who exceeded in the practice achieved an excellent level of precision. Exact arrival of goods met the acute need, waste and holding costs were optimized, and strategies focused on single source prevailed due to ease and reduction of costs". (*What Is Supply Chain Resiliency? - IBM Blog*, n.d.)

The pandemic caused the companies to focus on their supply chains and how resilient they are. Investments for this were on a low level before the pandemic and but are now rising. To achieve better resilience for the supply chain the answer can be found in visibility of the supply chain and the digitalization. Both supports each other and create value to the supply chain.

Supply chain resilience comes from the status of well the supply chain can resist unanticipated challenges to its stages. main key to discovering the resilience level of the supply chain is to conduct a risk assessment.

Risk assessment is based on research how vulnerable the supply chain is. Risk assessment calculates the risk possibilities based on how often the risk might happen and how severe effects it causes to the supply chain.

The following list below represents the possible risks that have the capability to cause severe harm to global supply chain.

- Natural disasters: Tsunamis, earthquakes, hurricanes, floods, etc., can cause significant problems to production within the economy, in homeland or abroad.
- Accidents: Fires, explosions, and contamination are the type of accidents that are specifically related to a location of production.
- Intentional disruptions: Sabotage, or actions undertaken by activists and terrorist attacks are examples of intentional disruptions of supply chains.
- International crises with contagion effects: COVID-19 is the extreme case of a crisis that spreads from one country and rapidly turns into a pandemic. (*Identify Potential Risks - The OECD's 4 Keys to #resilient Supply Chains Present Analysis and Evidence in Response to Unprecedented Disruptions to International Trade, in Pursuit of #sustainable and #inclusive Recovery.*, n.d.)

Natural disasters are difficult to prevent and the preparatory action for these kinds of incidents is expensive, moreover the actions can be futile in any case. Best way to prepare for natural disaster is development of infrastructure so that it minimizes the possible threat, moreover co-operation between the officials provides good foundation to coping unexpected situations.

Accidents are more easily prevented than disasters. Prevention of accidents starts in safety procedures and protective legislation; work safety is key

function in modern working life. Even with cost effects on the company's safety is vital to a modern company to operate in the global economy.

Intentional disruptions are mostly problems occurring in the developing countries. But the global economy connects every country involved in it and even minor disruptions can cause major effects. Intentional disruptions listed previously are usually related to societal problems or otherwise politically involved in that distinct country. Prevention of this kind of disruptions are not in the influential reach of companies. Best action is to minimize the business activity in volatile countries and thus avoid the possible damage to the supply chain.

International crisis such as the COVID-19 pandemic are hard to predict and the preparation for these kinds of occurrences was not in the needed level. The pandemic has forces companies to take preparatory actions, and this has helped forcing the resilience of the global supply chain.



Picture 6. (The Risk Assessment Matrix: What Is It and Why Is It Important? | AuditBoard, n.d.)

The risk assessment matrix above is a basic example of how the assessment is done. Every part of the supply chain is evaluated and placed into the matrix. The number received gives the likelihood and effect of the risk. It is not possible to anticipate every risk in the supply chain but with thorough evaluation the chances of major impacts can be lowered to an acceptable level.

3.3 Effects of COVID-19 to shipping costs

The pandemic caused dramatic increase in shipping costs. This was because shipping supply chains are complex entireties and the pandemic hit very hard on these. The freight costs of a shipping containers started to rise in July of 2020, in a moderate pace at first from approx. 2000\$/per container to over 4000\$ in a few months. The pricing peaked in the summer of 2021 when the price was 10400\$ for a single container. After the summer of 2021, the prices started to drop and returned to starting level at end of the year 2022.



Picture 7. (Global Container Shipping Rates 2023 | Statista, n.d.)

The global supply chain is a delicate system consisting of multiple links. Disruption to one the links can create a rolling effect that can cause financial damage to all the following participants down the supply chain. Creating protectional measures is vital procedure in maintaining the vitality of the supply chain.

Majority of the global supply chain is transported by shipping companies. A single container ship can carry a considerable amount of cargo in comparison of any other method of transportation. "Shipping makes the intercontinental trade and the bulk transport of materials possible.(*Shipping during COVID-19: Why Container Freight Rates Have Surged* | *UNCTAD*, n.d.)

3.4 Lead time development during the pandemic

Lead time is the best measurement of the supply chain. When there are drastic changes in the supply chain this will affect directly to the lead time. Lead time can be divided into three parts.

- Upstream lead time. This refers to the movement of the products from the factory to the warehouse.
- Downstream lead time. This refers to the action needed to transport the final product to the customer.
- Total lead time. The sum of upstream and downstream lead times.

Lead time in supply chain is the time that elapses between a customer order and the receipt. It can be between two companies (B2B) or between a company and an end consumer (B2C). Lead time is present in every supply chain stages, from the moment supplier starts extracting the raw materials to the delivery to the customer in the end of the supply chain. (Supply Chain Lead Time: What Is It and How To Track It, n.d.)

Lead time is the roof term, and the meaning differs between the industries. This means that the lead time calculations are made with different formulas in different industries. The general formula is: Lead Time = Pre-Processing Time + Processing Time + Post-Processing Time.

(Investopedia, 2023).

This can be altered to suit the process at hand. Shorter lead time usually means more profit for the parties involved. This is attained by reducing labour costs, faster order handling, efficient capital deployment and happier customers.

4 RESEARCH METHOD

The selected research method in this thesis is the qualitative method. The research in the thesis is conducted with a questionnaire. The questionnaire consists of 15 questions which covers the specific aspects of the supply chain and the effects covid-19 possibly brought to it. Questionnaire can be found in appendix 1.

4.1 Qualitative method

"To understand opinions, concepts or experiences, qualitative research collects and analyses non-numerical data (e.g., text, video, or audio). It can be used to gather in-depth insights and translate them into a problem to be solved or to form new ideas for conducting research" (What Is Qualitative Research? | Methods & Examples, n.d.).

On example of qualitative research is one-to-one interviews. In this method the research is conducted by interviewing the participants in person one at a time. This method gives the researcher a perfect opportunity to ask specific questions and guide the interview in the wanted direction.

Negative side of this methos is that people are usually biased and tend to bring their personal opinions out rather than just maintaining an analytical mindset. A seasoned interviewer can sort this kind of problem but to keep the original idea intact might be difficult.



Picture 8. (Qualitative Research: Definition, Types, Methods, and Examples, n.d.)

4.1.1 Primary information

The primary information in the research conducted in this thesis is the questionnaire send to the recipients. The primary information is gathered to gain the understanding of the situation which the topic of thesis is based on.

4.1.2 Secondary information

The secondary information is this research is all the other information that is gathered from the already written information. The target company's history information, company's organizational structure and internal rules, facts and basic information on Covid-19, the basic information about supply chains in the global commerce, resilience of the supply chains and financial figures.

4.2 Appliance of method

In this research the chosen method for collecting data is a questionnaire or an interview with a form. This method of research was chosen because the problem this thesis is trying to unravel is based on personal experience of the people involved in sourcing and supply. With a questionnaire it is easier to ask questions from a large group of people. Questions in the questionnaire certainly steer peoples answers in the preferred direction but this is unavoidable to a certain level. A simple yes and no answer does not give enough information on the subject at hand.

Questions were selected with the supervisor of thesis from my employer and the selection was made in the focus of getting the best results. The risk in this kind of method is that the recipients ignore the questionnaire, or they don't answer truthfully.

The possibility to conduct interviews should be taken into consideration. With an interview there is more possibilities to go in-depth with the interviewee. With a direct conversation the outcome is usually different than just answering to a questionnaire.

4.2.1 Conceptual framework

A conceptual framework usually includes one or more formal theories as well as other concepts and empirical findings taken from the literature. Conceptual framework is used to present relationships among these ideas and how they relate to the study involved in the research. Most common place to find qualitative research is the social and behavioural sciences, for example, because often the phenomena being studied requires more than one theory to fully address it. (*Introduction - Theories and Frameworks - Academic Guides at Walden University*, n.d.)



Chart 1. Conceptual framework.

4.2.2 Research process

The process of the research conducted in this thesis is divided into following steps.

- 1. Planning of the questions
- 2. Planning of the recipients
- 3. Sending the questionnaire
- 4. Collecting the answers
- 5. Processing the data
- 6. Writing the outcome
- 4.3 Questionnaire outcome



Chart 2.

The questionnaire was sent to 20 different persons in the Boliden Harjavalta organization. 10 out of 20 answered to the questionnaire, the answering percentage is 50%. On a general level the percentage of respondents is adequate.

The answering percentage is not as high as I had hoped it would be. Although the persons who answered were from different departments so there is enough perspective for the data analysis.

The questionnaire is done by animosity, so there is no statistic on gender, age, or position in the organization. The departments which the respondents work is listed in the chart below.



Chart 3.

Results from the chart gives out the information that sourcing returned less answers than the rest, even if it employs most of the people involved in the supply chain. There were few collective answers, but majority answered individually.

4.3.1 Validity and reliability

The quality of research can be evaluated by using the reliability and validity concepts. They indicate how well a method, technique. or test chosen in the research measures something. Reliability focuses on the consistency of a measure, and validity focuses on the accuracy of a measure. (Reliability vs. Validity in Research | Difference, Types and Examples, n.d.).

The basis of any research is that the results are valid and reliable. validity in qualitative research is a bit more complex that in quantitative research. Quantitative research has certain rules on validation which determines the way the results are interpreted. In qualitative research there are no specific rules on

how to interpret the results because answers are usually based on opinions of the answerers.

Validity in this thesis is formed by the concept of open questions included in the questionnaire. Each participant received personal copy of the questionnaire and was able to answer it without outside interference. The answers that were given reflected the questions and created an entirety that can be defined as valid research.

Reliability in this thesis is proven by the possibility to reproduce the research and return with the similar results. In this thesis the research is made with interview in form of a questionnaire. Since the answers given in this questionnaire are opinions of the people who answered, this creates a kind of paradox for reproducing the research. The people who answered to the questionnaire are working in the field of sourcing and this gives the reassurance that future research would give similar kind of answers.

5 SUPPLY CHAIN STATUS BEFORE COVID-19

5.1 Operational status

In Boliden Harjavalta the sourcing and supply of materials and services was organized by dividing the task between the strategic part and local part. On a group level there are synergies between the smelters. Business area that is the administrative entity for the smelters has organized the sourcing in a fashion that each unit has its own local team and there is a management team in the business area. The supply has a similar type of organizational structure as the sourcing.

5.2 Risk in sourcing and supply

There are several risks in sourcing and supply. Delivery risks, quality risks, safety risks and CSR-risks.

5.2.1 Delivery risks

Delivery risks are based on the possibility of the supplier not being able to deliver the ordered products with the agreed schedule. The COVID-19 pandemic hit hard on the delivery times. Delivery times are organized in a fashion that the ordered goods are at the site in predestined time. Controlling the delivery risks is the key operational task of the supply chain organization.

5.2.2 Quality risk

Quality risks consist of possible deviations in the ordered products or services. And how the organization can handle these changes. Quality of the product and the possible defects or changes can be anticipated by including the requirements needed in the ordering process. Quality clearance of the product should be conducted when the product is delivered. Auditing the supplier's production facilities is one of the components to ensure quality control.

5.2.3 Safety risks

Safety risks are more likely to occur when purchasing services. Is the service provider able to fulfil the safety standards set by Boliden? When the service is purchased, the contract should include the required safety protocols and guidelines. This requires monitoring of the service provider and aiding when needed.

Safety in transportation of the supply chain consists of choosing the correct method of transport and timing the actual operation in the best possible moment.

5.2.4 CSR risks

Corporate social responsibility risks involve ethical principles, international sanctions, laws on order responsibility.

In the 21st century it is critical for any company to have a CSR doctrine. Companies are very vulnerable for criticism based on the possible violation of ethical principles. These risks can have major impact on business if not taken care of properly.

CSR issues are governed by the policies that the Boliden group defines. Each unit complies with these policies and adjust their action in accordance. Importance in dealing with CSR issues is to recognise the local features each country has and adapt the policy for that.



Picture 9. Internal training material, (Boliden Harjavalta Oy, 2023)

New Boliden group has policies to ensure that the procurement of goods and services is operated in accordance with laws and regulations. Boliden also has its own code of conduct that determines the guidelines in which the group operates with its customers and suppliers.

The Boliden business area Smelters uses the OECD CAHRA (Conflict-affected and high-risk area) measurement for the list of countries where to purchase materials. War zones and armed conflict areas are blocked from the list and no procurement is done from those. The list of countries serves as an input for the ESG evaluation process for the business partners. (New Boliden, Smelters BA, 2023).

6 EFFECTS OF COVID-19

In this chapter I will go through the effects that the COVID-19 pandemic caused to the supply chain. The research is based on the questionnaire and the answers given there. The effects are categorised by the questions from the questionnaire.

6.1 Effects on key supplies and lead times

COVID-19 effected to the availability of numerous key supplies. Electronical components were one of the most difficult items to attain during the pandemic. This was caused mostly by the fact that the manufacturers had to close factories due to the COVID-19 infections. Also, special purpose valves and pumps were in the list of items difficult to get. similar problems occurred in property maintenance and information management.

Every department reported the same type of difficulties, this because all the parts and services go through the sourcing and supply organization.

Lead times increased and even in some cases the supplier could not give an exact date for the delivery. Shortage of component and material created effects through the whole supply chain.

6.2 Supplier changes

Based on the answers from the questions there were no major changes in the portfolio of the suppliers. Although the suppliers were of course affected by the pandemic, the co-operation with Boliden Harjavalta continued.

New suppliers were introduced especially with the providers of face masks and other protective gears. Also, new suppliers were used to cover the existing ones in the cases were the wanted product or service was unattainable.

6.3 Warehouse material levels

Warehouse materials were well prepared for the pandemic, this could be concluded from the answers. Personnel from the sourcing and supply organization could react in adequate speed to the emerging problems in the beginning of the pandemic. Certain key articles were ordered more, and the levels were kept in the state the sufficed to keep the production running. There was a possibility to acquire materials from the other units in the Boliden group if there was a shortage in the inventory.

6.4 Supplier reactions

Immediate actions taken by the suppliers was that they increased the delivery times or had to inform that the delivery time is not available. In most cases the

co-operation with the suppliers remained solid and both parties understood the situation and tried to cope with it.

From the answers you can conclude that some of the suppliers tried to gain advantage from the pandemic with "force majeure" clauses.

6.5 Transport methods

If the there was a problem in the transportation of the ordered goods. the use of a different transport method was possible. This option was already in the transport contract and therefore available.

In some cases, the change was made but it did not bring any specific advantage to the shipping.

The lack of container also caused problems for transporting, but in a major scale.

The pandemic affected everyone in the transport sector equally and this made narrowed the possibility of transport method change.

6.6 Incoterms

Incoterms are part of the transport contract, and the definition comes from the International Chamber of Commerce. These were not affected by the pandemic in a large scale. Some changes were made in the cases of special deliveries and in one-time projects. The change was typically from DAP to FCA.

6.7 Purchasing KPI

In every answer the answerer stated that the Key Performance Indicators (KPI) were not changed, and this was due to the issue that it was not needed. This gives the notion that the KPIs were in the beginning formed in the fashion that supports the resilience of the supply chain.

6.8 Reaction speed

From the answers it is possible to conclude that the reaction speed of each department was adequate. All the necessary decisions were made on time and everybody who was involved, contributed to keeping the operations going. The best review of the reaction speed is that there were no shutdowns in the production during the pandemic that was related to procurement.

6.9 Data availability

Data availability for decision making was overall good during the pandemic. It must be taken into consideration that there were of course differences in some cases. Based on the answers both data and the policies for the decision making were on sufficient level. The implementation of decisions was good.

6.10 Purchasing of new products

The new products that were purchases during the pandemic were mostly facemasks and disinfectants. These products were purchases because of the pandemic and the availability of those changed during the pandemic. Dealing with this required extra effort from the sourcing organization. In the purchasing process there was no major changes during the pandemic. Acquisition of services was much more difficult because of the COVID-19 restrictions. This was a problem with the maintenance services, monitoring the work was reduces to a minimum and the restrictions made contacting the service providers difficult.

6.11 Material and service quality

Quality of service was influenced more than the quality of materials. With services the main problem was the restrictions caused by the pandemic. Restrictions made close contact with the service provider difficult and caused more workload on handling the monitoring and understanding between the buyer and the provider that the safety regulations were clear.

6.12 Life cycle expenses

COVID-19 pandemic did not have an extensive effect on the life cycle expenses of the machinery. The pandemic was such a short period of time that there were no long-term effects that could be noted.

Most problems occurred in electrical maintenance and in property maintenance. Basic problem was the limitations set by the safety protocols regarding the pandemic. Distant work was not suitable for controlling the maintenance work and some projects were cancelled because the contractors could operate with safe manners.

Increase in prices had its effect also during the pandemic. Availability of the items required in all levels of maintenance was affected by the pandemic thus the increase of price for work.

6.13 Evaluation of COVID-19

Based on the answers there has not been any large-scale evaluation of the effects of the pandemic. The organizations have made some local level changes in the sourcing processes, but thorough evaluation remains undone.

7 SUMMARY OF GATHERED RESEARCH

This chapter consists of the summary of the received data from the answers from the questionnaire. Analysing the data gives the most encompassing answer and creates a foundation to further conclusions.

7.1 Research summary

The main summary of the gathered data is that the COVID-19 pandemic did not cause any major concerns to the supply chain of Boliden Harjavalta Oy. The company could operate almost in a normal production level through the pandemic. This would not have been possible if the supply chains would have suffered significantly during the pandemic. Increase in the workload of the people who were responsible for the supply chains was of course heavy.

The supply chains of the company were designed in the fashion that problems with a single supplier did not compromise the whole supply chain. This can be determined as basic construction of the supply chain but still it proves its worth in situations where the resilience of the supply chain is compromised.

Organization was quick to adapt with the changes required by the situation. Lack of data to back up the decisions was according to the answers limited at least in some areas the whole time of the pandemic.

7.2 Financial situation

Financial situation of Boliden Harjavalta Oy was good during the main pandemic years 2020 to 2022. Good financial situation as stated previously made possible to maintain the production levels and overcome the problems in the supply chain caused by the pandemic. Financial situation is best view by the financial ratios of the company and how they develop during a certain period.

The company managed to increase financial profit during the pandemic. Addison to this the Boliden group was also well balanced financially. Financial stability in an enormous advantage to a company in the case of global problems.



Picture 10. Boliden share price development 2020 – 2023. (Boliden, 2023).

Share price of the New Boliden group did change during the pandemic, but the changes presented in the picture does not indicate any major effects that could be targeted as cause by the pandemic.

Because Boliden Harjavalta Oy is part of the New Boliden group the share price of the group is an important indicator for measurement of financial situation during the pandemic.

7.3 Metal prices

Main articles of Boliden Harjavalta Oy are copper and nickel. These metals are exchanged in the London Metal Exchange (LME). The price of these metals affects the financial situation of the company and is one of the key elements in the process of clearing the effects of the pandemic. With good financial situation the company has far better chances to cope with the problems the pandemic caused.



7.3.1 Copper price

Picture 11. (Copper - 2023 Data - 1988-2022 Historical - 2024 Forecast - Price - Quote - Chart, n.d.).

In the picture above is the development of the price of copper during the last five years. The price is stated in tons / \$. It can be stated from the schematic that the price of copper rose in the beginning of the pandemic and dropped down when the pandemic was beginning to fade. The important information in this schematic is the development of the price. Because the price of copper was on a decent level the producers of the metal had a good opportunity to make profit.



7.3.2 Nickel price

Picture 12. (Nickel - 2023 Data - 1993-2022 Historical - 2024 Forecast - Price - Quote - Chart, n.d.).

The above picture shows the development of the nickel price during the last 5 years. The price is stated in tons / \$. The interpretation of the nickel price is that there were no major fluctuations during the pandemic. One peak in the development of the price in the beginning of 2022, but that cannot be stated to be related to the pandemic.

7.4 Delivery times

Development of delivery times from the situation before the pandemic and during it, can give some insight into the effects of the pandemic.



Chart 3. Delivery time development, (Boliden Harjavalta Oy, 2023).

The chart above shows the development of the delivery times in purchasing of Boliden Harjavalta Oy from the year 2016 to the year 2022 up to 1.5.2022. The year 2020 is missing from the chart because there was not enough data from the ERP system to collect.

From the collected data it can be determined that the delivery times of purchased items nearly doubled during the pandemic. This data verifies the conclusions retrieved from the questionnaire.

The main problem was that the suppliers were forced to delay their deliveries, and this created the increase in the delivery times. This, as stated before caused the main reason to the complications that occurred during the pandemic in the supply chain.

8 RECOMMENDATIONS

Recommendations are based on the outcomes of the answers received from the questionnaire and the interpretation of them. The recommendations are divided into three different parts based on the organizational structure.

8.1 Sourcing and supply

Recommendations for the sourcing are based on the thought that the main goal of sourcing is to deliver and maintain the supplies and services that the production needs to keep processes going.

The information for the answers gave a clear picture of the situation in the supply chain. The supply chain is divided into multiple streams and therefore has a good resilience already. This can be enhanced furthermore to a level where it is not easily disturbed. Enhancing the resilience should be done in a meticulous fashion and thus making it more resistance to interventions.

Supply chain routes should be organized so that they are not dependent on a single operator or method of transportation. Since there are multitude of operators in the field and the main problem is not process of transportation. I would approach this more on the side of business agreement. The agreements that are made with the operator should include clauses that take into consideration the possibilities of a larger scale disruptions. Delivery time is the first to suffer in the case of disruption and that can be handled to a certain extent.

One way of dealing with the problems in the supply chain is to minimize the lead time. In a long supply chain this is not easily done due to the many different operator it might require. Possible usage of local distributors can offer a solution to this problem. Cost issues rises when talking about local distributors, close is not always cheap. This is a matter of lost production and sales versus the possible cost rise in the procurement.

8.2 Maintenance and projects

Recommendations for the maintenance and project I would limit to the increase in information sharing between the outside of the departments. With information shared on thorough level and on time there should be no major effects on the supply chain or the delivery times.

For the maintenance there is already a list of key components and other spare parts that are vital to the production. Also, the major maintenance shutdowns are planned months ahead, so again no major surprises should occur. The supply chains are planned in accordance with these, and the delivery times are taken account. Only possible problems can occur in the disruptions of the supply chain and there should be protocols ready for this. With directions and information sharing the possible risks should be dealt with minimum complications.

Similar type of recommendations for the project department. Projects are involved in every investment that the company makes. Participation from the early stages of investment makes is possible to keep track on what is needed and when. The information sharing with sourcing can enhance the acquisition process on new equipment and services.

8.3 Others

In this thesis the remaining departments are IT-management and management. For the IT-management the recommendation is to keep the IT-machinery updated frequently, thus the problems with acquisition new machines and components does not cause immediate threat. The sharing of information and situational awareness will help in the case of occurring problems.

The role of the management is to keep the strings attached to themselves. Management should be always aware of the overall situation. When the "big picture" is clear the decision making can be based on it. This is not the case always and the amount of data is usually limited for the decision making. Since the financial situation plays an important role for the company's survival in the global economy, the management is the key in steering the ship through the rough seas. This requires clear decision making and flexibility to maintain a modern company.

9 CONCLUSION

COVID-19 was first modern era pandemic that shocked the global supply chains thoroughly. The pandemic showed the vulnerability of the supply chain especially in the situation that personnel is not able to work due to sickness in a large scale. Similar effects were with travel limitations and in the cases when companies were forced to limit access to working places. Coping with this but the tolerance of the work force to a test and made it necessary to change current methods of work or invent new ones.

The worst side of a crisis is that you cannot predicts when it is going to end. The dubiety can cause organizations to become depressed, and this will lead to economic difficulties. The research conducted in this thesis gave the notion that these obstacles were noticed in all the departments in Boliden Harjavalta Oy that were involved in procurement. The fact that the company managed to exit the pandemic with minor difficulties was accomplishment of the skilled personnel, rightly timed decisions, and the will to persevere. The pandemic and its effects are a perfect opportunity to learn from the events and reflect on the knowledge gained from the decisions made.

All the above was the building blocks for the recipe to steer the company through the pandemic. This was backed with the good financial performance of the company that gave leverage to make decisions to enable production and to keep the products delivered to the customers. a company is an entity, and it requires every part in it. These parts should be connected to in all levels of integrations and thus working to enhance performance. Information sharing and general knowledge of the overall situation makes a structure point for upholding the company in the next possible pandemic.

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APPENDIX 1:

Effects of covid-19 on the supply chain of Boliden Harjavalta

The function of this questionnaire is to clarify the effects of the covid pandemic to the supply chain. Please answer the questions as thoroughly as possible. All the information is this questionnaire will be handled according to the GDPR.

1. What were the key supplies that were affected the most by the pandemic? Was there a radical change in the lead time of those supplies?

2. Did any change happen with the suppliers due to the pandemic?

3. Were the warehouse material levels prepared to the pandemic?

4. How did the suppliers react to the pandemic?

5. Was it possible to change supplier or the transport method?

6. Was there a change in the commonly used incoterms during the pandemic?

7. Did the KPI of the purchasing process change during the pandemic?

8. In your opinion was the reaction speed of the organization if changes were made?

9. Was there enough data and time to make decisions if problems occurred?

10. What kind of new products were purchased during the pandemic and how the purchasing process was executed?

11. Was there a lot of difference between the purchasing of products and services?

12. How was the quality of the material and services maintained during the pandemic?

13. What effects if any did the pandemic have on the life cycle expenses of the machinery?

14. Has there been any evaluation on the effects of covid?

15. Free word.