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Supply Chain Risk Management in the Decade of 2020

Jeremias Fernandes

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ABSTRACT

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
International Business

Jeremias Fernandes:
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The purpose of the thesis is to provide understanding and in-depth knowledge into supply chain management and risk management. In recent years, supply chain risk management has faced new challenges. These new challenges have exposed vulnerabilities in supply chains which business risk management must consider. Thesis explains what supply chain and risk management is and focuses on three risk categories: difficulties with raw materials, globalisation and geopolitical distress and natural catastrophes. The time scope of the thesis is the on-going decade.

The work is conducted as an empirical descriptive analysis using qualitative research methods. The content of the thesis analyses trends and incidents of the decade of 2020 and builds conceptual scenarios explaining the possible processes of risk management. Risk scenarios are explained and visualised by creating case studies and examples of recent events in the framework of existing supply chain management tools and strategies.

The findings indicate that risks may have severe consequences to businesses considering the significance of supply chains. To help prevent supply chain disruptions, continuous risk management is a necessity. Difficulty remains as the improvements of today may not answer to difficulties and risks of the future. Further research on supply chain risk management is required due to the complex and continuously evolving subject.

Key words: supply chain management, risk management

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1 INTRODUCTION

Supply chain and risk management is an area of business operations which has developed tremendously within hundreds of years. Today the difficulties in said operations rise through the complexity of the globalised world. Due to the complexity, it is challenging to differentiate threats and opportunities from each other as each possibility may be inverted by continuous evolution. Concise and well evaluated risk management is one of the key elements to operate successfully in today's business environments.

Recent years have shown that the current state of many supply chains is extremely vulnerable. The visualisation and understanding of major vulnerabilities were catapulted by the effect of the pandemic, leading to the universal understanding of the importance of supply chain and risk management. Not only to cut costs and increase operating profits, but to truly incorporate a versatile, resilient and adapting supply chain is necessary to ensure business operations even throughout difficult and uncertain times.

During the decade of 2020, there has been an ever-increasing number of probable challenges regarding supply chains. Within these issues are three topics which stand out to me the most: material shortages, geopolitical distress and natural catastrophes. I find these three challenges the most essential matters within supply chain risks and will go further into depth regarding each above-mentioned topic with a chapter of their own. Before diving into these main risk topics, the research includes an overview chapter of supply chain and risk management introducing its history and development to modern tools and methods. Such an introductory chapter will help the reader to understand the basics of supply chain and risk management.

To complement the introduction of methods and tools the thesis further describes and analyses supply chain risk management. For the purpose of concretisation, certain instances within the thesis include an imaginary business JayJay Corporated. Case studies and examples of recent events in the thesis

are visualised within the framework of existing supply chain management tools and strategies.

Conclusion of the thesis is dedicated for discussion. The chapter addresses topics such as what is known today, how to mitigate known risks of today, and speculation on the possibilities of the future of supply chain risk management. The discussion ties the previously mentioned main topics into larger conversation, where the subject leans into internal and external influences.

2 SUPPLY CHAIN AND RISK MANAGEMENT

2.1 History of supply chain management

Supply chain management is a concept and practise of operating a business's goods flow from point A to point B. Usually, this is referred to as how a product or a service, can be provided to the customer from raw materials to an end product and furthermore, to the end-of-life cycle of a certain good. Throughout the time of humans and evolution, supply chain is something which has affected our lives. In general, before the 1900's and the introduction of railroads, supply chains mainly consisted of local and restricted routes in land, accompanied with very slow and seldom trade ships by sea (Ashcroft, 2021). Within 100 years of technological and industrial revolution and development, supply chains, risks and their management have taken drastic changes to withstand the test of time.

One of the most important examples of such adaptation is the post-world war Japanese economy. The war left Japan in need of complete rebuilding with very limited resources and tools, forcing Japanese businesses to adapt and overcome the situation. This led to the creation of lean management philosophy. The lean management philosophy revolves around minimising costs while maintaining supreme quality to supply just the required amount of goods as quickly as possible with minimum to no surplus. As difficult as it seems, this is the idea, which was allegedly developed at Toyota, to ensure survival in desperate times. Later, such management philosophy spread all over Japan and landed into the western world as it proved to be more profitable and superior to other management ideas.

Now more than ever, individuals and businesses alike, are dependent on proper supply chain management to ensure and provide even basic human necessities and consumer goods. As the world keeps changing, we are required to understand risk root causes and minimise their probabilities to continue evolving.

2.2 Supply chain management today

In today's world, supply chain and its excellence are measured using different key performance indicators or KPI's. These indicators can visualise the actual operational excellence from a business point of view. Understandably, businesses provide different goods and services, so it is important to understand which type of performance indicators one should use to properly and accurately view the performance of said business. Examples of widely used KPI's are on time delivery, quality and inventory turnover. Understanding the meaning of KPI's is extremely important as they are direct data on performance which can be further analysed via different tools and methods. Such tools, for example, are five times why, KAIZEN and Ishikawa diagram or better known as fishbone diagram. Tools and methods will be further discussed in chapter 2.4.

The core idea of most supply chain tools is to analyse data to pinpoint root causes of flawed or lacking performances. When a root cause can be pinpointed, the next step is to evaluate the damage it has caused and to plan corrective measures in tackling the issue. When fixing root cause errors, it is of most importance to dig deep enough to properly discover the actual error as it can be relatively easy to find a problem, which might only be a side effect of a deeper issue.

As materials are growing shorter, global tensions are rising higher and natural catastrophes occurring more often, the importance of supply chain risk management is greater than ever. The economy has developed to a phase where more must be delivered quicker while using less resources.

2.2.1 Analysing performance

Key performance indicators are tools which help businesses understand their competitive effectiveness and visualise statistics to better understand the company's performance. Usually, KPI's tend to be important for investors, upper management, and board members as the data of any measurable performance can be quickly and effectively showcased. Out of all performance analysing

tools, KPI's are the most mainstreamed as they can be used even in managing personal day to day life.

In supply chain management, performance indicators must be selected accordingly. In a basic example, on time delivery or OTD is a key indicator as it reflects the business's reliability, customer satisfaction and supply chain planning. If a business's OTD is too low, it could be wiser for customers to look for options elsewhere. The question remains, how to tackle the delivery risks and what are the root causes for the performance indicator to be so low? This is the point where careful risk assessment and planning comes in.

To set an example case: JayJay Corporated provides goods for customers. These goods are produced, packed and delivered to the customers for further use. To produce the sellable goods, JayJay Corporated must purchase raw materials to maintain production at required pace. To deliver ready made goods, JayJay Corporated must purchase third party delivery services to be able to transport the required goods to their end customers. The simplified supply chain of JayJay Corporated is shown in figure 1.

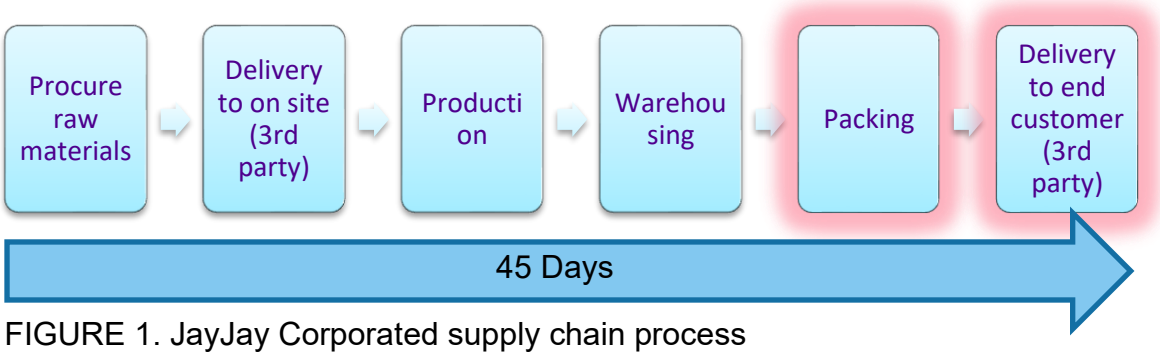

FIGURE 1. JayJay Corporated supply chain process

The full process takes 45 days from procurement to final delivery. To measure on time delivery, JayJay Corporated must agree on a universal delivery time from customer purchase order to delivery. This is practised at 15 days, meaning that from order receival, JayJay Corporated promises to fulfil delivery in full in

15 days. Once the purchase order is received and processed to the company's resource management system (ERP), warehouse will begin to pack the sold goods. This is followed by logistics planning the dispatch and delivery to the customer premises. Lastly, the items are picked up and delivered to the customer. Packing and delivery are the processes, highlighted in red in figure 1, where all sub tasks must be completed within the 15 days. As the supply chain process is explained, the accuracy and completion of deliveries proportional to all received purchase orders can be calculated.

TABLE 1. Calculating on time delivery – Formulae: On-Time/Received PO's x 100 (149/156 x 100)

OTD 1 Year	**Received PO's**	**Late**	**On-Time**
Number	156	7	149
%	100	4,49	95,51

As calculated above, if JayJay Corporated received 156 purchase orders during a year and successfully delivered 149 of those orders in full on time, the on-time delivery percentage would be 95,51%. This percentage number is then reflected to the businesses target number which in this case will be 95%. After reflecting and comparing the numbers, JayJay Corporated can agree that their on-time delivery target for the year was successful, and the business process is operating as intended.

Above results may be satisfying from an investor standpoint as it proves that the business is performing in intended levels. However, from an operational excellence point of view, there is 4,49% of flaws which should be investigated and understood why they are late. The beauty of integrating OTD to an enterprise resource system like SAP, is that JayJay Corporated can view each individual row, purchase order or item to understand what is wrong and where the mistake happened. Then it is just a matter of investigating deeply enough to find possible solutions for identified problems.

2.2.2 Increasing risks

The possibility of something bad happening drives decision making in everyday life. Thus, understanding risks is essential as neglecting them can be detrimental. Dealing with risks on a business level can be extremely difficult and they may even lead to global tensions and consequences. This is why risk management is at its all-time high. There are an un-recognisable number of risks in today's business world. Presented in this thesis are the following topics: raw-material, geopolitical distress and natural catastrophes. In addition to these, there are also risks such as human error, transportation and routing disruptions, cyber security, economy, and inflation. Within these risk categories, there are already multiple different examples of risk management due to the unusual events within this decade.

Take for example, the incident in Suez Canal in March 2021, where a cargo ship got stuck due to human error, resulting in days of standstill traffic of cargo ships and containers. This error led to more than 160 vessels being stuck and waiting for the crashed ship to be removed leading to the estimated value of standing by goods to be at 9,6 billion USD every day (Harper, 2021). Or how, due to the Ukraine invasion, all air trafficking within Ukraine and Russian regions was closed off, and how flight services like Finnair had to adapt to the situation by re-routing all eastern air traffic leading to average travel time for example to Shanghai to rise up by two hours (Finnair, 2022). As stated in the same article, such increase in travel times significantly increases navigational, fuel and personnel costs which again leads to risk in profitability. While these continuous adaptations are underway, what happens to quality? What about costs and the time it takes to get something from point A to point B? These questions are pivotal for every business and lead to the development towards better operational excellence.

2.3 Risk management in supply chain management

To quote one of the leaders in supply chain management and enterprise resource planning technology SAP,

> Just a few years ago, supply chain risk was a behind-the-scenes business term. But today, it has become one of the most talked about topics in the world. For many businesses, it was the pandemic that served as a catalyst – exposing the degree of vulnerability that their supply chains represented. Today, as companies recover from the COVID-related disruptions they endured, their overwhelming priority is to optimize their supply chains. (SAP, n.d.)

Above mentioned paragraph contextualises the core trend of the decade of 2020 in businesses worldwide. While the core of risk management and supply chain optimization is only now trending, the tools for such practises have been available for multiple decades now. Covid pandemic surfaced new vulnerabilities in business practises, and it is interesting to see how fast and efficiently will new tools and methods be created to further develop existing risk management tools and methods. While the future remains to be seen, the existing methods revolve heavily around lean methods and manual root cause analyses.

As artificial intelligence has had an immense leap forward and has become one of the hottest topics in the recent years, there is reason to believe that the future of risk management will be partially managed by AI. The possibility of having a continuous algorithm, counting and measuring every step of the way for a probability of an anomaly happening is fascinating.

2.4 Methods and tools of risk management

Today, risk management plays a key role in any supply chain and operational management. As mentioned in the previous chapter, most tools for risk management today, heavily revolve around the lean philosophy and root cause analyses. Besides these two areas of methods, all entities must view their own preventative risk managements on supply chains regarding the respective field the entity is working in. What is meant by this statement is that there is no benefit for entity A to employ a method used by entity B if the area of field is vastly different and the method is not optimized for entity A. Something that works for you, may not work for others and vice versa. Now, to look further into risk management the category is divided into three areas: before, during and after.

First, the ‘before’ category handles risks before they have happened. This is most commonly done in planning phases of any operations as the idea is to map out possibilities and figure out the necessities to eliminate the possible risks. An example of such technique is preventative maintenance. A factory needs machines to operate and if a machine brakes down the factory line is stood still, hence, breakdown equals risk. For the factory to manage as few breakdowns as possible, it is beneficial to complete preventative maintenance to the machines to ensure that they always operate at best possible capacity. After all, having planned and scheduled stop in the factory line to assess and change worn out parts is far less expensive than having the machine to break-down and halting manufacturing by un-controlled means. Additionally, preventative maintenance mitigates the possibility of flawed products as the factory machine is kept always at best possible condition. Key point of this area of risk management is to prevent something from happening before it has happened. A tool relevant to prioritizing and identifying preventable risk is risk assessment matrix. (Table 2)

Second, the ‘during’ category focuses on constantly developing and updating existing methods. This category usually takes the longest of the three as the idea is to map and figure out areas within one’s supply chain to improve and update the full process. This type of operational improvement is commonly done using lean methods and tools as the idea is to chase the un-obtainable, perfection. Examples of such lean methods are Lean Six Sigma which will be further discussed in chapter 3.3 and Theory of Constraints (TOC). TOC as a tool is excellent in constant development as the philosophy itself, revolves around identifying constraints such as bottlenecks and eliminating them. Once a constraint is eliminated it is important to understand that the cause and effect leads to the constraint developing somewhere else. (Vome Industires Inc., n.d.) Then, continuing to use TOC and supporting lean methods, the idea is to eliminate the next identified constraint, and again the next one and so forth. The reason why such constant improvement is necessary is because the world is constantly developing. If for example, a business stands still and does not adapt, the odds are that said business will evidently lose and fall out to adapting competition.

Third, managing risks ‘after’ they have happened generally requires root cause analysis. Root cause analysis tools are used to categorize and sort what has happened and why it happened. A perfect tool for such analysis is for example, the five times why method, where the idea is to simply ask why until a root cause can be identified.

- Why did the car break down?
  - Because of engine failure
- Why did the engine fail?
  - Because of a cylinder cracked
- Why did the cylinder crack?
  - Due to too much friction
- What caused the friction to be too high?
  - Faulty part

Once the root cause is identified, risk and operational management will start to plan methods to eliminate the problem, thus mitigating the risk of such problem happening again. The most important factor in root cause analysis is to dig deep enough to find the actual root cause and not only a sub effect of the deeper issue. For example, in the above engine failure example, the car manufacturer would want to dig deeper as the faulty part is only an effect caused by the part manufacturing line. Just changing the faulty part and calling it a day, would lead to other faulty parts emerging in the future.

3 DIFFICULTIES WITH RAW MATERIALS

3.1 Raw material shortages

Raw material shortages are not a new phenomenon in the world of business. In fact, these shortages have been affecting global markets for quite some time but in a more, “invisible” type of way. Now, in the decade of 2020, material shortages are disrupting businesses more than ever, and force global markets to adapt and overcome issues, which were more manageable before. Most notable effect of these shortages is the rise of pricing which directly effects the pricing of end products.

During the ongoing decade, the rise of pricing has been extremely notable for example in lithium, oil, nickel and wheat (Achilles, n.d). These price fluctuations have been a direct effect of material availability and demand. As can be viewed from figure 2, these previously mentioned items have had a massive increase in average price already in the four years we have lived this decade.

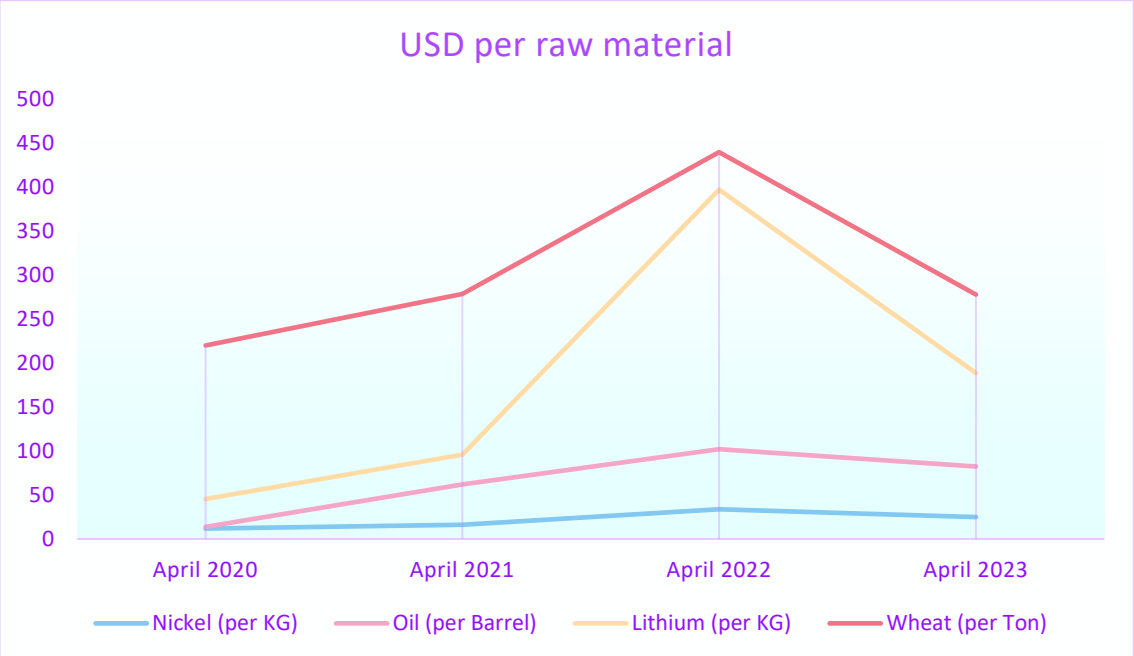

Figure 2. Price comparison of raw materials in the years 2020-2023 (Businessinsider; Tradingeconomics, n.d)

These prices directly affect the total cost of goods and services which affect the prices of the end product. As an example, the price of a barrel of oil has in-

creased by 599% from April 2020 to April 2023. This major increase in pricing has devastating effects on global supply chains as the cause and effect of this issue leads directly to massive price increases in transport services. Considering the pricing of oil and assuming the mode of transport selected for business usage consumes or is dependent on oil, evidence shows that the pricing of such services has risen exponentially during the decade of 2020. The reasoning in this price increase is not only due to material availability, but also due to the pandemic and the war in Ukraine. As an example, the cost of shipping of a 40-foot shipping container has increased from 1300$ before pandemic to 11000$ in September 2022 (Rao & Saul, 2021).

With raw materials diminishing and prices skyrocketing, businesses must be vigilant and aware of the risks they must take. Acknowledging such risks is the reality businesses worldwide live in, and this is one of the major tasks every operations manager must understand.

3.2 Procurement

Looking deeper into the matter of material availability, everything starts with procurement. Today, in a global market, competition is fierce, and materials can be acquired from many different sources. In this line of business operations, reliability is key. While reliability can be measured via many key performance indicators, deciding on the correct raw material business partner must be made with careful caution and considerations. Afterall this is the beginning of all supply chain processes.

Decision on the material supplier should be made considering operations on a macro scale. If the target demographic for a business is individuals who appreciate local and environmentally friendly produced products or services, it would be wiser to invest capital on a local trustworthy supplier, instead of a cheaper alternative abroad. During contract negotiations it is important to do good and thorough background checks as well as negotiate on standard practises as some suppliers may have their own “sub”-suppliers who operate on a worse code of conduct than what is required. An example of such case occurred to

Apple and Dell in 2014 when it was discovered that a Chinese factory which provided parts for both companies, had extremely hazardous working conditions, leading to a widespread negative media cycle and investigations (Miller, 2014). Such cases may destroy a business's reputation and rise legal actions even if the culprit is a second party business but associated to the main corporation. To avoid subjecting oneself to above possibilities, collaborators and business partners must be thoroughly screened as lack of due diligence may cause un-necessary catastrophic risks.

3.3 Sustainability

Sustainability plays a vital role in this century's business and economics. What is meant by sustainability does not only revolve around pollution and usage of fossil fuels, but to raw-material usage on products as well. Sustainability raises uncomfortable questions regarding efficiency, pricing and ecology in business practises, as most businesses want to achieve maximum monetary value instead of providing the best benefit or common good overall. To ensure that all companies implement sustainability practises, legislative and regulatory entities have set obligatory rules and regulations. Examples of such measures are the European Union's directives on plastic usage, leading to most straws to be made from cardboard, and Amsterdam's new climate neutral policy which aims at the city to be completely neutral of emissions by 2050. (Amsterdam, 2020) Such policies as the Amsterdam climate policy, create challenges for businesses regarding operations. As an example, if JayJay Corporated were to transport goods to Amsterdam, after the year 2030, all transportations should be done with a carbon neutral vehicle. This naturally causes risks for JayJay Corporated as not obliging to local policies could create legal actions against the company resulting in loss of revenue, public relations and trust.

Using JayJay corporated as an example again, it is possible to illustrate that abiding to sustainability practices can cause major risks as well. Look through the situation from product manufacturing point of view, changing to a new more sustainable material might not be as suitable as a direct replacement compared to already existing non-sustainable material. This causes risks as unstable

products might cause harm to users leading to loss of trust. A product causing harm to an end user is such a risk that further research and development should be considered in order to create a newer variant or model, which utilises the new sustainable raw material. Most often external policies do come with a transition phase of an x-amount of time meaning that for a well prepared and maintained business, such research and development process should prove to be less of an issue.

Regarding sourcing and procurement, JayJay corporated must re-assess their suppliers to comply with new raw-material requirements. As usage of new more sustainable raw material usually means rising production costs, JayJay corporated must also re-assess their pricing strategy to maintain revenue and income streams. In addition, JayJay corporated must take into concideration packaging, maintenance and end of life cycles. What started as a simple task of changing raw materials, quickly turned into a full-scale operation. Thankfully for JayJay corporated, there are supply chain management and risk management tools which can be used to assist in such transitions.

Practicing a case study example, it can be showcased how JayJay corporated can tackle the issue of changing raw material and the risks it causes. After the new material is chosen, the board of JayJay corporated have decided to launch a project to identify other points on the supply chain which can be improved to be more sustainable. JayJay corporated have decided to launch the project using Lean Six Sigma approach, which can decipher possible points of interest where improvements should be made. By going through the project with the standardised DMAIC method (figure 3), the team produces a schedule and worksheet which guides the project forward.

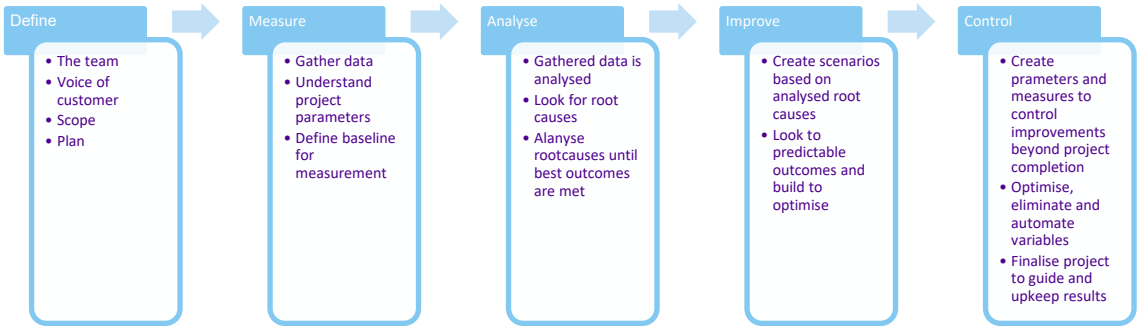

FIGURE 3. Lean six sigma project DMAIC process example for JayJay corporated

In the define phase the project team will be decided, scope and scale planned, and the voice of customer will be investigated via quantitative and qualitative means. Gathering the voice of customer is very beneficial as it will give the company a more definitive idea of what and who the target audience is and what the audience really requires. Once the define phase is complete, the team will move to measure phase. Here the project team will define baseline measurements and further collect data so that a sufficient sample size will be acquired. The main goal of the measure phase is to know that the proposed change is beneficial. Once the benefit is confirmed the team can start to analyze all data to determine main issues and their root causes. This phase can consist of multiple different tools in which some will measure risks for example risk assessment matrix.

Now that the team has analyzed the acquired data and further processed the results, it should be clear what must be done in order to actualize the theorized benefits. Finalizing the project, the team will move to improve phase where the before learned and analyzed methods and results will be put into practice. Here the team will want to look for predictability and optimize new methods to reach wanted results. Now that improvements are in place, what remains is to control

and create parameters to ensure that sought benefits will remain. Most often this phase will want to eliminate, optimize and automate all variables as variables can create errors and errors are risks.

To summarize, JayJay corporated wanted to optimize their operation and internal supply chain to reach better customer satisfaction together with their new more sustainable raw-materials source and use. A lean six sigma project was made to understand the true necessities of the market and to optimize company operations. Most often, such projects create businesses long term profits and reduce the seven wastes (Transport, Inventory, Motion, Waiting, Over-Processing, Overproduction, Defects) which neutralizes unnecessary costs and risks.

4 GLOBALISATION AND GEOPOLITICAL DISTRESS

4.1 Protectionism

Towards the end of 20th century, humanity's technological advancements were so enhanced that the first true glimpses of a globalised world were seen. Information could be shared within an instant, cross-country transportation became cheap and seamless, and businesses spread their assets more globally. Progress of this calibre became immense in 2000-2015, when technology reached its new peak with smart phones, free internet and cloud services. What was thought as an era of never-ending advance towards a united globe and free trade, halted as protectionism segmented itself into global trade. One of the best examples of this is the trade tariffs and sanctions former US president Donald Trump listed against China as this triggered a counter act by the Chinese government to also increase trade tariffs against USA (Figure 4), leading to more local sourcing.

Protectionism as described in Cambridge dictionary, "Actions of a government to help its country's trade or industry by putting taxes on goods bought from other countries or by limiting the amount of goods that can be imported." (Cambridge Dictionary, N.d.) This basically means that a country protects domestic industries by handicapping foreign competition and pushes businesses and residents to source their goods from local suppliers. Protectionism does not only revolve around goods and services but to humans as well. For example, in Finland a dangerously rising ideology of protectionism is the idea that foreigners and people who look like foreigners are not welcome.

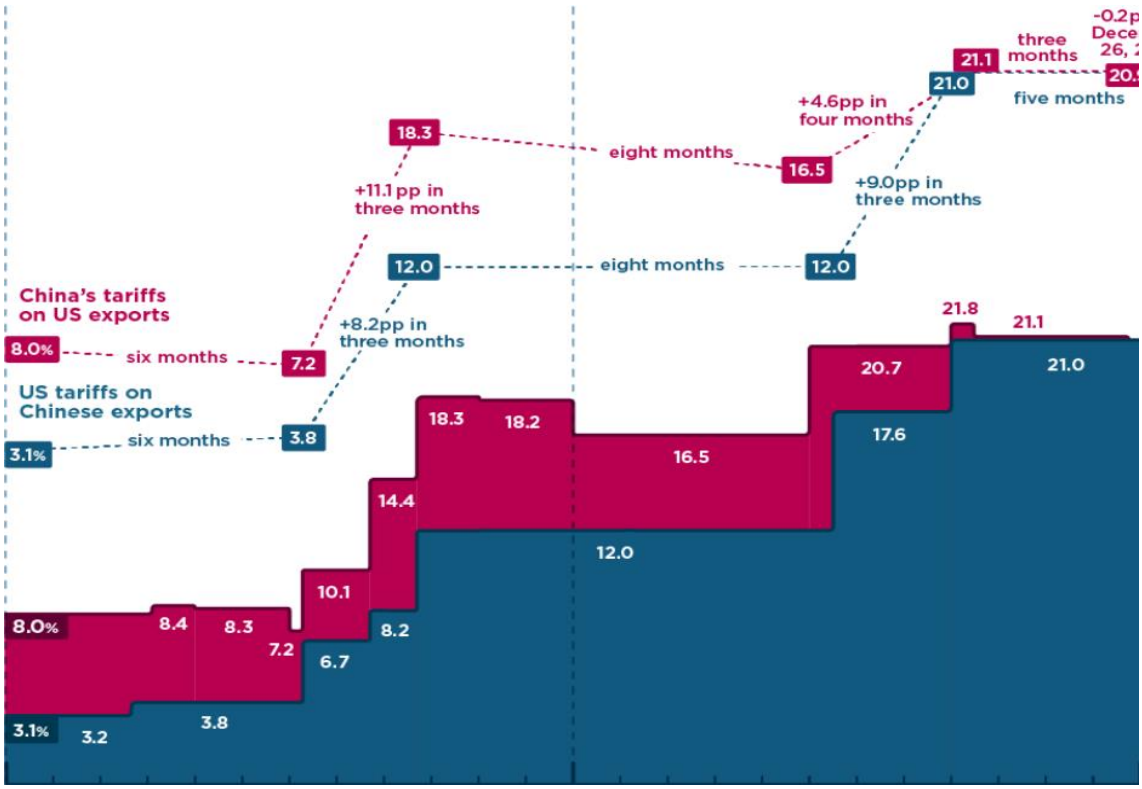

Figure 4. Usa and China export tariffs between January 2018 and January 2020 (Bown, 2019)

From a risk assessment point of view, protectionism plays a major part when planning business operations and supply chains. As an example, Chinese electronics manufacturers have had to source required computer chips from less advanced suppliers as the west agreed to close sales of the latest technology to China. (Ezrati, 2023) As can be understood from the above example, this risk plays a part in supply of raw materials, but additionally, protectionism is a risk in supply of end products and services as well. Again, a prime example of this can be viewed from the USA versus China trade wars as Chinas president Xi Jinping, decided to 'ban' Apples iPhones from 'public' use by government officials and influencers to push the usage and power of Chinas own local brands such as Huawei. Reportedly due to this decision, Apple stock fell by over 2,5% in a single day resulting in a perceived value loss of approximately 200 billion dollars in early September 2023 (Goodkind, 2023).

Retrospectively speaking from Apples point of view, addressing the USA versus China trade war and looking into Apples markets, it could be established that the political distress may affect their sales if something was to happen, resulting the trade war and Chinese markets to be a business risk. While the business

risk might be realised, the severity of the risk compared to the benefits of accessing the market weight so little, that the business opportunity should be realised and not left standing.

Protectionism and risk management is currently a controversial topic as conception of foreign equals bad, and local equals good, is somewhat a rising but socially unacceptable principle, which divides population. What can be said, is that globally speaking, most markets are so dependent on each other that it is difficult to imagine that globalised markets could take a downturn due to protectionism, but recent trends show that near future risk management should consider this a potential threat. All in all, to consider protectionism as a risk to business opportunity, depends on what is the businesses proposition and target audience.

4.2 Risk of war – case study

Together with protectionism, global political distress has catapulted the concern and possibility of war conflicts. Quite sadly, during the decade of 2020, conflicts have been a very center piece of global activities. This naturally disrupts supply chains from all operational angles and has even forced changes through trade compliance agreements and sanctions.

As mentioned above, war conflicts have been a very unfortunate center piece of the ongoing decade. Specifically speaking, the invasion by Russia to Ukraine in the beginning 2022, caused a landslide of butterfly effects which are compiling even today as the war is still ongoing. To understand the scale of effects the invasion has led to in the business world, this chapter will provide a case study to visualize the severity of the incident from a supply chain point of view.

4.2.1 Pricing and availability of raw material

Since the beginning of Covid, material unavailability and pricing have been on a steady rise as was indicated in figure 2 on page 14. In said figure, it can be

seen that April 2022, had a massive spike in pricing across the board. This spike was caused by the war in Ukraine. Part of the reason the rise of pricing was so massive, is the fact that the conflict is in Europe, which directly disrupts major transport routes and availability. The other part of the cause and effect is the significance that the countries in the conflict are Russia and Ukraine.

Concerning the food industry, Ukraine is one of the largest wheat providers in the world, as Russia on the other hand is a major power in providing natural sources as gas and oil. These three mentioned materials have had a steep increase in pricing since the war started and the availability has proved to be an issue. As an example, Finland faced challenges in acquiring gas and energy resources as Finland heavily depended on Russian energy sources. International trade with Russia became politically unacceptable and Russia counter acted against European sanctions by cutting the export of their natural gases. To tackle the issue of the lack of natural gas, Finland acquired a LNG-terminal ship which sources natural gases from other export countries such as Norway and Qatar, and pumps the newly attained natural gas directly to the harbors gaslines. (Gasgrid Finland Oy, 2022) It is estimated that the project will cost Finland +460 million euros over a 10 year lease and planning of a more permanent solution.

Now what can be interpreted from the example case Finland faced, it is necessary to always account for your security of supply. By investing majority supply to Russia, Finland set itself into a risk in security of supply. As a general rule of thumb in supply management, it is important to create a vast enough supply grid to account for possible sudden changes. When these changes occur, your supply chain is more prepared and versatile to adapt and overcome arisen issues instead of having to alternate to emergency solutions when it is already too late. In Finland’s situation, the lack of risk management cost the nation and its people, an un-necessary amount of resources as adapting to an emergency without already existing alternatives, is often far more costly than proper planning and versatility.

4.2.2 Sanctions and trade compliance

Further complicating the availability of materials provided by Russia is the fact that the rest of the world condemns Russia's action to start the invasion. This has led to boycotts and sanctions to penalize any entity working with other entities who have connections to Russia. The purpose of the sanctions is to passive-aggressively force Russia to end the war, but the impact of the sanctions is felt globally. As an example, some sanctions condemn any direct business with Russian entities which started a severe energy crisis within Europe as most gas and oil was imported from Russia as was explained in the previous chapter.

The sanctions imposed on Russia are set by governing entities like the European Union and impose a heavy guideline for all business entities to follow. This is where trade compliance comes first as it is any business entities due diligence to know from where their resources come from and where their products and services end up in and by whom the transaction is done with. Faulty compliance on the sanctions is one of the greatest risks any business entity currently faces as breaking the guideline can lead to legal actions, loss of trust and the offender itself to be put into the sanction list. An example case of the importance of following sanctions is what has happened to two Finnish companies Luminor and Siberica. After being caught on exporting products to Russia, US sanction governors put both companies and their CEO on the USA regulated blacklist of sanctioned entities. Later on the CEO and the employees of the company were imprisoned and are waiting for trials against braking the sanctions. (Harju, 2023)

4.2.3 Overcoming geopolitical risks

As has been examined within chapter four, geopolitical conflicts like the war in Ukraine pose a major threat of disturbance on supply chains. A poorly maintained business entity can face catastrophic results if risk management is neglected and business opportunities are tackled without required due diligence. To overcome such risks and maintain a well-prepared supply chain and business operations, it is important to consider and question all options and not to make hesitated decisions.

As showcased in chapters 4.2.1 and 4.2.2, and understanding the importance of multi sourcing, it can be stated that from a supply chain management point of view, it is beneficial to maintain relations with multiple suppliers to lower the severity of geopolitical risks. This strengthens one's security of supply and maintains adaptable awareness and flexibility to react more cost efficiently and quicker to low likelihood but catastrophic changes. On the other hand, a business should not focus all of its resources to unlikely but severe risks, as risk assessment matrix can visualize these types of risks are usually considered medium-high.

Table 2. Risk assessment matrix

	Severity				
Frequency	Insignificant	Minor	Significant	Major	Catastrophic
Very likely	Medium	Medium	High	Very high	Very high
Likely	Low	Medium	High	High	Very high
Possible	Low	Low	Medium	High	High
Unlikely	Very low	Low	Medium	Medium	High
Very unlikely	Very low	Very low	Low	Medium	Medium

4.3 Rules, laws and regulations

The last topic regarding globalisation in this thesis will focus on localised rules, laws and regulations. Rules, laws and regulations are mostly localised guidelines created by governments and targeted for business entities. These guidelines are permanent when comparing to sanctions, which are usually temporary. A global company must always abide to local rules, wherever the business unit is. As an example, taxation laws differ vastly between nations meaning that each business unit must abide to their local tax. However, the business unit itself may also need to comply to the local laws where the headquarters are. For example, a US based company's business unit which resides in Germany, must comply to German laws. However certain actions and most commonly employees within the German based business unit may need to comply to certain US rules if required by the company. From an employer and employee perspective,

the purpose of such policies are most commonly made to create a common rule set for all business units of a larger company.

From a basic supply chain point of view, these differentiating laws and regulations mainly concern, pricing, product quality, material usage, sustainability and trade agreements. To minimise risks in business related conflicts and issues, certain global entities like International Air Transport Association (IATA) have created regulations for which every business entity must comply if they want to benefit from air transportation. Another example of common grounds in regulations is incoterms. These terms are created and upheld by the International Chamber of Commerce (ICC) to further mitigate miscommunication and misunderstanding between two business entities. As an example, incoterms are an excellent method to mitigate transportation risks as indicating an incoterm in a business transaction or contract sets the base ground for handling unwanted inconveniences like loss or damage of goods during transportation. Another example of the benefits of Incoterms is the incident in the Suez canal in 2021, where a cargo ship got stuck in the canal for multiple days halting transportation. In such case the Incoterms clarify and specify, which party (buyer or seller) is responsible for the goods at the given time.

Governmental associations like the United Nations and European Union are also responsible for providing progressive rules and regulations. Examples of such regulations are the UN 2030 agenda for sustainable development and EU's Corporate sustainability reporting directive (CSRD). CSRD requires companies to publish reports on the social and environmental risks they face (EU, n.d). And the sustainable development goals (SDG) aim to unify global efforts in achieving further sustainable development by for instance, reducing carbon footprints and ensuring usage of sustainable raw materials (UN, n.d). Such governmental association policy regulations affect heavily in global guidelines and business procedures.

5 NATURAL CATASTROPHES

5.1 Preparing for the unpredictable

One of the leading causes of sustainability efforts is the severity and frequency of natural catastrophes. Ever since the industrial revolution in the 19th century, the usage of fossil fuels and expanding consumptions has led to steady average surface temperature rise of 0,18 celsius per decade. (Lindsey & Dahlman, 2024) The man made additional heat has increased the risk and likelihood of forest fires and draught which have the capacity to paralyze certain supply chains. Additionally to fires and draught, there are also other natural catastrophe risks such as volcanic eruptions, earthquakes, hurricanes, floods and tsunamis. All above mentioned scenarios pose an immense risk on any supply chain hence why accounting for natural catastrophes in risk management is important.

What makes scenarios like earthquakes and volcanic eruptions so volatile, is the fact that they are near impossible to predict. In today's world there are institutions which have tools to measure and monitor for example seismic activity, but monitoring is not much of a use if the catastrophe happens in an instant. This is why nations, businesses and many other entities have prepared in advance for such occurrences. Some examples of such preparation can be viewed in infrastructure as for example in Japan, most buildings are built to withstand some levels of seismic activities. Again, utilizing risk assessment matrix (Table 2), we can assess that the severe catastrophes are high on risk assessment as they are possible or at the very least unlikely.

Most common practices to prepare against the risks of natural catastrophes in supply chain management is to invest capital into preventative measures. As mentioned before, constructing infrastructure to better withstand seismic activities is a must in geographical areas where earthquakes are more common. Choosing a business location is one of the key aspects of any business decision. Due to the rise in amounts of natural catastrophes, the importance of location is more significant. Choosing a location with lower expectancy of natural

disasters may well be advantageous if accompanied by proper and efficient logistics.

5.2 Low probability, high severity

As mentioned in the previous chapter, utilization of the risk assessment matrix can visualize the potentiality of natural disasters causing catastrophic and severe damages while occurring seldomly. European Commission has reported that between the years 1980 and 2020, natural disasters caused an approximate economic loss of 12 billion euros per year (European Commission, n.d). This caliber of economic value risk can cause un-survivable consequences for any business entity. Due to the immaculate severity of the risk, preventative measures and understanding of risk management in the field of natural catastrophes becomes highly important.

Tackling the issue of low probability creates difficulties in many sectors. For example, most insurances do not cover un-expected and instantaneous natural catastrophes like earthquakes as that would put the insurance company at the forefront of any risks and loss of monetary value. In some cases, it may be possible to acquire insurance which would cover most probable disasters however, such insurance would likely cost an immense amount of money. These costs should be evaluated carefully as such an insurance would create unnecessary losses considering the low probability of natural catastrophes happening.

From a business risk management perspective, preparedness for natural catastrophes should not be maintained around the clock in means requiring personnel as that would take an unnecessary cut from human resources. Instead, as mentioned earlier, the most viable method is to tackle the issue in a preventative measure. Try to affect and negate the risks to your best ability in the earliest stages when creating and developing the core business. For example, when choosing a location for a business unit, it is beneficial to also consider the vulnerability of the location and not to only focus for example on how to reach the target demography as efficiently as possible. Where and why, when and how are questions one must be able to answer when developing the core business strategy.

5.3 Effects on logistics

The main uncertainty of the effects of natural catastrophes revolves around logistics. Of course, any disaster may hit directly on a business unit but what is certain is that any disaster can and will destroy and disrupt logistic networks. Any supply chain must be capable of adapting to logistic disruptions, thus highlighting the importance of risk management, and planning of alternative options.

Assessing options for alternative transport routes preventatively, allows for the benefit of flexibility and swift reactiveness without very high costs. For example, if a natural catastrophe would affect a railway network and disrupt its availability for six days, a business reliant of that railway network should find an alternative method of logistics to maintain operational. In choosing the best alternative method, consideration should be made on the following: how much will it cost, how long time will it take and how sustainable it is. Solution could be perhaps a multimethod transportation by first picking up the goods via truck to transport the load to the next possible train station or perhaps to take the goods straight to the nearest airport for faster transition. In addition, following issues may rise: contracting, what incoterms to use, is the packaging allowed and sturdy enough to handle truck transportation, is the product itself allowed for air transport or does it contain chemicals which could react with temperature changes?

All these questions require time and money to solve and may lead to severe supply chain disruptions if not handled accordingly, again highlighting the effectiveness and importance of preventative risk management. In a worst-case scenario, mis-managing such issues could lead to legal actions and even bankruptcy. Considering natural catastrophes, one of the solutions could be to accept longer lead times when building core business strategies.

6 DISCUSSION

6.1 What is known today

Today, risks of supply chain management are vast, affecting in various areas and setting an internal game of chess of managing the right amount of resources to correct areas. As can be understood from the three risk categories of this thesis, proper risk management requires an immense amount of macro and micro knowledge to comprehend and visualise the full picture.

Today's economic and political difficulties create further complications within the management of business units thus leading risk management to an even greater importance. Understandably, solutions are required sooner than later and from a business perspective, this must be comprehended by any medium to large company as survival is not guaranteed even for the largest of businesses. Take for example, the 2023 collapse of Silicone Valley Bank (SVB) and Signature Bank amid what could be called as recession, which perfectly visualises and realises the vulnerabilities of businesses and the severity of the risks.

Right now, the impact of the risks and challenges on supply chain management are remarkable. For example, only in Finland the challenges provoked by the war in Ukraine and the recent political strikes affecting all produce moving in and out of Finland, are creating dangerous effects around the Finnish economy and businesses.

6.1.1 Effects on a macro level

Macro environment in business and economics revolves around factors outside of one's control. These effects are most commonly referred to as PEST meaning: Political, Environmental, Socio-cultural and Technological. (The Investopedia Team, 2023) In general, all of the factors affect business models, ethics and supply chains as they are influencing the global markets continuously and are usually un-controllable from a business perspective. Understanding

macro effects is crucial in risk management and analysis as they will set a base value and premises of what is possible and what may come. For instance, the current economic situation has led to a steep increase of inflation, which directly affects markets for businesses and consumers alike. This macro effect needs to be understood and viewed by risk management team to assess possible dangers or possibilities to strategically assist the overall business. As mentioned in the Investopedia article; “The goal is to prepare management in advance with information that assists them in making operational decisions.” (The Investopedia Team, 2023)

Raw materials and globalization are multi-level issues which in some instances may be controlled in a micro level, however some of the parameters of the micro issues are set by macro environments. Take for example, raw materials and figure 2 on page 14, where it is illustrated that the average price of common raw materials has risen drastically due to shortages and other global effects such as the tensions with Ukraine and Russia. Due to these macro level issues the pricing of such items have risen and from a business management point of view, these matters are out of your control. However, what is in business management’s control is, from where, where to and how materials will arrive. In its basic form, risk and business management need to assess this macro level problem to strategize and ensure that the required material is acquired via the preferred methods and needs.

From a risk management perspective, macro environments must be monitored to ensure the businesses flexibility incase of changes in the macro scale. Regarding the ongoing decade, the massive advancements in artificial intelligence technology is currently setting one of, if not the most major risk environments to all tech-companies. Currently, there is a race between Silicon Valley and other global tech companies to supply the markets with their own AI tools as the fear is that the losers of this battle may face heavy loss of market share. This is showcasing the importance of understanding and monitoring macro scale issues as even the largest of companies may fail if not adapting to changes.

6.1.2 Effects on a micro level

Micro scale issues in a business management area consist purely of parameters the business can directly affect. Such issues are commonly referred to as employee, product, management, supplier and distribution. Comparing to macro level scale of risks, micro risks and issues are usually much easier to control and analyse as the business is constantly in direct association with said environments. Even if easier, decision making in micro scale issues still require a hefty amount of analysis and strategical assessment to avoid unnecessary risks and to bulletproof your supply chain.

Many micro scale issues in the world are currently rising through the macro difficulties the current economic state has set as inflation keeps swaying the value of money downward. This has directly resulted for instance in employee strikes leaving businesses balancing amid different economic and social positions. Employees are a micro scale issue, meaning that entities who have monitored the situation accordingly, could have a higher worker satisfaction and drastically reduce the chances of strikes on a base level.

From a supply chain management perspective, having micro scale issues such as suppliers and distribution in check, consistently reduces possibilities of threats and secures one’s supply chain. In an era of constant emerging challenges, ensuring your supply chain from vulnerabilities goes hand in hand with success and stability.

6.2 Mitigating risk

6.2.1 Just in Time versus Just in Case

Due to the broarder awareness of vulnerabilities in supply chains which the recent years have brought, there has been a rising discussion of increasing stability. The topic within business and supply chain management has been shifting to “just in case” (JIC) instead of “just in time” (JIT). This is an extremely interesting switch up within business strategies as just in the past decade the majority trend was to reduce costs by supplying what is needed to the right place at the right time, thus reducing surplus stocks. But as the current decade has shown, shortages of raw materials, the rising dangers of geopolitical conflicts and the risks of natural catastrophes have put supply chains into such dangers that it may be more beneficial to increase costs by inducing surplus and buffer stocks. As mentioned by Jochen Schwenk (2023) in a Forbes article about supply chain risk mitigation, it may be substantially beneficial to secure business operations and rising costs as the benefits of maintaining operations outweigh the expenses (Schwenk, 2023).

Returning to adaptability, it remains top priority for supply chains to be able to change their natures regarding the trends and difficulties set by the situations today. As it currently stands JIC may be the best solution to strategically ensure operations and enhance supply chain resilience as running out of supplies or produce may stall business operations and create severe losses when compared to the costs JIC brings. But, what works today may be obsolete tomorrow, emphasizing the fact that the trend may very well switch back to JIT, if global business economy regains its stability.

6.2.2 Diversity of supply

As geopolitical tensions rise and the effects of natural catastrophes keep radicalizing supply chains, it is of most importance to look into diversification. What is meant by diversification, is the idea of not investing all eggs into one basket

to ensure flexibility and redundancy while minimizing risk and increasing agility (DHL, 2022). Ideally, in a supply chain management and risk assessment point of view, a business should always opt into having more suppliers than one. As was stated in chapter four, investing all or most efforts into one source of supply, may and potentially will leave your supply chain security at a major risk. The mentality in diversification is similar to JIC as the idea is to prevent scenarios on a ‘what if’ scale.

In general, it is difficult for business management to hold good ties with multiple suppliers at the same time as usually, these suppliers do compete against each other. However, if there were to be difficulties with having multi-sourcing, often the reason would most likely be political instead of business to business. After all, all parties engaging in exchange of goods and services, usually have something to gain. Using the European oil and gas struggles since the Russian invasion as an example again, a multi sourcing method would have been a better option from a security point of view. Once political relations were damaged, the back-and-forth sanctions left most of European energy supply chains extremely vulnerable and finding quick alternatives proved to be costly.

As the heart and soul topic in supply chain and risk management in this decade has been flexibility, security and agility, diversification is the driving force in achieving exactly that. Ensuring resilience and security of supply may increase costs but the advantages in risk reduction and operative excellence heavily outweigh it.

6.2.3 Utilizing lean and risk analysis methods

Compounding all topics the world of supply chain is facing currently, it is understandable that overcoming the issues of this decade is no small deed. As has been discussed, the world of business is constantly evolving as outside influences shift operations regardless of the results. Such influences are the material shortages, geopolitical risks of globalized world, natural catastrophes and many others. Additionally, the constant economic difficulties, which ravage the

purchasing power and pricing of materials, create an unrelenting struggle and competition to survive in current global markets.

The first step to tackle these issues is continuous utilization of existing lean and risk analysis methods. This is crucial to maximize your supply chain resilience. Understand your market, build relations with suppliers and distributors, and focus on operational excellence. Include methods like KANBAN (figure 5) to visualize fork flow or SWOT analysis (figure 6) to further understand on-hand opportunities and threats. A SWOT analysis can be helpful as it visualizes and categorizes internal parameters as strengths or weaknesses and helps to understand and categorize external matters in opportunities or threats.

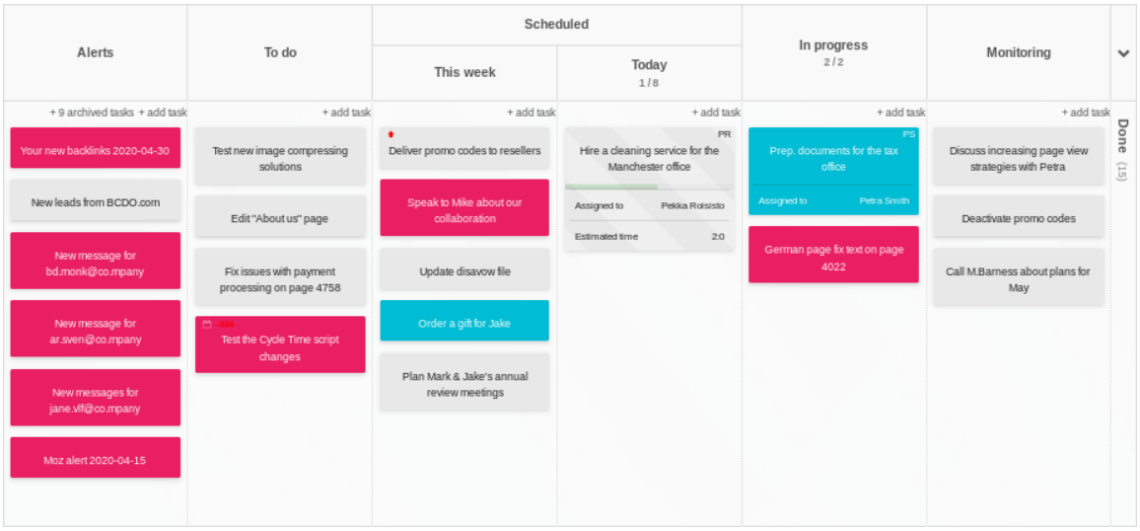

Figure 5. Example of a KANBAN board. (Shore Labs, N.d.)

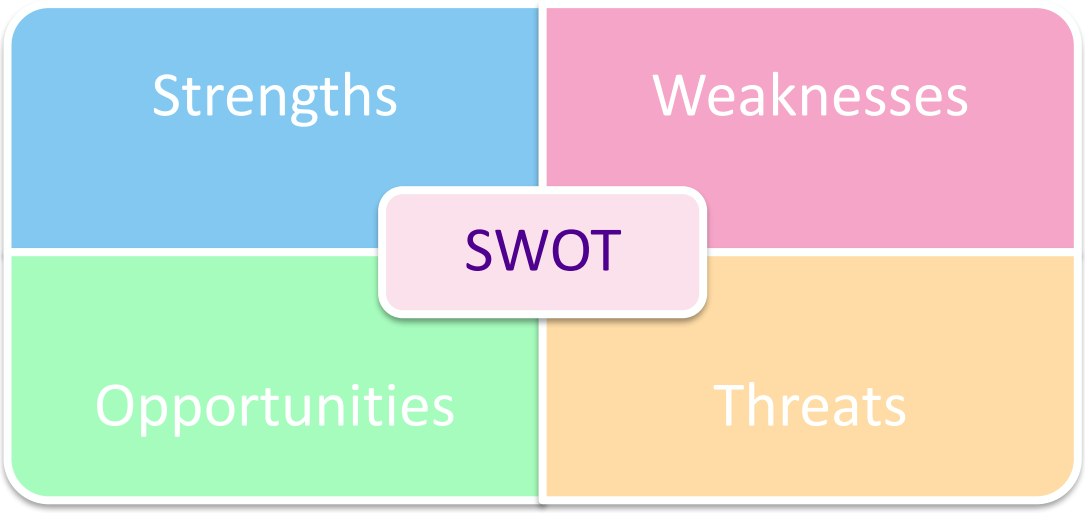

Figure 6. Example of SWOT analysis table

To mention again, utilizing lean methods is highly advantageous in saving costs but it's necessary to also consider the current threats and risks of logistics and global market. As discussed in chapter 6.2.1, due to the current dangers of material availability and on time supply, it may be beneficial to utilize a hybrid variant of lean and just in case supply chain management. If careful consideration and well assessed risk management is taken into account, utilizing existing management methods and adapting to existing market parameters will help to overcome possible threats and risks.

6.3 How to advance for the future

Today's supply chain risks revolve heavily around physical and regulatory obstacles such as material shortages, geopolitical distress, and natural catastrophes. But what about the future of supply chain? How can risk and supply chain management prepare for the difficulties of what is to come? These questions are currently surfacing, for instance, due to the uncertain possibilities caused by the sudden significant advancements in artificial intelligence (AI). Currently, largest tech companies and rising start ups battle against each other on who can produce the best application of AI for current business environment, risk management and enterprise resource systems. Proving the race on AI is the estimation that the value of AI driven risk management market will increase from the value of 1,7 billion USD in 2022 to 7,4 billion USD by 2032 (Srivastava, 2023). And as is written in Bloomberg, it is estimated that generative AI will hit market value of 1,3 trillion USD by 2032 (Bloomberg, 2023).

The possibilities of artificial intelligence are, at the moment, unfathomable. In its very simplistic core, the possibility exists for a machine to be able to collect, calculate and inform data in milliseconds to realise possible SWOTs in preventative measures currently unavailable to us. However, with this newly found innovation comes its risks as well. The larger the market grows, the more prone it is to targeted malware and cyber threats. With this in mind, the importance of proper installation, training and handling of cyber security is a rising concern for many business entities. To further bulletproof the full business operations, risk

management should look and opt into discovering and realise SWOT areas in cyber security.

To summarize, there is no simple answer nor a solution regarding the questions and risks on supply chain risk management, however there are possibilities to provide improvements. It is important to understand the full scale of challenges which exist and may affect your business. Managing risks require constant and continuous development to maintain resilience and adaptability. Introducing performance measurements like KPIs and monitoring operations, focusing on continuous improvement, create a balanced baseline for supply chain management. Categorize and illustrate risks using assessment matrixes or SWOT tables and tackle the risks which oppose a threat. If a negative anomaly occurs, aim to expose and neutralize it. Staying vigilant and noting developing and fading risks will help any business to stay afloat. Difficulty remains as the improvements of today may not answer to difficulties and risks of the future thus emphasising the importance of continuous risk management in supply chain management.

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