Supply Chain Major Disruptions and Sustainability Metrics: A Case Study

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Abstract. Major Disruptions and Sustainability metrics in supply chains (SCs) are presented by means of a case study involving a large manufacturing organisation. The main findings point to four main strategies which organisations could use in the face of disruptions, namely: maintaining stock, sharing information, disaster management planning, and pursuing initiatives with suppliers (e.g. dual sourcing, outsourcing, SC visibility and risk modelling). The sustainability metrics indicate that being successful at managing disruptions in SCs does not preclude manufacturing organisations from also being successful in the sustainability dimensions of the triple bottom line.

Keywords: Supply chain · Disruptions · Sustainability · Case study · Metrics

1 Introduction

The nature of SC major disruptions is that they are usually unexpected and have a low frequency of occurrence [1]. They range from natural disasters e.g. flooding, to man-made disasters, e.g. wars, how a company can deal with these SC major disruptions will determine their survival and growth [2] and sustainability. The research question addressed in this paper is: *How does an organisation's SC disruption preparedness relate to its sustainability in the supply chain?*

2 Literature Review

2.1 Supply Chain Disruption (SCD)

Early literature regarding disruption emphasises the need to prevent and protect one's company against SCD [3–5]. However, this emphasis has now shifted to a longer-term approach, which is to recognise SCDs and strengthen the company's preparedness in order to build resilience towards disruption risks [6–10]. Researchers have recognised that SCs have become increasingly interconnected so effects of disruptions can surpass

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the actual point of disruption, potentially, across entire SCs thereby having far-reaching effects [11, 8]. A number of researchers [11–13] believe that the phenomenon of just-in-time (JIT) has worsened the effects of SCDs. The use of JIT to reduce cost and improve efficiency may be effective in a stable environment, but can be destructive if a disaster strikes, due to the JIT system being less flexible [9]. Barker and Santos [6] evidenced that having inventory available can decrease the burden which the SC disruption has caused; whereas this option would not be available if a JIT approach was being practiced.

2.2 Sustainable Supply Chains (SSC)

Due to organisations looking to become more environmentally-friendly and to use their materials more economically, a trend in SSC literature is reverse SC, [14]. Kusumastuti et al. [15] extended previous studies by Krikke et al. [14] who provided models for reverse SCs, by incorporating location and other complexities which are present in a SC. Their study investigates the difficulties of reverse SCs due to them being dispersed as organisations seek to manufacture in low-cost countries, such as China.

2.3 Combining SCDs and SSCs

Recently, research has combined SC disruptions and sustainability [16–20]. Some of them appear in academic journals whereas some papers were published at conferences, which indicate the early phases of the current topic. Rush et al. [19] provides recommendations for communities in case of disruptions, however, it does not provide quantifiable evidence. Hofmann et al. [20] study how SC disruptions can arise from sustainability issues. These studies emphasise the need for further research on the combined SC disruption and sustainability with quantifiable results. Furthermore, the latest Global risk report [21] shows how changing climate with extreme weather events have become a source of substantial risk for individuals and businesses. The constructs of SCDs and SSCs emerged from the literature review and were explored further through semi-structured interviews in the case study.

3 Methodology

The methodology consisted of a case study comprising semi-structured interviews, historical data and observations. Company A is a Danish Multinational engineering and electronics company with its headquarters in Denmark. It was established in 1943 and currently has a network of sales offices in 55 countries worldwide. Its markets are in different sectors, such as: aerospace, airport environment, automotive/ground vehicles, defence, environmental noise and vibration, space, wind energy and telecom and audio. This case study was chosen because it was expected that a large organisation would have the resources to dedicate to responding to SCD and to enhancing sustainability metrics. The data collection phase took place at two different locations. First, a day data collection in the UK followed by a two-day data collection in Denmark (HQ). The interviewees were: SC manager, group sourcing manager, global logistics manager, product engineering manager and

manufacturing manager. The SC manager and the group sourcing manager facilitated one day in the UK, whereas the group sourcing manager additionally facilitated two days in Denmark. The rest of the interviewees granted an interview (with some follow ups) lasting for an average of one hour. The questions used in the semi-structured interviews were developed prior to the visits allowing for some open questions that could emerge during the course of the interview. The interviews covered two parts. First, questions in relation to SCDs, e.g. rating the frequency and impact of SCDs, the role of information sharing in tackling SCDs. Second, questions in relation to SC sustainability metrics, e.g. importance of sustainability targets and assessing their achievement of those, and rating their sustainability metrics and SSC performance. The qualitative data analysis comprised of three different stages: transcribing the semi-structured interviews taken at both the UK and Denmark sites, using NVIVO coding and classifying direct quotations to analyse the semi-structured interviews and writing the report including production of tables, charts, graphs and detailed results. The results were presented in the form of a written report which was sent via email to the key facilitators (SC Manager and Group Sourcing Manager) so they could assess confidentiality and accuracy of the report, as well as provide feedback comments.

4 Results

4.1 Safety Stock

To guard against disruption, Company A has two months' safety stock of most components and this is extended to three years' worth of stock for one core product with a single supplier for (despite searching for an alternative). It believes this safety stock strategy will provide them with sufficient robustness. If a disaster were to occur, it would still be able to operate with the stock levels they have and do not see severe disruptions to their organisations as the Product Engineering Manager states *"we would be up and running three to four months in worst case scenario after a disaster"*. Therefore:

P1: *Firms with high levels of safety stock in their SC are less likely to be negatively affected by SCDs.*

4.2 Suppliers

Dual Sourcing. Sourcing from a single supplier will enable a firm to reduce some costs, but can create problems on occasions where a major disruption occurs. Dual sourcing is not always available for every one of Company A's critical products. As indicated above for one critical product, they have not yet found an alternative source and therefore they source from a single supplier and have safety stock of up to three years. However, it has recognised the need for dual sourcing and the strategy they have used to select suitable products is as follows: *"Firstly, it was which product has the highest turnover or highest value for us and our customers and where this comes from in the SC and where we have the highest risk in the SC. Suppliers that make small bits and pieces – we can get elsewhere so it was depending on criticality"* – Group Sourcing Manager.

Outsourcing. Although in the last 20 years Company A has outsourced all its lower level components, which are not the main value-adding components, it has still retained the value-added production stage at its own site. Outsourcing could increase the risk of a disruption occurring; however, it has taken steps to ensure their robustness against such disruption. *"I think we have a very complex SC, but […] we went from buying raw materials to buying semi-finalised goods. So we have strategically moved off the SC that makes it easier for us."* – Group Sourcing Manager.

SC Visibility. To ensure Company A is not affected by a disaster in the SC, they obtain the exact information they require from the suppliers including they require to know exactly where their components are. They therefore have full visibility of their products, both incoming and outgoing. Added to this, the suppliers are checked annually on their financial position to ensure there is no risk of bankruptcy. *"If for example, there is a risk of bankruptcy from one of our suppliers, we follow the supplier every year, are they in good shape, etc."* – SC Manager.

Risk Modelling. Another way in which Company A has actively sought to reduce the risk of disaster is by carrying out a simulation with a supplier in a region which is prone to disasters; flooding in particular. They simulated that a real-life flood had occurred in the area and that, despite the disaster, the supplier had to deliver the goods to it within eight weeks. This target was achieved by the supplier and the simulation was declared successful. It A has also ensured that its suppliers have a contingent supplier in case of floods. However, it needs to guard against becoming complacent; the nature of disasters is that they are unpredictable, which means a disaster could take place in a region where its suppliers are located and no disaster plan had been devised. Therefore, it seemed wise to carry out simulations with other suppliers too, starting from the ones most prone to disaster. Therefore:

P2: *Firms with strong supplier management practices are less likely to be negatively affected by SCDs.*

4.3 Disaster Management Planning

Company A has a disaster management plan in place which covers events ranging from the likely to the very unlikely. This plan is audited regularly by a group that owns it. Within this disaster management plan, many areas are covered. Each step of recovery is presented along with who is responsible for each stage. Along with these are contact numbers for the relevant staff members. The fact that it has not yet had to use this disaster management plan could be an indication of their robustness. Having a plan stands in contrast with some organisations which take disasters on a 'as they come' basis and do not have a set-up procedure to re-start the system to normal operations if a disaster were to occur. *"We have different kinds of contingency plans: We have specific insurance if something happens to specific suppliers for us – it's only for the biggest one. There is insurance for loss of turnover. Then we have another plan – divided into financial/office suppliers/transport – we have all the major suppliers – if something happens, we know what to do. Then, we have a third one –*

how often does the disaster happen, then we have different plan to take action and then they choose from a high risk to a low risk." – SC Manager. Therefore:

P3: *Firms with strong disaster management planning are less likely to be negatively affected by SCDs.*

4.4 Information Sharing

Information sharing is key to preventing disruption occurring and responding appropriately when a disruption does occur. Company A shares information both internally and externally. Each department gets regular feedback from questionnaires completed by employees, which is then discussed within the department to see whether targets have been met; comparisons are made with previous targets and plans within each department are produced following this. This information sharing also happens between departments, via shared files in the Information System they work with internally; these are typically in the form of MS Excel files, in which they have traffic light colour coding to represent progress on solving a problem. It also shares information externally with two other companies that are also owned by the same group; this sharing occurs approximately once a year in order to *"exchange best practices"* – Group Sourcing Manager. Therefore:

P4: *Firms with strong information sharing within their SC are less likely to be negatively affected by SCDs.*

4.5 Sustainability Metrics

Economic. The interviewed managers claim economic sustainability is built into Company A's ethos of providing a quality product. This means *"not just quality in terms of touch and feel but quality in terms of surrounding"* – Group Sourcing Manager. Due to this desire for high quality, it has not increased price because they are already operating in a high quality area, i.e. Its approach is not based on low cost. It is known that some multinational organisations operate in countries where unethical issues, such as child labour, are very common and go unnoticed.

Environmental. In addition to having a high quality product, Company A has a goal to be 3% more cost efficient than the previous year. The researchers recommended that it investigates eco-efficiency and how it can help them, as the survey responses of how eco-efficient it is varied significantly. In theory, being more eco-efficient should also yield economic benefits. It has the resources, such as highly skilled staff, to look more in to the area of eco-efficiency which could yield long-term benefits. Company A is certified by ISO14001 for which they are audited every year. Other aspects such as reduction of waste and energy consumption are also measured. In order to be more environmentally friendly, it sends out consolidated shipments rather than shipping out every day. The waste ratio is medium while one employee believed it to be very low and one employee believed it to be very high. These results may suggest that more progress is needed in terms of looking at environmental factors, such as the waste ratio

and also making employees aware of progress. This point is backed up by a statement made by Product Engineering Manager regarding sustainability targets "It is available so everybody can access them, but that's not the same as being aware of it – more than half would say they don't know. All employees can look at our KPI's, but not many do it."

Social. Company A has many initiatives in place, for example, they run an ethics programme where they train all their employees in relevant areas. When selecting suppliers, it looks into the social characteristics of the suppliers and have dismissed some suppliers due to unethical behaviour, e.g. child labour practices: *"When we are selecting suppliers, we look into the social dimension from the suppliers – we wouldn't use child labour etc. They do challenge us that we do have low cost suppliers but not for any cost – it has to be ok in an ethic and social correct way. We have had suppliers that have been dismissed because they were not fulfilling the standards we required by [owner Company]"* - Group Sourcing Manager. Company A's HR department looks at how employees feel they are treated. At the UK location, employees are free to give suggestions about production improvements. It is certified to ISO14001, but they may also want to consider the ISO18001 certificate in this situation. All responding employees believed that it is a good employer and "*employees here have a huge degree of flexibility"* – Group Sourcing Manager. The average number of years an employee works there is 17 years and retired employees also return to keep in contact at their 'senior club', which indicates a degree of satisfaction. H&S is extremely important and they have occupational health advice which they can call on, as required per case. An audit is also carried out to ensure employees are not working more than the hours they are allowed. From the employees surveyed, half believed the standard of H&S is high whereas half deemed it to be very high. Therefore:

P5: *Firms with strong SCDs preparation are more likely to exhibit high levels of SC sustainability metrics.*

5 Conclusions

This paper has addressed the research question: *How does an organisation's SC disruption preparedness relate to its sustainability in the supply chain?* Company A has made great efforts to address the different SCDs possibilities by adopting several of the reported strategies in the literature, e.g. information sharing, disaster management planning, hence making it strongly prepared to SC disruptions, i.e. robust. It has also taken into account its sustainability metrics achieving a strong performance overall. However, it needs to pay more attention to the long lead times, the waste ratio and the resource utilisation rate. On the positive side, labour equity shows that all employees interviewed are extremely satisfied to be working there. The limitations of this paper are mainly related to the drawbacks of single case studies, namely the lack of generalisation of results, which other research methodologies could overcome, e.g. survey. Thus, the results presented here apply to Company A and its SC without further implications for other organisations. Nevertheless, the in-depth understanding gained through the

relatively close contact with the organisation is valuable to understand the phenomenon under scrutiny, i.e. SC disruption and sustainability. Future research avenues could include more case studies, especially at the other end of the spectrum of expected resilience, e.g. SMEs which do not have the resources to dedicate to major disruptions with "low probability and high impact" occurrence. Furthermore, empirically testing the five propositions stated in this paper can shed some light on the topic.

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