An Exploratory Analysis of a Decade of Supply Chain Disruptions

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Abstract: The goal of this study is to analyse a decade of publically announced supply chain disruptions. We analyse over 2,400 unique disruptions to examine the causes, impacts and duration of disruptions across several industries and regions. We find that although duration and financial impact has not increased over time, there are significant variations across industries and regions in the types of disruptions and their consequences. Our research presents implications for both research and managerial practice.

Keywords: Supply Chain, Risk, Disruption

I. Introduction

In recent years the management of supply chain risks has risen to prominence within both academic and practitioner communities. High profile events, such as 9/11, SARS and the outbreak of foot and mouth disease, have clearly highlighted the vulnerability of today's global interdependent supply chains. In response, the academic community has sought to understand how organisations can identify, assess, manage, and to a lesser extent, monitor supply chain disruptions e.g. [2] [3]. Despite the value of this research, the field of supply chain risk is still very much in its infancy and there have been calls to further our understanding of this complex subject [7] [8].

This study seeks to add to this body of literature by examining *actual* events of supply chain disruption. Whereas previous empirical research is largely based on case studies and surveys, our study uses a proprietary database of 2382 publically announced disruptions to take an exploratory view of the following research questions:

1. What are the primary causes of supply chain disruptions?
2. What is the impact of these disruptions?
3. Do disruptions vary by time, region or industry?

II. Developing the Database

We addressed our research questions by constructing a database of publically announced supply chain disruptions. Following the data collection method of Hendricks and Singhal [4] [5] [6], we undertook a systematic review of the business press to identify specific disruption events. The search was based on a rigorous and repeatable process using specific databases and keywords (see Table 1). The databases included Reuters, Dow Jones Factiva, FT, The Economist, Business Week, Forbes, Fortune, Bloomberg, and The Wall Street Journal. These sites delivered broad coverage of disruptions but were also perceived to have high journalism standards and therefore reliable sources of business related information.

We took two approaches to the development of our search terms. First, we analysed the academic literature to extract terminology relevant to supply chain risk management. Second, we worked with managers and directors at a global financial services company who were responsible for developing the first insurance product for supply chain disruptions. We synthesized the results from both stages to ensure search terms were reliable and sufficiently broad to capture as many events as possible. The output was that our keyword search combined supply chain related phases, such as *Business, Cargo, Cyber, Delivery, Logistic* (s, al), Ship* (per, ping), Suppl* (y, ies, ier), Supply Chain, Supply Network Trade, Transportation*, with disruption-related terms such as *Attack, Bottleneck, Bribery, Continuity, Delay, Disruption, Failure, Fraud, Glitch, Hiccups, Interruption, Inventory, Problem, Risk and Resilience*.

A team of four researchers searched for events between 2000-2009, with two researchers responsible for each five-year period. Both teams followed the same process using the databases and search terms above. Events had to fulfil a set of strict criteria for entry into the database. First, we checked that the event could, at face value, be interpreted as a supply chain disruption. Second, the event had to appear in a minimum of two of the databases. Third, the report(s) had to contain the majority of the information we required for our database. These criteria help improve the validity of the data. As a final check of consistency, the two lead researchers examined a random sample of 200 events from the other team's entries.

We were interested in collecting data on whole range of factors relating to the disruption. First, we recorded the article title, source, date and URL link. This was useful for tracking information and quality control. Second, we recorded several key facts about the disruption itself. These included the region, country and city where the disruption occurred, the type of disruption (Natural, Human, Intentional, Non-intentional), its risk category (according to ISO 28002 classification), and the primary and secondary causes for the disruption (again based on ISO 28002 classification).

Second, we examined the affected party. We recorded the company name, industry sector, region and country, the type

of impact (financial, economic, image, human, environmental), the duration of the impact, and the financial consequences. Third, we also examined the impacted party(s). By *impacted* we mean customers or suppliers who may have been disrupted by the *affected* party. We recorded the same information as for the affected party. The final database contains a total of 2382 unique disruptions between 2000-2009.

III. Results & Discussion

Figure 1 shows the top 10 causes in our database. It is striking that the top four causes of accidents, production problems, labour unavailability and natural disasters account for a large proportion of the disruptions (59.8%). It is also acknowledged that there is a long tail of causes. All 29 categories identified by ISO 28002 have at least one incident within the database, demonstrating the breadth of factors that supply chain managers need to consider during risk identification and scenario analysis. We suggest that managers focus their planning on the more common causes in our database and that academics focus their research on the development of methodologies that can help in their management and/or mitigation. We also analysed whether disruptions were caused intentionally. Of the disruptions caused by human factors, 40% were classified as intentional acts of disruptions, including strikes, cyber attacks and piracy. This represents an interesting avenue for future research.

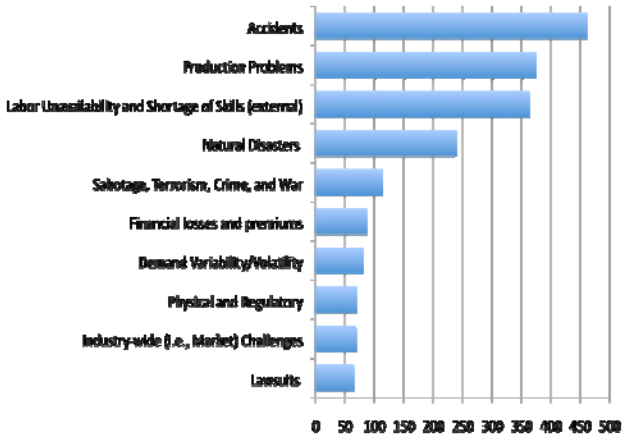

Figure 1 Top 10 Causes

We analyse the impacts of disruptions in several ways. First, we classify the impacts according to the five types identified by ISO 28002. Figure 2 clearly indicates that nearly all disruptions had financial consequences, thus supporting the findings of Hendricks and Singhal [5] who demonstrate the impacts for shareholder value. Interestingly, the database shows that over 50% of disruptions have broader economic impacts for the regions in which the disruptions occur. Costs to corporate image were identified in over 40% of cases, highlighting impacts beyond immediate financial or production issues to the longer-term brand health of the organisation. Finally, environmental and human factors were identified in only a small minority of disruptions.

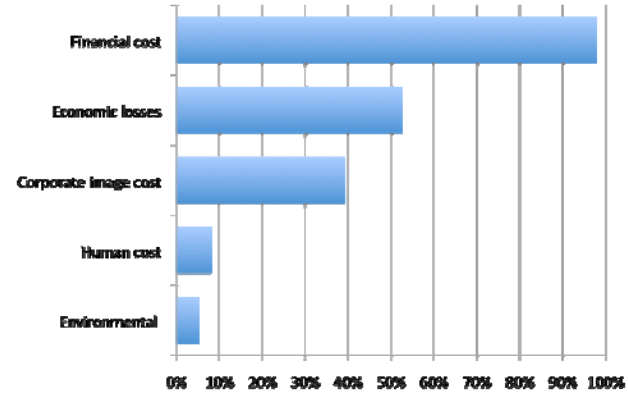

Figure 2 The Impacts of Disruptions

Second, we examined the duration of disruptions. Previous research has shown that the financial impacts of disruptions last an average of over 60 days [4], however, little research has examined the duration of the disruptions themselves. Figure 3 shows that the majority last less than one month but that a significant portion (15%) last for over one year. Future research could examine whether different causes or regions have any bearing on the length of disruption.

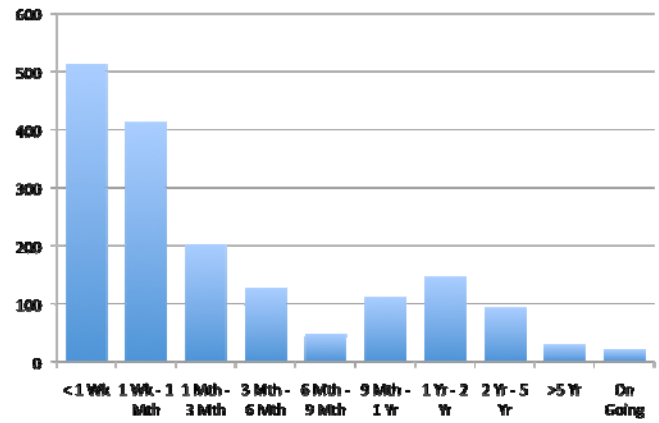

Figure 3 Duration of Impacts

Third, we analysed the financial impact of the 686 disruptions for which data was available. Of these, 20% of disruptions had a financial cost of less than $1 mill, 22% between $1 – 10 million, 25% between $11 – 100 million, 14% between $101 – 500 million, and 19% over $500 million. It is interesting to note that the financial impacts are spread relatively evenly across the five categories and that there are as many disruptions with impacts of less then $1 million as there are disruptions costing over $500 million.

Subsequent analysis indicates a strong correlation ($r = .43$, $p < .001$) between duration and impact.

Our final research question asks whether trends varied industry, region or time. While it is beyond the space constraints of this abstract to present all possible trends, we wish to comment on a few of the interesting analyses. First, we examined whether the type of disruption varied by region. While accidents and labour unavailability dominate the European disruptions, production problems are a much greater issue in the Middle East and N. America. Moreover, we note a greater number of disruptions due to sabotage, terrorism, crime and war in Africa. Second, we analysed whether the duration of the disruptions varied across industry sectors. We found that short-term disruptions are more common in the oil and gas, ICT and utilities sectors, while long-term disruptions are more frequent in the aerospace sector. We suggest that the nature of supply chains within these industries, in terms of clockspeed, complexity and vertical integration, could be responsible for these trends and represents an excellent opportunity for future research.

IV. Conclusion

Our exploratory research reveals several implications for research and practice. First, the data does not indicate that either the duration or impact of disruptions has increased over the 10-year period. This differs from previous research e.g. [1] and may be explained the fact that our data does not rely on managerial perceptions where the availability heuristic (a bias where frequency is associated with ease of recall) does not skew the data. Alternatively, it could be argued that although the frequency of disruptions is on the rise, supply chain risk management is starting to have an effect, maintaining duration and impact at a steady state. This, of course, needs to be explored in greater depth. Second, more research could be conducted on intentional disruptions. Such threats are often underplayed in the supply chain risk management literature, but represent a large percentage of the number of disruptions in the database. In terms of managerial implications, we suggest that firms build their own proprietary databases. Over time the information in these databases could be used for risk modelling and/or probability analysis. We also suggest that the causes contained within the database could be used to forecast future disruptions or to help build early warning systems.

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V. References

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Background of Authors

Dr Brian Squire is Senior Lecturer of Operations and Supply Chain Management at Manchester Business School. Brian's research straddles the fields of operations and supply chain management with a specific focus on supply chain risk, behavioural operations, sustainability, and product and process innovations, such as the rise of mass customisation and modularisation. He is currently Principal Investigator on an EPSRC project: 'Managing Supply Chain Vulnerability: Understanding the Impact of Supply Chain Design.

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