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A SUPPLY CHAIN RESILIENCE CASE STUDY LINKING KEY RESILIENCE AREAS WITH PROCESS MINING

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ABSTRACT

At a time when supply chain disruptions are on the rise, supply chain managers are often overwhelmed by a simple question: How resilient is my supply chain and how can the status quo be improved? We present a case study of a manufacturing company in Central Europe that uses a two-step approach to help managers answer these questions. In the first stage, Key Resilience Areas (KRAs) are applied to transactional data to identify critical elements of the supply chain and their potential impacts. In the second stage, process mining is used to analyze the root causes of the identified impacts. In the case study, we reveal vulnerable locations and relevant product characteristics of the material flows of the company's inbound network, and process mining is used to analyze why, for example, a single sourcing strategy was chosen for a critical supplier.

1 INTRODUCTION

Since supply chain costs directly reduce the profit that companies can make, supply chain optimization has become an important success factor in recent decades - the efficiency of the supply chain is therefore the dominant topic in many companies. However, times are changing, and the world has experienced events that have led to large-scale supply chain disruptions (e.g., Suez Canal Blockade, Ukraine War) where efficient supply chains failed. As a result, building resilient systems has become a major buzzword in business and, by extension, Supply Chain Management (SCM). But where should supply chain managers start when trying to make their supply chains more resilient - which is accompanied by measures that contradict the principles of the last decades?

Resilience management has traditionally been associated with risk management. As a result, companies have either identified a series of discrete risk events that could lead to a disruption and created preventative contingency plans, or they use real-time information during crisis events (e.g., using commercial IT tools) to enable operational firefighting shortly before or during a disruption. The exclusive focus on efficiency and a lacking strategic view on the supply chain design regarding resilience has created a bottleneck in both practice and research. This gap is the target of our applied research. How can supply chain managers be helped to measure the resilience status of their overall supply chain design? What are the most critical and vulnerable elements in the supply chain? Which supply chain partners are at risk of having inadequate processes that could lead to disruptions?

2 METHODOLOGY

To support supply chain managers in answering the questions above, we have proposed a *two-stage approach to resilience management* (Schätter et al. 2022). In short, the two stages address two different levels of complexity in examining supply chain resilience using different sets of enterprise data. In the first

stage, we use a historical transaction data in terms of delivery items to perform an initial "resilience check"; the second stage focuses on the decisions made in the organization that led to the resilience-related shortcomings of the supply chain design. For this purpose, process mining is used to uncover deviations from defined processes and their consequences (van der Aalst 2016).

Stage 1: Key Resilience Areas (KRAs) are applied to the delivery items. We propose a certain analysis sequence to uncover critical elements of the supply chain that are at risk in terms of locations, transport relations, or materials. Failure of these elements could cause severe turbulence in the network. Such an impact analysis is performed based on eight KRAs related to the geographic distribution of entities, material sourcing strategy, inventory materials, lead times, transportation delays, consolidation of deliveries, transportation distances, and intralogistics processes. Stage 1 is a starting point for the in-depth analysis using process mining and the KRA grid and predefined analysis sequences provide a framework for this.

Stage 2: The parts of the supply chain identified as critical are now analyzed in detail, particularly the processes behind the decisions that led to the current supply chain design. We use process mining to identify the reasons for process deviations in various decisions. Based on the results, transparency is increased, and strategies can be developed and applied. One of the biggest challenges in applying process mining is the overwhelming amount of event log data available in the enterprise. This is where our approach comes in. To ensure that the highly relevant event log data can be used to uncover real opportunities to improve resilience status, the first stage is to use it as a filter: the collected event log data should be analyzed with a particular focus on the identified critical entities, transport relations and materials. This is because these elements are responsible for potentially weak resilience and should be assessed and possibly changed.

3 FINDINGS

The approach is illustrated by a case study that examines and improves the resilience of the tier 1 inbound supply chain of a manufacturing company with a warehouse in Hamburg, Germany (see Figure 1). We consider all shipments from suppliers to the warehouse. By following the two stages we see, inter alia, that there is a cluster of single-source suppliers in the Czech Republic that have also experienced significant delivery delays of more than 7 days in the past year. For the most critical supplier, it can be revealed based on process mining that the single source decision was a process error. If the first visible event is the creation of the purchase order, it becomes clear that an approval in the form of a purchase requisition is missing. The next event that should be logged is that the purchase order has been sent to the supplier and confirmed. A dual sourcing strategy should be followed, but the event log shows that only one supplier has received a purchase order confirmation. This immediately indicates a possible bottleneck in the process, which has an instantaneous negative impact on the company's resilience for this material. A finding that should be adjusted by strategic management to reduce the criticality and vulnerability of the material in question.

Figure 1: Inbound network and critical suppliers.

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van der Aalst, W. 2016. *Process Mining: Data Science in Action*. 2nd ed. Berlin: Springer.

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