An effective disaster recovery model in supply chain management at times of pandemic

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Abstract

An automated model representing communicating states for a given moment in actual time is theorized in an Automated Supply Chain Dual (SC). When handling instability threats in SCs, we look at the circumstances surrounding the architecture and deployment of the digital twins. Combining models with data-driven methods show interrelationships between data risk, modeling disturbances, and performance evaluation. Digital network networking maps are distinctly visually illustrated by the SC blow and modifications amidst the COVID-19 pandemic, along with the after-event recovery method. The findings of this research complement SC risk management’s science and experience by enriching forecasting and corrective findings to exploit the merits of SC modeling, quantitative predictive data, and evidence of disruptions in real-time. The supply chains have been severely impacted by the recent coronavirus pandemic, known as the COVID-19 outbreak. Due to supply failure, demand for certain items has increased significantly, while raw materials supply required to produce those items has decreased; therefore, to address these issues, this paper proposes some strategies for improving service levels for the most sought-after products, such as toilet paper, during a severe pandemic, such as COVID-19.

Keywords

Supply Chain Risk, Data Analytics, Supply Chain resilience, COVID-19, Risk Management

Introduction

The risk of the supply chain is multilayered and can be categorized as operational and disruptive risks. While operational risks include routine problems in SC activities, volatility in lead times and demand is linked to low-frequency, high-impact cases. Exemplary examples are natural disasters (e.g., the 2011 tsunami in Japan and its huge impact on the global Supply Chains), human-made cataclysms (e.g., the 2016 German BASF plant explosion, and the consequent shortages in the global Supply Chains), legal disputes or strikes. These risks characterize the architecture of the SC network because several manufacturing units, suppliers and DCs, and transport connections become temporarily inaccessible. They are very significant and instantaneous [1].

An epidemic outbreak is a unique case of Supply Chain risks, distinguished by three constituents. These constituents include: (i) the presence of long-term disruptions and their uncertain scaling, (ii) parallel unfurl of SC disruption (i.e., ripple effect), and populace eruption (i.e., the spread of the pandemic), and (iii) concurrent supply, demand, and logistics architecture disruptions. In contrast to other perturbations, the disease outbreak starts small but quickly and spread across many geographical regions [2]. COVID-19, which impacted about 203 countries in late 2019, infected over 8,525,042 people and claimed the lives of 456,973 people, became a worldwide disaster by the end of June 2020, [3], which should be remembered that all figures are valid at the end of June 2020. The number of individuals affected and the fatality rates change radically daily. The pandemic situation caused by the novel COVID-19 coronavirus triggered from Wuhan, China, adversely affected Chinese transports and eventually slashed the supply accessibility to Global Supply Chains [4]. The pandemic caused by COVID-19 has certainly caused one of the greatest disruptions accentuated in that humanity has witnessed in current decades, which is “breaking many global Supply Chains.” [5].

The SCs of many companies, being slender and globalized in structures, have become highly susceptible to epidemic outbreaks. In 94% of Fortune 1000...
businesses, SC-driven coronavirus disturbances have been identified [6]. A Dun & Bradstreet report states that 51,000 major corporations own one or more distributors in Wuhan. At least five million multinational firms have one or more of the tier two suppliers in the Wuhan region, which is the origin of COVID-19 [7]. In addition, there are tier-one or tier-two providers in 938 of the fortune 1000 firms in the Wuhan area. This disaster has led to many SC disruptions, leading to long delays in delivery, reductions in revenue and sales, and production stoppages affecting employees’ use [8]. The uncertainty has impacted Supply Chain output internally and externally, rising stock returns, and profitability on the markets. The efficacy of model-based support for sturdy SC design and improvement depends critically on the accessible information and on the possibility of acquiring valuable data, [9] e.g., data on vendors and path disturbance likelihood, i.e., data used for generating disturbance scenarios for a study of robust Supply Chain architecture, are but are not limited to or data for the timely implementation of recovery policy in real-time disruption detection [10]. As a result, modern proactive, flexible supply chain structures, including solution planning and proactive real-time monitoring, have rapidly become a prevalent concern in multilateral SC risk management with the introduction of contingency strategies [11].

Given the continuous development in analytical capacities for businesses, it is more necessary than ever to foresee possible interruptions and recover Supply Chain operations. Companies are searching for ways to develop Supply Chains using their data-sets and investigating how vast amounts of data can be used in risk analysis and threat evaluation and enriched effective Supply Chain disaster management [12]. Accentuated digital technology can substantially affect SC performance in terms of Agility, Adaptability, and Alignment [13].

An improved Decision Support System, i.e., an automated SC dual – a computerized digital SC model that reflects a network status in real-time at any given period and can increase the end-to-end SC transparency and testing contingency planning - can be generated using current decision support resources [14]. The physical Supply Chain is an automated dual replica based on factual data on transportation, stock, needs, and supply capacity to be leveraged for scheduling and actual-time control decisions [15]. Supply Chain risk management can profit from information analysis techniques using new technology and monitoring technologies in actual time, predicting potential impacts and responses [16]. The referenced work reveals a gamut of expertise and observations on Decision Support Systems in Supply Chain disruption risk management. However, it remains a fragile diversity [17]. Growth in quantitative analysis and data-driven learning remain still closely related. Although limited attempts were made to identify the effect of the business intelligence on Supply Chain risk reduction and tracking, the juxtaposition between data-driven technologies and the management between SC risks was not understood [18]. This research project aims to establish further the theoretical framework for SC volatility theories, structural engineering, and risk analytics [19]. This research draws the methodology of modern SC risk analysis. It integrates them to establish a Decision-making System based on the postulates of industry 4.0. It is useful for the development of an interruption risk management digital supply chain [20].

The methodology would be used to formulate an interruption risk management Automated supply chain (SC) dual [21]. This study latches the gap by bringing together multiple areas, information-initiated analytics, and automated judgment support for SC risk management. We are focused on the growth of management to close the study gap [22].

The study contributes substantially. The findings of these studies are presented as a concept-technology structure for a generalized DSS for the administration of SC disruption consisting of data-driven interference analysis in the SC and the dissemination of risk data interrelations, disturbance analysis, and performance evaluation [23]. Settling based on offline decision-making processes alone and neglecting reliable statistics on the provider and route major crisis, advanced signal recognition, and real-time disruption can trigger distorting SC probability analysis disruption possibilities and late or ineffective implementation recuperation policies [24]. This study is based on conceptual research for research methodology and logic. This research allows conceptualizing an SC risk designing framework to build an Automated SC dual established on a mixture of replica parametric and information taxonomy. Ultimately, the derived and Automated Dual principles are being combined to a more generalized DSS architecture that for the first time represents an integrated model of risk analytics and information-based study prototype for SC
disaster recovery administration that establishes a hypothetical basis for an Automated SC Dual [25]. The clear conceptual offering implements methodological principles more complicated and a widespread concept of Automated Dual SC design conceptualization. The businesses have specific questions to implement the Automated Dual model: Do the firm have a model to tackle the Supply Chain disruption? What time will it take for an SC to recover its company strategy (e.g., recognition of temporal scarcity; use of planned contingency pandemic plans) after the outbreak? [26].

**Literature review**

**Model-based disruption risk management**

Over the past two decades, the operational risk strategizing of SC disruptions has been attracted to the research community. The volume of model-based studies increased dramatically over the current decade, as demonstrated by recent evaluations of calculable process applications to SC instability risks and stability [27]. The literature review facilitates the detection of many types of cases and datasets described in this session. The analytical techniques at the SC architectural level are used to analyze the disruptive effects on Supply chain efficiency by disabling a few design components or changing certain operating parameters (e.g., capacity) [28]. At the tactical decision-making point, this review is beneficial. In consideration of inventory, sourcing, or shipment control dynamics, these models also have restrictions. Dynamic modeling framework allows for the analysis of the SC behavior over time, the calculation of performance, and a resilient SC design that is suggested focused on a range of financial, customer, and organizational efficiency indicators, comprehensive and in real-time data, and control policies [29]. In addition to further data on optimization models, model simulations take significant logical and random limitations into accounts, such as discrete disruption, stock, manufacturing, supply, shipment control policies, and the gradual degradation and regeneration of capacity [30]. The simulation was primarily used in this class for problems. Simulation research has played an essential role in academic research since it covers time-dependent dimensions, the length of recovery measures, and storage degradation. The advantage of modeling is that it can be used to deal with multiplex optimization problem scenarios by changing the system situation over time.

**Data-driven models**

Data analysis implementations can be found in procurement, production floors, omnichannel promotional measures, route optimization, real-time traffic tracking, and strategic security management, observes T.-M. Choi et al. offer a big-data analytics study for logistics projectile prediction using RFID-powered manufacturing information. Used simulation, analyzes the impacts of sensor-powered data quality in an automatic SC. Places were identified by Nguyen et al. that in the coming years, data analysis could be found in SCs. These include production quality controls, complex truck routing, and in-transit supply chain management/transport material controls, and warehouse order selection and material monitoring systems. Broaden the discourse on the complexities of implementing Blockchain in SCs. SC study implementations can be categorized into four areas: a descriptive and analytical study, statistical modeling and recruiting management, real-time tracking, and adaptive learning. Data-driven strategies have recently been implemented into the research agenda as far as SC risk management is concerned. Information is provided by T. M. Choi & Lambert about how SC resiliency can be enhanced with the utilization of client repositories and comprehensive data sizes for risk analysis, threat evaluation, and improvement of SCs. It is suggested by Bierwirth & Corry that data collection at the strategy phase can be used to determine the vulnerability of suppliers to risk, and that can aid to track and predict disturbances at the responsive level.

**Decision support systems and various data-mechanized models**

As data study approach affects SCs and SCs are also affected by outage risks, interrelationships among information-mechanized technology and SC risk management are rational. During the last few years, the exchange and utilization of data sets for risk management have been introduced in technological frameworks because of harmonization, synchronization between data and information resources, and encourage fast discovery. For instance, Nandal et al. stated that it is an open e-infrastructure that facilitates information sharing, data development, silico research, and toxicology risk assessment modeling. For SC risk control, comparable programs are also uncommon. Repositories are featured by Gusikhin & Klampfl as a predictive risk-exposure model and a performance simulation.
tool in their contingency-analysis process. Procurement policymakers and risk analysts can use this support system to control risk management in near actual-time as stock rates wander and Supply Chain systems change. A visual analytical framework is formulated by Park et al. to improve and strengthen SC managers’ decision-making processes. In the literature review, information technologies can be categorized as simulation systems, countermeasures, and event-detection systems in real-time to manage SC disturbance risk. In SC recuperation preparation and the organized implementation of recovery policies, the collection and transmission of real-time information are critical.

The aim of monitoring systems (T&T) is to detect variations or hazards of variations in SCs, evaluate such deviations and provide real or possible interruptive warnings, and elaborate control measures to restore SC operability. Such programs provide the latest information on the implementation process in conjunction with RFID (radio-frequency identification) and mobile platforms. This program is focused on enrollment in the SC to improve visibility and performance. IBM and Wal-Mart are now studying how consumer SC monitoring can be strengthened using blockchain technologies. Supply on Industry 4.0 Sensor Clouds cloud-based analytics tool helps you monitor an SC through the latest information in real-time, schedule, and adapt processes. The ability to analyze the data allows the efficient market of all orders with longer lead times to allow for the rapid identification of doubtful transportation. Resilience 360 at DHL allows robust risk control of disturbance by visualization of the end-to-end SC, creating risk profiles, and detecting vital hotspots for prevention and alerting of events that may interrupt SC in near-real-time. Risk Methods tools assist aggressive SC Risk Control. The module ‘Risk Scanner,’ ‘Impact Analyzer,’ and ‘Action Manager’ comprises risk management, threat evaluation, and mitigation preparation, and -Devised a risk assessment tool, which incorporates asset systems, acquisition, logistics, and complex risk control of SC.

Deriving data principles- a decision support system powered for supply chain risk management

The literature study and functional illustrations help articulate numerous technical concepts of DSS info-driven and SC interruption risk management digital technologies. In order to take into account the SCs as Systems of Systems (SOS), as defined by T.-M. Choi et al., we are concerned with the derivation of such concepts to the Data Management postulate, i.e., System and Cybernetics, and buttressing the Supply Chain System-cybernetics framework Bierwirth & Corry.

The SC disruption risk research recurrently leads to ‘losing control,’ state Christopher & Peck. Thus, the concepts of cybernetics cannot be overlooked when contemplating the simulation of the possibility of SC damage. Cybernetics also provides an overview of the open network context. T. M. Choi defines three key data and risk control concepts.

The first is the requirement for variety. Variability is used to calculate the number of potential system conditions that can be separated from one another (Ashby’s Book “Introduction to Cybernetics,” n.d.). ‘A controller has requisite variety when he can maintain the outcomes of a process within targets, if and only if he can produce responses to all those disturbances that influence the process,’ according to Ashby’s law of requisite variety. Beer’s Viable System Model is the second. The third principle has to do with reactive planning and control, which is related to second-order cybernetics. The goal of second-order cybernetics is to influence and manipulate the world in which we live. Electronic data reports on adaptive and input management have a strong relationship with this theory.

**Principle 1: a balanced network model consisting of pre-disruption, disruption, and post-disruption process support for decision-making is considered**

Literature review notes that decision-making in SC risk management also refers to disruption profiles, which include phases of pre-disruption (preparation), intervention (response), and post-disaster (recovery and stabilization). Optimization and models for simulation allow for flexible SC architecture, stability testing, strain testing of different alternate SC models, and contingent recovery policy replication. These are only a few highlights of the other implementations possible. Therefore, this three-phase grouping should be used as the main context under which Automated SC Dual offers a decision support system.

**Principle 2: integrating digital sc models of physical and network data sources**

Decision-making support process data from tangible sources (for example, ERP, RFID, sensors) and cyber sources (example, Blockchain, manufacturer communication platforms, and risk data) can be applied to sup-
port models. Chronicled data about previous interference or geographical data concerning local risks could, for example, bolster in building actual SC resilience assessment scenarios. RFID and sensor data can contribute to the provision of simulation and optimization models with capacity and parametric stock ingredients for SC recovery simulations, considering the resources available in an unshakable system. The second concept of building a modern SC twin is combining physical and virtual data sources with SC modeling.

**Principle 3: converging the concepts of the supply chain as a physical and digital network**

SC models are wider and encompass both on-premises SC and its cyber system with data-powered DSS. Therefore, SC frameworks in terms of convergence between tangible and virtual platforms in terms of second-order cybernetics are called the third concept of automated dual-design.

**Principle 4: risk detection programs focused on the supply chain service data use to understand learning and disturbance patterns**

A new data analysis standard can be applied by the learning aspect of Automated SC Dual. Learning from actual stimuli and the associated SC activities provides a framework for defining intervention and response patterns that can be used to develop both quantitative analysis and experimental design. In summary of the above four concepts, SC risk analysis data structures in the form of Automated Duals may help judgment-making in the chronicled evidence-based SC resilience analysis, forecasting, and replication of alternative SC models and organizational contingency strategies, actual time recovery management, and the utilization of knowledge to understand learning and disturbance trends.

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**Results and discussion**

**Automated Dual Supply Chain Model: A Decision Support System**

**Data-driven model**

In expectation of disruptions and systemic-parametric adaptation in the event of disasters, data-driven disturbance modeling offers a foundation for a pragmatic, robust SC architecture. Modeling incorporates analysis, optimization, and data processing to build an Automated SC Dual and mitigate disruption risks.

In the Automated SC dual model, simulations of the dynamical behavior can be performed in model-based decision-making assistance in case of disruption. However, theoretically, impacts on SC efficiency can be assessed before a disaster happens, which would improve recovery policies. On a strategic point, data analysis is used to construct practical destructive models based on risk evidence on past disruptions and other evidence (such as ERP technology manufacturer reliability) during the SC design process. Data processing is employed in the responsive stage, leveraging data from process input, e.g., sensor, T&T, and RFID in real-time, for disruption detection. Incorporating data analytics in this form is to integrate data for disruption in a dynamic simulator for simulation and optimization of recovery policies. Data analytics can also build a strategic, evidence-based study framework to produce appropriate disruption possibilities for the design and preparation of robust SCs. The automated SC Dual’s data analytics component also empowers controlling and monitoring functionality to be incorporated into the management of SC disruptions by shutting the ‘plan-monitor-adjust-control’ chain shown in Figure 1.
Procedures

Historical risk statistics are gathered at the systematic risk analysis level from relevant datasets (e.g., historical natural hazard events and national risk assessments) and internal records (e.g., manufacturers’ reliability statistics ERP). This dataset is used in the simulation optimization to construct the destructive scenarios for the SC resilient study. Every logistics uses functional data preprocessing feature to pass incoming disturbance data in the simulation model to dangerous events. The network enhancement and stimulation parameters (e.g., usable capacity) are also defined under the conditions of potential unavailability of supply, loss of infrastructure, and natural hazard events. Using modeling and simulation methods to check the current and alternate SC designs and analyze the resulting various disturbance scenarios.

Next, an example of an outage similar to a truly catastrophic event, such as Typhoon Mangkhut’s long-distance shutdown in Hong Kong in September 2018; The risk management program is used to check for pertinent disruption data in the SC simulation model, e.g., in a regional logistics center, which may impact the potential for the facilities. The program then gathers data on the planned interruption time. The simulation is then conducted with the current SC architecture to track the effect on the performance of SCs of such an interruption length.

The recovery strategies, like the alternate SC models, can be used during the disruptive period for replication. In real-time, data obtained at the different sources are used to change model parameters, such as manufacturing and delivery storage capacity and inventory supply in the SC, for instance, size, invents, and cycle time. Such data are used for the retrieval policies simulation.

To assess the outputs of disturbances and impaired KPIs, the analysis of experiments using the recovery policies will be passed to an ERP program or a BI device. The data processing feature is used theoretically for moving the effects of modeling techniques to an external performance assessment method in any Logistics.

Finally, data analytics can be used at the strategic level to create appropriate disturbance possibilities for the robust SC architecture and preparation of the data-driven learning system. Decision-makers can use the system developed for asset risk evaluation, risk analyses for vendors, decisions on the position and transport, and risk control in land acquisition, distribution, and SC reporting.

Implication

Description, we relate by growing the awareness of the importance and use of data for analytical and corrective judgments by the researchers and decision-makers to the philosophy and application of SC disaster risk mitigation. The concepts developed and a simplified structure of Automated Dual SC led to modern SC and SC risk-based theory; the growth of commutable SC administration theory in particular.

Supply chain tolerance is as critical for businesses as adaptive processes are for living organisms. Mechanisms of adaptation track predict and respond to complex conditions continuously.

Similarly, companies are also subject to environmental and organizational factors changes and are influenced by them. The Digital Twin is a development framework for applying the concepts of cyber-physical convergence in production, logistics, and SCs. These frameworks also evolve by systemic adaptation and realignment, i.e., through systematic engineering. Due to the two axes, our thesis will find the theoretical ramifications for the research fields of modern SCs and risk analysis. The first aspect consists of the transition and management of current development and SC models. The SC’s focused on cyber-physical concepts are sponsored by our definition. Visibility is the second dimension. Big data and Blockchain technologies require central data management priorities to be tackled to improve accessibility, response times, and performance within the SC. Increased consciousness and recognition in the supply chains have also allowed for advancements in sensor technology and IoT.

Conclusion

There has been a noticeable pattern of work in integrating model-led and data-driven support for decision-making in recent years. The efficiency, completeness, fullness, relevance, accuracy, and prompt availability of model-based support for decision taking are heavily affected by evidence. These data criteria are especially important in the management of SC risk for forecasting and responding to disturbances. Industry 4.0 and emerging technologies, in general, contribute to solutions for data collection to gain a higher level of support and decision-making in the handling of significant disturbances. An Automated
Dual SC shapes the synthesis of modeling, optimization, and data analytics: a new computer-driven paradigm in SC risk management. An automated SC Dual is a prototype that shows the network situation for a given period and provides the full point-to-point SC visibility to optimize robustness and testing recovery plans. In the COVID-18 pandemic, when many companies were forced to change their supply-demand assignments rapidly, SC dual's need and importance became unquestioned. The experts expect SC’s growing position in post-pandemic recovery to be observable and evident. This research focuses on developing a standardized structure for managing disruptive risks of an Automated SC dual, i.e., a DSS for data-based modeling of constructive robust SCs and reactive risk management in real-time. By enhances knowledge by policymakers of the importance and the use of risk data from a company's own and that of its collaborators for analytical and reactive decision-making, we add to both the philosophy and application of decision-making help in SC disruptive risk management.

System-cybernetic modeling was used to establish the scientific concepts of data-enabled DSS and the IT for SC disorders risk administration. Future DSS will use data-driven technology to form the support and learning structure for SC risk analysis in SC disruption risk management and be unified by three fundamental concepts of system cyber science. Simulation of the risks associated with the SC design process and pre-disruption mode, evaluating the risks associated with supplier disruptions, estimation of possible supply disruptions, and measurement of configurations and contingency routes in the alternate supply network evaluation of approximate arrival times will all be possible with the framework. In dynamic mode, the device can model disruptive effects for SC and alternate SC architectures, including non-disrupted arcs and network nodes based on the inventory, demand, and power data of real-time usage. The effects of the SC can be reported and quantified to ERP programs using KPIs, such as revenue, income, production on schedule, etc. By leveraging the advantages of SC demonstrated, historic data analysis, and in-time disruption data to ensure market continuity for global businesses, as well as the broad-based nature of the Automated SC dual, this study would theoretically deepen research into constructive and recitative resilience approaches and contingency planning. The findings presented will also direct an organization to manage data correctly for model-based support for decision making. Ignoring exact details about the likelihood of provider and path disruption, advanced channel estimation, and real-time disruption detection could lead to deceptive SC architecture mitigation intrusion scenarios and the late implementation of the reorganization plan. Instances of SC and risk analytics activities entail logistics and SC monitoring using real-time data, stock tracking and management using sensor data, automated distribution of resources, the development of big data processing prediction model, SC visibility and risk analysis, network optimizing predictive analysis knowledge, and combination of optimization and computer simulation algorithms. In addition to optimization and simulation modeling, data analysis would become increasingly important in SC disturbance risk management.

Limitations
There are some constraints on our research. First, there remained beyond the framework of this paper to address the technological demands of data processing power. Secondly, the thorough technological review for the extraction of disturbance results, e.g., machine learning techniques, will make the paper more extensive. A variety of potential research avenues for expanding these technologies can be established using data-driven approaches concerning SC risk management technologies. The scope of this report may be expanded by a detailed, technological review of the innovations suggested and how they can be implemented. SC digitalization's growth and reach is a phenomenon in which the SC risk management performance becomes largely dependent on SC risk assessment. The design and implementation of numerous cloud systems for manufacturing and logistics, both performance and resiliency perspectives, are promising research directions; Finally, awareness of organizational transformations in modern decision-making contexts with an increasing role of artificial intelligence technology forms a core research area for the philosophy of the emerging new field of the digital SC.

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