Theoretical Framework of Supply Chain Uncertainties

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Article Info
Journal of Journal of Enterprise and Business Intelligence (http://anapub.co.ke/journals/jebi/jebi.html)
Doi: https://doi.org/10.53759/5181/JEBI202202016
Received 05 January 2022; Revised form 22 March 2022; Accepted 20 April 2022.
Available online 05 July 2022.

Abstract – The increasing complexity of multinational supply networks has generated a new issue (supply chain uncertainty) for today's managers. This article surveys the existing literature on the topic of supply chain uncertainty and establishes the theoretical framework for future study in this area (in addition to supply chain risk). This literature study identifies fourteen potential causes of uncertainty, including both well-studied phenomena like the bullwhip effect and less well-known ones like parallel interaction. Ten solutions try to eliminate the core source of uncertainty, while eleven others aim to adapt to the existence of these unknowns in order to reduce their effects on manufacturing performance. The theory of manufacturing strategy and core concept of contingency and alignment establish a foundation of the supply chain uncertainty framework that is thus establishment using the research findings. More future empirical study is required to discover which uncertainty exists in distinct industrial settings, the effect of suitable sources and management strategies on productivity, and the intricate interaction between management techniques and diverse uncertainty sources.

Keywords – Supply chain, Supply chain management, Supply chain uncertainty, Supply chain risk

I. INTRODUCTION

The term "Supply Chain Management" (SCM) refers to the process of planning and executing the movement of materials, data, and cash from the point where a product or service is needed to its ultimate destination. Although logistics is a vital part of the supply chain, it is by no means the only part. Modern digital SCM processes include material movement and technology for the parties involved in the service and product production, information tracking, and order fulfilment. Every participant from the manufacturers to retailers is covered, from raw materials to finished goods to logistical services. Purchasing, production planning, procurement (which includes inventory control and management of business assets and production lines), transportation (which includes transit and fleet governance), and order processing are all components of the supply chain. SCM may also refer to the operations involved in international trade, such as international product development and procurement coordination.

The idea of supply chain uncertainty has been extensively defined and operationally defined throughout the years, and the history of the link between uncertainties and SCM is not a new one. Several authors (e.g., [1]) in operational management and sustainable supply chain have created models where business or uncertainty plays a significant role in determining the results. For example, supply chain integration has been proven to increase delivery performance, but this gain has been shown to be offset by demand volatility. Sharma and Lote [2] discovered a link between demand volatility, a company's supply chain location, and environmental legislation. Moreover, it was shown that corporate uncertainty in the form of sector benevolence elevated the risk inclination to engage in reverse supply chain operations. Distribution network complexity and risk have also been described in terms of uncertainty. Uncertainty was first conceptualized as the "dynamic" element of supply chain complexity by Inman and Green [3], who then showed a negative and substantial relationship between uncertainty and performance of manufacturing firms.

Supply chain uncertainty is a difficulty that every company faces because of the increasing complexities of global production networks, which leads to issues including increased late deliveries and quality issues. As per Cohen [4] such uncertainty was thought to be a serious worry and a necessary knowledge of complex networks. There has been a lot of study in the years since on the supply chain uncertainty source, e.g., internalized manufacturing procedures, demand-side challenges, and supply-side procedures, but there are other uncertainties that arise that have not been given enough consideration. A similar problem, supply chain risk, has recently gained a lot of attention. Poor risk-management methods, according to authors in [5], may have a catastrophic impact on a company's bottom line; for example, Forbes [6] explain the financial losses incurred by industry giants such as insurance firms as a result of inadequate risk-management. Given the

rapid appearance of new risks in today's global, information-technology-driven industry, it's evident that enhancing our ability to analyze and manage uncertainty and risk is a never-ending endeavor.

Before studying supply chain uncertainty, the word must be defined. Given their frequent practical interchangeability, differentiating between the two expressions is very important. Some experts in the field draw a firm line between danger and uncertainty, while others argue that it's not even worth the time to try. When individuals disagree, one typical point of contention is the potential consequences. Concerns about the future have the potential for both positive and negative consequences, yet some authors e.g., Suryawanshi and Dutta [7] do not consider them to constitute dangers. The only thing a natural disaster can do is disrupt the supply chain, albeit customer demand may be greater or lower than expected. As a result, one may argue that the phrase "supply chain uncertainty" is more inclusive, since it can be used to express issues that have hitherto been considered solely in terms of risk. Therefore, the phrase "supply chain uncertainty" is used here to refer to a wide range of problems that might arise at any point in a global supply chain.

Here, Shaar, Khattab, Alkaied, and Al-Abbadi [8] present a more comprehensive and detailed explanation of supply chain uncertainty: “Uncertain goals; insufficient knowledge of the supply chain or its environments; inadequate data processing capabilities; inability to effectively estimate the influence of probable control measures on supply chain behavior; or a lack of effective control actions are all examples of supply chain decision-making contexts where uncertainty reigns”. To determine the present status of research and future research, it is important to conduct a literature review, encompassing the key characteristics of both the uncertainty and risk literatures, after concluding that both are fundamental to research of supply chain uncertainties. The majority of existing evaluations are either broad in scope, as Atkins, Sener, Drake, and Marley [9] analysis of Supply chain Management, or narrowly focused, discussing just one particular aspect of SCM, such performance metrics or supply chain adaptability. Though a review of quantitative modeling methods has been conducted in the face of uncertainty recently, no work has yet been published those surveys the whole range of strategies for dealing with unpredictability in the supply chain as a whole.

While research on supply chain risk does exist, it contributes nothing to the existing body of uncertainty literature or the most current findings in either discipline. There has been no effort to advance theory in this area by recognizing the many uncertainty sources and the potential connections to management strategies for enhancing supply chain performance. Kinet [11], nonetheless, has purposed to present the ideology of the SCM scheme, supply chain risk, or specific types of uncertainty, such as demand and supply uncertainty. This study aims to help fill that void by offering both a literature assessment (in which gaps in the research are noted) and a theoretical framework for further research into the effects of uncertainty on supply networks. The remaining sections of this work are laid out as follows. Section II presents an analysis of literature review and classification employed for this research. Section III focusses on defining the sources of uncertainty in the supply chain. Section IV discusses the supply chain uncertainty management approaches, while Section V presents a theoretical framework, which are applicable for futuristic research. The last Section VI present final remarks about the whole research work.

II. LITERATURE REVIEW

The supply chain's equilibrium and profitability may fluctuate as a consequence of foreseen and unanticipated events, needing a response to restore stability. An unanticipated order, a late delivery by a supplier, or the breakdown of a critical piece of manufacturing equipment are all instances of occurrences. The phrase "supply chain risk" refers to the possible threats to your inventory caused by interruptions in the supply of components or raw materials. External causes of environmental dangers, such as economic, social, governmental, climatic, and even terrorist activities.

This literature research mainly searched the management and business segments of: EBSCO, ProQuest, as well as Academic search, using the terms "supply chain uncertainty" and "supply chain risk." Because the word "supply chain uncertainty" appears in multiple mathematical modeling articles as well as empirical and conceptual researches, its use alone identifies almost 20,000 works. There has been little in-depth evaluation of mathematical modeling studies since they have lately been assessed and tend to concentrate of a minimal number of uncertainties. Instead, this article examines theory and data-driven research. Many of the featured articles deal with issues of uncertainty and risk in the supply chain, but this investigation attempts to be all-encompassing in its analysis of the causes of uncertainty, the methods used to mitigate it, and the results it has produced so far.

The research may be broken down into two groups: those that explain the origins of uncertainty, and those that provide ways to cope with it. Techniques for dealing with uncertainty can be found in many of the same literary sources that pinpoint the origins of doubt, but they can also be discovered in more argumentative works that center on specific management procedures, such as supply chain cooperation. We present a wide classification of techniques to handling uncertainty in this study:

a) Reducing uncertainty strategies: any theory of managing uncertainty that helps businesses cut down on it where it starts. An effective price plan or incentive, for instance, may help stabilize consumer demand.
b) Coping with uncertainty strategies: a plan of action that does not aim to affect or modify the cause of uncertainty. Rather, it seeks for mechanisms for adaptation in order to lessen the effect of uncertainty. For instance, businesses may use more sophisticated methods of demand forecasting in order to better anticipate client needs and cut down on forecasting mistakes. In this situation, the uncertainty in demand remains the same, but because to improved forecasting outcomes, businesses can prepare for any shifts in consumer demand.

Mitigation concept associated with coping with uncertainty; it refers to anything that may reduce the negative implications of supply chain operations. In the context of ecological disturbance, the idea of mitigation is examined extensively in the research on risk assessment. We will refer to risk mitigation methods as coping with uncertainty strategies for the sake of this research since we feel they share a similar perspective. The literature is broken down into two broad groups: those concerned with theory and those concerned with practice. It is considered in the literatures that a complete inventory of possible supply chain uncertainty stimulators is essential before designing effective management strategies.

With our expanding understanding of the factors that contribute to supply chain uncertainty, we are able to classify those factors into 14 distinct groups (described in Section III), most of which are indicated as multi-factor. It is also important to consider the potential effects (both good and negative) of reducing uncertainty from one source on another. Similarly, there might be a variety of ways to cope with a given degree of uncertainty. Therefore, a thorough inventory of management processes is necessary prior to attempting to examine how approaches and origins of uncertainty are connected in the literature. There are ten techniques for relief and eleven strategies for adaption that have been discovered via study. The next sections expand on the information offered in the subsections "Uncertainty Origins" and "Uncertainty Management Techniques."

III. SOURCES OF UNCERTAINTY

Various models that have evolved through time and increased in complexity have been used to identify and present sources of uncertainty in the literature. Contingency theory begins with uncertainty and contends that an organization's effectiveness is determined by how well its structure, processes, and environment are matched. Customers, suppliers, competitors, and regulating agencies are all examples of task environment components that play a part in attaining the organization's objectives. Because of its heterogeneity, it must interact with a broad range of diverse components, all of which live in their own specialized ecosystems.

Physical perceptions, manifestations, social expectations, and behavioral response repertoire, are the four sources of uncertainty outlined by Kwong et al. [1]. Thus, they define uncertainty as a phenomenon that exists at several levels, including the psychological, social, functional, and organizational. Technical and organizational rationality are physical expressions of the mental. Managerial rationality encompasses the inputs received by the key technologies and the use of its outputs, whereas technical justification refers to the activity's technological underpinnings. Environmental metrics are external influences in the context of technology that may impact the system's basis. They may be dealt with as limits and addressed in this manner. However, the efficacy of the artificial heart may be jeopardized by unexpected changes in the surrounding environment. These sorts of partnerships are unavoidable due to the complicated nature of the flow of goods and information through supply chains, which necessitates coordination across several organizations. The complexity of a supply chain is determined by its size and the extent to which its various components interact with one another.

Due to its reliance on the limited resources supplied by other supply chain participants whose interests differ from its own, a given member generates a risk for the others. Depending on how they see the issue, other elements of the supply chain may opt to make changes out of goodwill or self-interest. As a consequence of the interdependence of all parties involved, the physical manifestations of supply chain instability are heightened.

Decision-makers' perceptions of uncertainty's physical manifestations are impacted by how they organize and interpret information to give meaning to what they perceive. Since the cosmos lacks inherent meaning and human beings have limited data processing capacities, interpretation is a selective, interpretative process; "man cannot engage directly with his surroundings; instead of interacting with it, he should map it." In order to create manageable mappings in a dynamic and complicated setting, a high level of abstraction is required. Decision makers are more likely to encounter uncertainty as a result of inaccurate information and untestable cognitive maps resulting from inadequate mapping. Those who have a greater ambiguity tolerance may see less uncertainty in the world around them.

First, we will discuss the simplest concepts that have been offered in the literature, and then we will go on to the more complex ones. We'll highlight any unique sources of uncertainty that each model accounts for as we go through them. To begin, Elango, Prakash, and Umasankar [12] was among the first to identify three uncertainty sources: demand, supply and manufacturing. According to this concept, the uncertainty in the production process determines the timeliness with which orders may be completed. Wen, Qin, and Kang [13] suggested that the most important sort of uncertainty is demand uncertainty, which may be caused by either unforeseen demand or erroneous forecasts. We disentangle demand uncertainty into two distinct components—final-user demand and demand amplification—in this evaluation to present four uncertainty sources in the antebellum literature.

Control uncertainty, or a company's ability to use flow of information and actions to translate customers' orders into a production schedule and raw material prerequisites, is the fifth source of uncertainties in Januardi and Widodo's [14] uncertainty circle model, which builds on Aladejare and Wang's [15] earlier work to identify these sources. The model forecasts savings when production uncertainty is reduced; this uncertainty may come from any of four sources: the demand side (including both final customer demand and requirement augmentation), the supplier side, the production process, or the control systems. This highlights the significance of a streamlined supply chain that has been found to lessen potential for disaster. The supply chain uncertainty circle may be simpler and easier to understand than Aitken, Childerhouse, Deakins, and Towill's [16] approach. Firstly, it is detailed since the fifth component is integrated (controls). Secondly, subsequent works that potentially leverage this framework has provided its theoretical importance in retrieving high coherence and

performance across the supply chains. This is because the model is used to determine how well a company's supply chain is integrated.

Wilding's [17] "supply chain complexity triangle" adds a sixth major uncertainty factor to the mix, dubbed "parallel interaction." This relates to the complexity that arises as a consequence of the many ways in which a consumer may interact with several suppliers. If a customer's first-tier supplier is unable to fulfill an order for any reason, the client will need to speak with and maybe revise orders with any remaining first-tier distributors. Uncertainty among suppliers and decreased supply chain efficiency are the results of this disruption. We have already established that the three main vertices of Neiger and Pernet's [18] complexity triangle are deterministic chaos, parallel interaction and amplification. Amplification is caused by the bullwhip effect, according to models, but deterministic chaos may be detected in control systems such as IS networks.

Rajagopal et al's [19] framework is a foundational basis of the complexity framework; they updated recently it and included previous work to create a significant micro and macro framework. Binder [20] not only revealed 4 macro uncertainties, but he also unearthed 8 micro uncertainties by extra study. The term "micro-level uncertainty" is used to describe a narrower source of uncertainty which calls for more targeted responses, whereas the term "macro-level uncertainty" describes a more general kind of uncertainty. For instance, the bullwhip effect and its comparable micro-level influence may be broken down from unanticipated uncertainty at the macro scale. A seventh cause of uncertainty, selection complexity, is introduced by the existence of several objectives with ambiguity about the relative significance of every goal, in addition to the presence of various limitations, some of which could be disregarded.

Tian and Guo [21] who studied the relationship between uncertainties and reconfiguration of supply chains in the food industry. Liao, Zhou, and Wang [22] who established the framework to explicate uncertainties in the transnational fashion supply chain delivering new items, and Nguyen and Schinckus [23] who differentiated between quantity uncertainty and mix specification uncertainty are all examples of dependent models. These models aid in identifying new sources of uncertainty. Vali-Siar, Roghanian, and Jabbarzadeh [24], in particular, explain four additional risks deriving from chain design, facilities and infrastructure; information systems/information technology (IS/IT) complexity; human behavior; and order prediction horizon. More crucially, each of the twelve sources of uncertainty revealed in these three studies is related with a distinct feature of the items themselves.

Moore, Ruffle, McQueen, Thakali, and Edwards [25] created an integrated risk management framework within the area of risk models to account for the difficulties of cross-border business. The framework posits that the external environment, the industry, and the firm itself are the three primary sources of uncertainty. Liu, Jaramillo, and Vincenzi [26] refined this strategy after statistically analyzing the uncertainty factors. Le, Nguyen, Do, and Ngo [27] developed a risk management approach that categorizes possible causes of damage into three major classes: network-related (demand and supply), external, and internal (control and process).

According to the aforementioned research, IT poses no hazard. According to Ganbold, Rose, Rose, and Rotaru [28], as the complexity and reliance on IT rises, although IT may assist solve some concerns, it might paradoxically make supply chains more susceptible. Akashi and Tong [29], for example, address IT vulnerability; and stresses IT (system and technology) risk as one of the five reasons of operational risk. The other four are the people within and outside the company, internal procedures and rules, and external events. The majority of the risks mentioned here have been flagged as potential unknowns in earlier models. By illuminating the causes of the uncertainties and risks at hand, these investigations contribute the most to our knowledge. Only two more sources are discovered in addition to the twelve already identified. As a result, this article includes competitive uncertainties as a component of the twelfth source: environmental uncertainties (political, macroeconomic, social and government policy). The fourteenth category comprises uncertainty created by natural catastrophes and other calamities.

We can identify 14 distinct categories of uncertainty using the aforementioned models, which are presented in **Fig. 1**. The 14 categories could be grouped into three categories:

a) Uncertainties from the focus industry, i.e., internal corporate uncertainties and integrate: IS/IT complexity, behavioral/organizational challenges, decision complexities, chaos/control, manufacturing processes, and product characteristics.
b) Internal supply chain uncertainties, which originate from the controls of the focus industry or its partners within the supply chain and integrate: chain configuration, facilities and infrastructure, order forecast horizon, parallel integration, supplier, demand amplification, and end-customer demands.
c) Environmental factors, such as government legislation, competitor behavior, and macroeconomic concerns, and disasters factors, such as earthquakes, hurricanes, and high seas, are all examples of external uncertainties, which originate from external supply chains and are thus beyond the firms' control.

Many causes of uncertainty have several dimensions, as was mentioned in this section above. Uncertainty regarding product attributes may pertain to questions about the item's specifications, packaging, shelf life, perishability, or range, while supply-related questions could center on concerns about delivery times, quality control, or stock levels.

Fig 1. Fourteen categories of uncertainty

Research gaps

Despite the fact that all of the uncertainty source has been defined in recent literatures, we stress that further effort is needed to evaluate them using additional empirical data, particularly if an element is only cited in fewer publications. It is important to verify whether or not each element has a substantial role in the development of uncertainty across different industries. In addition, no one study has incorporated all 14 sources; studies are needed to investigate the interplay between these source materials and the way they are likely to be integrated in reality in certain settings.

IT is a growing source that adds to the development of supply chain unpredictability, particularly dependence on the Internet, as we've stated above, thus further study is required on this topic. The increasing importance of information technology in every industry is a conundrum, since this sector's rapid development both reduces the prevalence of some supply chain issues and makes other vulnerabilities more likely. Despite the increasing literature body purposing to comprehend the influence of the Internet and IT on supplier relationships, Yang, Liu, and Jia [30] argue that much more study is needed in this area.

IV. SUPPLY CHAIN UNCERTAINTY MANAGEMENT APPROACHES

After cataloguing the many causes of unpredictability, this article will focus on doing the same for the various methods of dealing with it. In Section III, we saw how to categorize various methods into those aimed at either decreasing or managing with uncertainty. There are ten of the formerly mentioned in this section, as well as 11 coping approaches. In this section, we also discuss the knowledge gaps that exist in regards to the management approaches themselves.

Reducing Uncertainty Approaches

Complex quality controls, re-organizing the supply chains, and innovative designs of products were the three approaches Zhao, Yang, Xing, Chuang, and Schüler [31] advised to begin mitigating uncertainty. Concerns about the process can be addressed by the first two methods, while those about future demand and supply may be addressed by the third (see **Fig. 2**). It is vital to take into account the supply chain's configuration (its structure, amenities, and personnel), control (its decision

capabilities that supervise performance of operational operations and strategic goals), systems engineering, and structure and accountability when you rebuild it (its authorities and responsibilities). In addition to modifying the structure and/or design of the supply chain, and proposed two more methods for reducing risk. It has been suggested by Lai, Wang, and Chiu [32] and others that fostering collaboration among large suppliers and customers assists in removing obstacles across supply chain phases, which might also minimize uncertainty related to the complexities of decisions undertaken within the network.

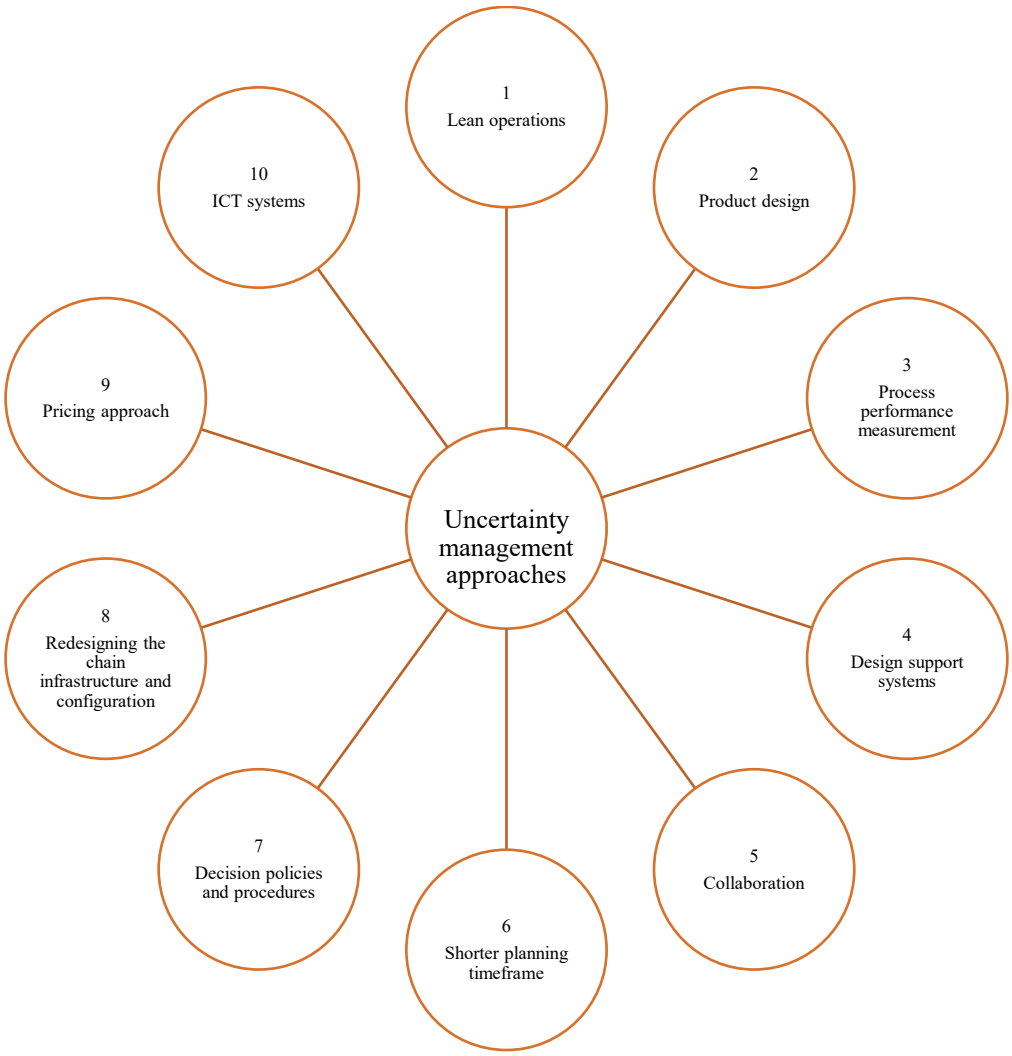

Fig 2. Ten Uncertainty management approaches

The second is that limiting human participation may aid in lowering the uncertainty induced by human behavior. Bureaucratic decision-making processes and procedures might be simplified or automated to accomplish this. A number of Oyedijo, Francois Koukpaki, Kusi-Sarpong, Alfarsi, and Yang [33] have built on the concept of cooperation/collaboration by claiming that if all actors in the supply chain are closely coupled and "work as one," fewer difficulties with the process, supply, demand, and control of a product may be anticipated. The next step in an integration plan is to integrate management information systems upstream to distributors and downstream to consumers, once operational and institutional integration have been completed. Delli Gatti and Grugni [34] laid out the "well-trodden road" to creating a streamlined supply chain, which involves reducing uncertainty across all four links in the chain (control, process, supply, or demand). This requires synchronizing flow of materials throughout the supply chain and using lean techniques for waste reduction. Valera, Feliu, and Lansberg's [35] analysis of American and European businesses demonstrates that integrated supply chains may be successful. However, their research is too general and doesn't account for the specifics of any one company, and lean (or effective) procedures are more often linked with the manufacture of conventional items than with the provision of the individualized services provided by a flexible supply chain.

Companies often rely on information and communication technology (ICT) to achieve efficient data sharing that is a critical element of any collaboration approach, regardless of whether the supply chain in issue is lean or agile. These ICT solutions, when integrated with an appropriate DSS, have the ability to minimize control uncertainty by developing both the quality and process of making decisions. Unfortunately, control uncertainty may increase if the information-sharing process is poorly managed, resulting in, for example, erroneous data that impedes decision-making. Several methods were offered

for mitigating the dangers presented by ICT complexity; they included regular staff education and awareness programs; assessment and evaluation cycles; tracking cycles; recovery and backup cycles; and safeguards for all sensitive data assets. Marketing incentives and price strategies are two more methods for coping with demand unpredictability. Reducing the bullwhip effect may be accomplished via a variety of means, the most well-known of which are price adjustments and planned marketing efforts.

Last but not least, Palkina [36] advocated for "responsive stock renewal," in which the forecasting time is less than the time horizon, to mitigate the dangers inherent in the sale of novel goods, which often have a brief product lifespan and a broad range of components. According to food industry studies, one business was able to fulfill consumer demand and unload surplus inventory as items reached the end of their usable life span by using a stock refilling cycle, which was less compared to the minimal product life cycle of six months. Lean management, product development, procedure performance monitoring, decision support systems (DSS), cooperation, reduced time management skills, decision strategy and procedures, information and communication technology (ICT) system, pricing policy, and infrastructure/configuration redesign are all examples of such methods.

Uncertainty Coping Approaches

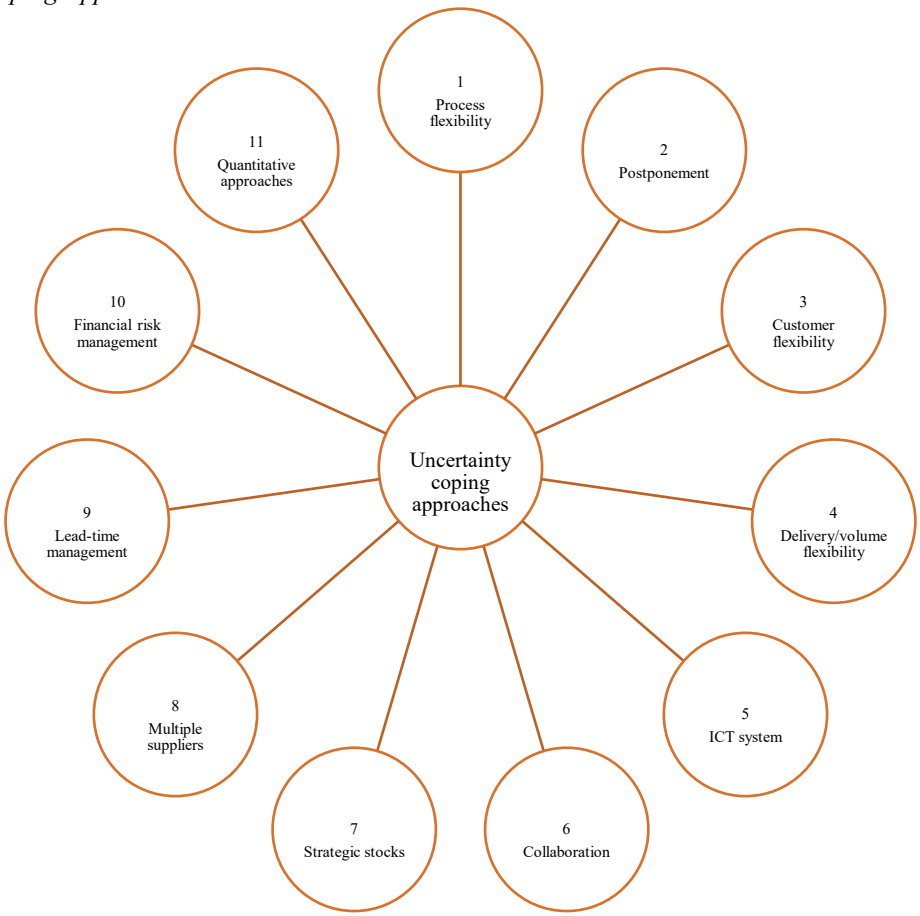

Fig 3. Eleven Uncertainty coping approaches

According to Sufyati, Suganda, Shafenti, and Fahlevi [37], process flexibility of the supply chain is one method for coping with uncertainty (see **Fig. 3**). For example, Richardson and Patton [38] employed the concept of transformational systems to give a flexible framework for change (inputs, processes, and outputs). Working with a number of vendors allows a firm to expand its input flexibility. The expense of managing numerous suppliers is often higher, and there is an increased possibility of supply risk, including quality difficulties or delivery dependability, when acquiring vital commodities. As a consequence, striking a balance is critical. Using labor and machine flexibility, it is possible to manage equipment, human, and infrastructural unpredictability throughout the process stage. When customers are less price- or time-sensitive, output stage customer flexibility is used.

Additional methods for dealing with demand uncertainty include postponement, information sharing, the use of strategic buffer stocks, the assistance of ICT systems, and lead-time management. The latter involves promising retailers a delivery lead time that is longer compared to the real lead duration, providing an opportunity for the manufacturer to accommodate sudden shifts in orders due to unpredictability in end consumer demand, but is obviously inappropriate in situations where

speed to market is not a competitive requirement. In the research on risk management, monetary solutions like insurance are often mentioned as ways to lessen the impact of interruptions like natural catastrophes on supply chain activity.

Finally, the most recent paper by Tuni, Rentizelas, and Duffy [39] evaluates and categorizes quantitative methods for supply chain management under uncertainty, adding to the large body of research on managing uncertainty using advanced quantitative methodologies. Unfortunately, we will not be able to provide more information on the quantitative framework subcategory of our research at this time; nonetheless, the reader is directed to the following works as representative samples of the extensive literature in this field: [40] and [41].

Research Gaps

Developing more scenario-based research in supply chain uncertainty management is an important topic for future research. As an example, the lean technique employed in previous supply chain integration researches in order to establish a supply chain that is seamless is unliked to be applied to the various contexts since it limits the system's flexibility in the face of shocks. Kara and Edinsel [42] both survey a large number of organizations, but the former concentrates on the automotive industry, whilst the latter takes a more generic approach, thinking that the technique will be relevant in a broad range of situations. Furthermore, whenever product life cycles are shorter, the issue of coordinating among the expanding number of global supply chain partners becomes even more critical.

Another area of interest is research on the feasibility of management approaches, particularly when these tactics come at a cost. For example, some authors in [43] claim that flexible abilities might provide a competitive edge when rivals are not able to handle uncertainty, but Halac [44] suggests that such flexibility is costly. More research on "ideal" adaptive systems that do not make excessive efficiency sacrifices is required. Think about how different management strategies could affect various potential causes of uncertainties, and then provide evidence to support your claims. As can be shown below, deeper exploration of this topic requires laying a theoretical groundwork for future study.

V. THEORETICAL FRAMEWORK FOR FUTURE RESEARCH

In this part, we provide a theoretical framework for appreciating supply chain uncertainty in light of industrial strategy theory, a field of study that draws on the disciplines of contingency and alignments hypothesis (as will be shown later). Therefore, we first provide an explanation for why this theoretical model is necessary, then sketch it out, and last populate it with data from the aforementioned resources. The manner a firm decides to cope with environmental unpredictability, according to the literature on industrial strategy, is a critical aspect in determining its overall degree of success. The theory's assumption is that the manufacturing strategy chosen by a business from a set of strategic possibilities greatly influences its performance, which in turn is highly impacted by the external environment in which the organization works. The hypothesis of the production approach has been employed in different literature works regarding supply chains; for instance; Ofori, Zhang, and Ling [45] utilized it to define the implications of the environment on the productivity of producers in Singapore, they used its constructs to check supply chain functionality, and they adapted it to create a distribution network transformation framework using factors of uncertainty and flexibility. This is thought to have ramifications for supply chain management in general.

Manufacturing strategy theory, according to some scholars, is comparable to contingency theory and may be regarded of as a model based on the latter. The optimum management approach for a particular circumstance, according to the contingency theory, is dependent on a variety of 'contingency' aspects, such as the degree of environmental unpredictability. Although Raymond and Bergeron [46] do not explicitly address it, the concept of "alignment" is crucial in the philosophy of industrial strategy. The core thesis of Steinbach, Holcomb, Holmes Jr, Devers, and Cannella's [47] alignment theory is that an organization's strategic choices should be matched with environmental demands. The improved efficiency of the business is due to this coordination. The "congruence" between (1) sources of uncertainty and management impressions of them and (2) the selection of uncertainty strategic plan is said to have a significant impact on organizational productivity in the setting of supply chain uncertainty. Chakraborty, Vashishth, Lyambo, and Mutingi's [48] study suggests that improving perceived performance may be achieved by coordinating the four archetypal management techniques of efficiency, responsiveness, risk mitigation, and agility with the unpredictability of demand and supply.

Fig. 4 presents an argument for extending industrial strategy theory in order to offer a robust theory in order to stimulate futuristic research in supply chain uncertainty, which integrate a wide-range sources of uncertainties compared to those examined by. The word "environmental uncertainty" has been enlarged from the industrial strategy theory to embrace all types of unpredictability on the left side of the figure. It should be noted that the sources specified in Section III might be either external or Internal to supply chains. Resultantly, in **Fig. 4**, the terminology "environment" is employed widely to refer to any conditions that may impact the management approach chosen for the center box. Second, the content variables required to operationalize the ideology of supply chain uncertainty management approaches were identified by the above-mentioned literature review. **Fig. 4** contains a process variable that indicates how strategic judgements are executed in a business setting, which is beyond the aspect of this study but is integrated for completeness. Readers interested in learning more about this topic might consult the works of DuHadway, Carnovale, and Hazen [49], two recent studies that look at the methodologies used to detect supply chain hazards and assess these risks in practice.

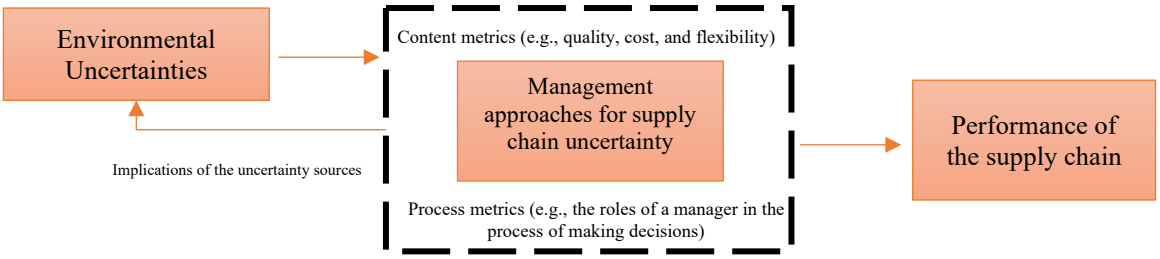

Fig 4. Contingency theory-based framework of uncertainties in the supply chain

In **Fig. 4**, we see a feedback loop between various tactics for dealing with uncertainty and the many factors that contribute to it. The idea behind the feedback loop is that addressing one source of uncertainty might have unintended effects on other sources of uncertainty and on the item of uncertainty that was first addressed. Deploying an ERP, for example, might enhance manufacturing planning and minimize the control uncertainties, but if you rely too much on this computerized system, you risk encountering problems like process delays as a result of system crashes.

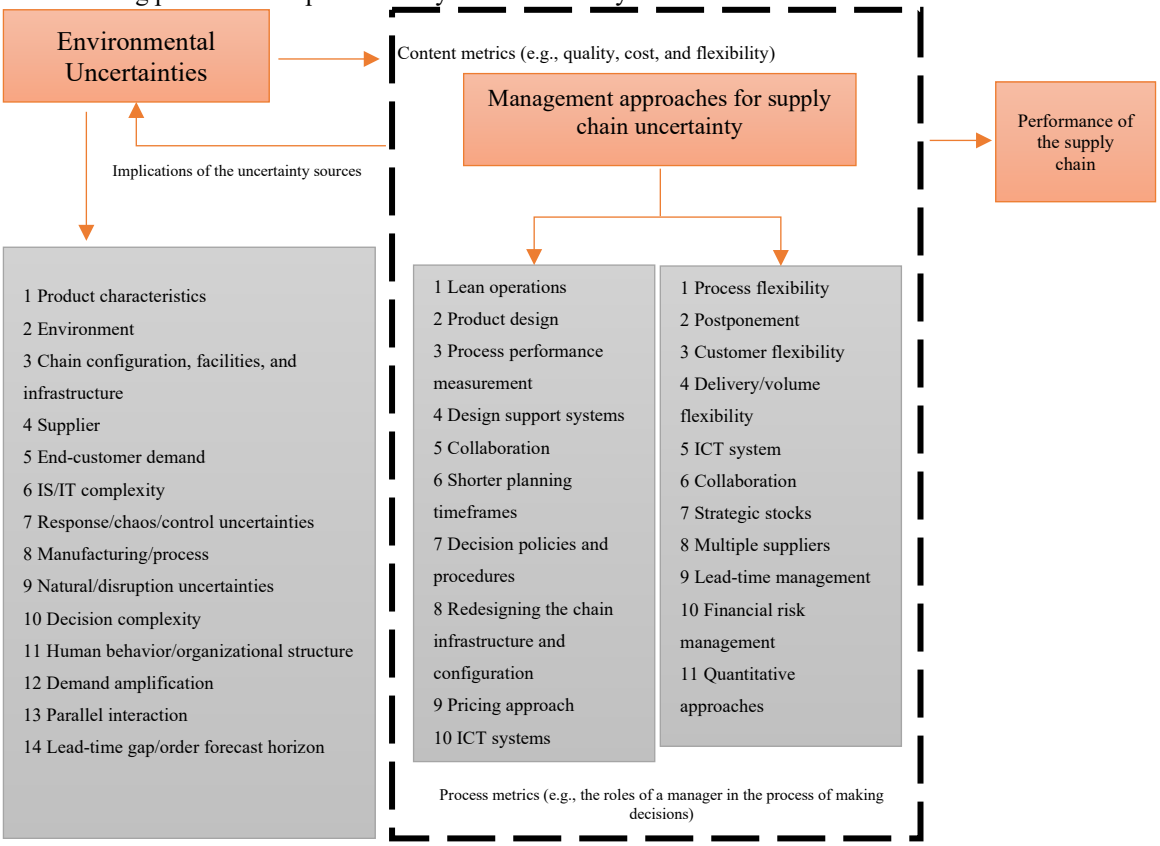

Fig 5. Contingency theory-based framework of uncertainties in the supply chain

Fig. 5 shows how the conceptual framework given in **Fig. 4** may be completed using the 14 recognized uncertainty sources found in the literature review. Nevertheless, the publications on assessing the impact of managerial techniques on performance should be taken into consideration before describing which of the uncertainty methodologies/approaches have indeed been coordinated to every particular uncertainty source in the literary works, thus populating the conceptual framework. Derdar et al. [50] advocate implementing a performance monitoring system to verify that alignment and coordination are regularly maintained. According to Soraya, Warda, Fitrianti, Sulistiyanti, and Adiningrat [51], assessing performance is critical for establishing whether or not a strategy for increasing productivity is likely to be effective.

Numerous academic publications have addressed the subject of how to interpret and assess the success of supply chain techniques. In these experiments, many ways of assessing performance were utilized. Authors in [52] categorize metrics as output, resource, and flexibility; Bouchard, D'Amours, Rönnqvist, Azouzi, and Gunn [53] categorize metrics as strategic, tactical, and operational; Brimelow, Amalathas, Beattie, Byrne, and Dissanayaka [54] advocate the use of a balanced scorecard; and Kitchin, Brown, and Kulkarni [55] propose four different metrics: predictive/operational, outcome/operational, predictive/financial, and outcome/financial. Irrespective of the divergences, the performance indicators may be divided into two general categories: financial indicators (such as transportation costs, inventory costs, production

costs, sales revenue, and raw material costs) and non-financial indicators (such as quality, resource utilization, and inventory levels).

Previous studies on supply chain uncertainty have mostly offered broad reasons for why and how uncertainty control techniques impact productivity. For instance, Zilberfarb [56] argues that better financial results may be achieved by eliminating uncertainty in four areas: process, supply, demand and control (e.g., on the basis of cost reduction). Here, the coordinated control of many uncertainty sources simultaneously affects a single performance measure. Even though they don't provide any measurements, Roushangar, Ghasempour, and Alizadeh [57] are only one of many other research that offer an uncertainty management technique to boost supply chain efficiency. It is difficult to utilize past research works to pinpoint the precise performance increases that have been realistically projected since certain performance indicators are not well-known. In actuality, the complexity of the factors involved makes it difficult to pinpoint how a certain technique would affect any one performance measure. However, it is critical for managers working in the field to have a deeper understanding of how tactics affect an organization's ability to compete.

VI. CONCLUSION

In this paper, a review of the previous works based on management and business databases of EBSCO, ProQuest, and Academic search, using the phrases "supply chain uncertainty" and "supply chain risk." Because the term "supply chain uncertainty" occurs in several mathematical modeling publications as well as empirical and conceptual studies, its usage alone identifies about 20,000 works. There has been limited in-depth review of mathematical modeling studies since they have recently been examined and tend to focus on a small amount of uncertainty. Instead, this article looks at theory and data-driven research. Many of the featured articles deal with concerns of uncertainty and risk in the supply chain, but this inquiry strives to be all-encompassing in its examination of the origins of uncertainty, the strategies utilized to minimize it, and the outcomes it has achieved thus far. The studies may be divided into two categories: those that explain the causes of uncertainty and those that give solutions to it. Techniques for coping with uncertainty may be found in many of the same literary texts that highlight the roots of doubt, but they can also be found in more contentious writings that focus on particular management practices, such as supply chain collaboration.

Based on the assessment of the present supply chain uncertainty framework as well as other literature works on the uncertainties and risks, this paper has established a theoretical framework, which is application in future research. The framework may then be used as a basis for more research and actual implementation. It has made an effort to be all-encompassing in establishing the complete scope of potential causes of uncertainty and has narrowed the field down to 14 primary areas of concern. The analysis finds that more research is needed on a wide variety of uncertainty causes and management solutions for IT complexity, decision complexity, and parallel interaction impacts. Nonetheless, there has been a scarcity of research works attempting to focus on a systemic analysis of uncertainties in the supply chain or that assesses how distinct uncertainty sources correlate to managerial approaches. The predicted linkages and effects of techniques on performance have not been well shown, and there has not been sufficient empirical work in this area. The impact of uncertainty management strategies on uncertainty sources and other important performance indicators should be studied in depth. This kind of study might be beneficial to the supply chains of both the industrial and service industries. The food sector, with its worldwide supply networks and inherent uncertainty, may offer the greatest backdrop for such research and give rise to novel sources of uncertainty and approaches to management.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author(s) declare(s) that they have no conflicts of interest

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