INFLUENCE OF PRODUCT AND BUSINESS ENVIRONMENT CHARACTERISTICS ON MANAGING SUPPLY CHAIN VULNERABILITY

Jelena V. Vlajic [a,*], Jack G.A.J. van der Vorst [b], Dragan Djurdjevic [c]

[a] Queen's University Belfast, Northern Ireland, the United Kingdom
[b] Wageningen University, the Netherlands
[c] University of Belgrade, Faculty of Transport and Traffic Engineering, Serbia

Abstract: *Increased changes of trading rules in a global economy, more frequent adverse weather events due to climate change, and other unexpected events add more uncertainty to the ever-present logistics challenges for companies to manage their supply chains. Thus, there is increased theoretical and practical interest to prevent disturbances of logistics operations, as well as to manage disturbances when they occur and avoid supply chain vulnerability. Decreased vulnerability of supply chains is desired as it leads to robust and resilient supply chains. The objective of this paper is to understand how contextual factors, i.e., product and business environment related factors affect relationship between redesign strategies and vulnerabilities in the supply chain. We consider typical redesign strategies, such as the adoption of assurance systems, the use of proactive control, use of redundancy, or enhancing flexibility in supply chains. Seen from the lens of contingency theory, the findings from our literature review suggest that contextual factors affect the link between redesign strategies and vulnerabilities in the supply chain, but further research is needed to examine how each of the contextual factors affect selection and implementation of each redesign strategies used to manage supply chain vulnerabilities.*

Keywords*: Contingency theory, Prevention of disturbances, Impact reduction*

1. INTRODUCTION

Studies in the supply chain management discipline conducted over the past decades show that an increased focus on efficiency and leanness of supply chain processes has resulted in an increased vulnerability of supply chains to risks and disturbances (Stecke & Kumar 2009). Vulnerable supply chains suffer from a negative impact to their performance, i.e. they are not robust (Kleindorfer & Saad 2005). Ability to recover from these disturbances or to improve performances beyond previous levels, indicate their resilience (Vlajic 2017; Christopher & Peck 2004). Robust and resilient supply chains are able to predict and

* j.vlajic@qub.ac.uk

detect relevant disturbances in their processes, to respond fast, and to redesign their supply chains quickly (Blackhurst et al. 2005). However, the literature suggests that choice and success of implementation of redesign strategies might be a subject to contextual factors (Sousa & Voss 2008). This approach indicates suitability of contingency theory to explain effects of the contextual factors. The contribution of our study is the application of this theory in the area of supply chain vulnerability, as most of the identified studies applied contingency theory to the manufacturing strategy (Sousa & Voss 2008).

Thus, the *research objective* of the study is to investigate how contextual factors related to the product and business environment characteristics affect link between prevention and mitigation redesign strategies and vulnerability of a supply chain.

The remainder of the paper is structured as follows: First we present a literature review and a theoretical foundation. Subsequently, we briefly present the choice of a methodology to help achieving our research objective. In the concluding section we present the key idea, the propositions that result from the literature and possible future research.

2. LITERATURE REVIEW AND THEORETICAL FOUNDATION

To explain the model (Figure 1), we depart from a supply chain scenario and its vulnerability. In line with (van der Vorst 2000; Vlajic et al. 2016), we define a *supply chain scenario* as the configuration of four elements of the supply chain: 1) *the managed system*: the physical design of a network of facilities and all other elements that perform logistic activities (e.g. equipment, vehicles, and people), including inventory; 2) *the managing system*: the planning, control and co-ordination of logistic processes in the supply chain while aiming to achieve strategic supply chain and logistics objectives within the restrictions set by the network design; 3) *the information and decision support systems* within each decision layer of the planning and control system, as well as the information technology infrastructure needed; and 4) *the organizational structure* within the supply chain as well as the coordination of tasks in order to achieve defined objectives.

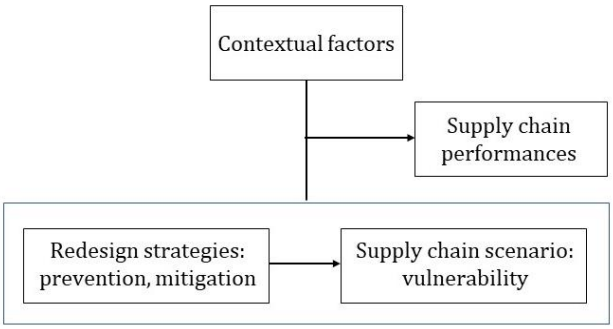

Figure 1. The model

This supply chain scenario is subject to various risks and disturbances that negatively affect supply chain performances and cause supply chain vulnerability. Failure of a production or logistics equipment, decision making errors, supplier failures, accidents, etc. are typical examples within a wide range of possible risks and disturbances. To manage this vulnerability, redesign strategies can be implemented. For example, Hopp (2008) recommends strategies to manage disturbances in the context of their likelihood

and consequences: in the case of minor consequences, regardless of the likelihood of disturbances, companies should do nothing; in the case of medium to severe consequences a choice of strategies depends on the likelihood of these disturbances: buffering/pooling is recommended in the case of a high likelihood, contingency planning in the case of a medium likelihood and crisis management in the case of a low likelihood. While this can be accepted as a general principle, buffering appears to be costly for high value products (Lovell et al. 2005), and very limited in the case of perishable products. The success of pooling might depend on the readiness for collaboration between various supply chain members (Cao & Zhang 2011). Thus, the use of redesign strategies to manage disturbances is context dependent, and *contingency theory* might explain this dependency (Sousa & Voss 2008).

Thus, to manage supply chain vulnerability, it is important to understand how contextual factors affect choice and the use of redesign strategies to manage vulnerabilities of the supply chain scenario. This is in line with Chang et al. (2015) who stated that a 'one size fits all' approach does not fit with the selection, application and effectiveness of the redesign strategies.

Generally, we propose that contextual factors might act as vulnerability sources or they can hinder application of redesign strategies, which might amplify supply chain vulnerability. They can also enable or contribute to easier implementation of redesign strategies that prevent or mitigate disturbances and result in robust and resilient supply chains. A supply chain is considered to be *robust* when a disturbance of supply chain processes does not impact significantly the supply chain performances (Vlajic et al. 2016), and it is considered *resilient* when a disturbance of supply chain processes impacts the supply chain performances, but they are restored to the same or better level after the recovery period (Christopher & Peck 2004).

In this paper, we consider product and business environment related factors as the relevant contextual factors to manage supply chain vulnerability (Inman & Blumenfeld 2013), and a set of guiding principles that can help managing supply chain vulnerability. In the remainder of the paper, we explain this in more detail.

2.1 Guiding principles towards achieving robust or resilient supply chains

In general, the most common guiding principles to manage disturbances in logistics processes correspond to traditional risk management approaches. Two basic principles are a) reduction of the probability/frequency of a risk or disturbance occurrence and b) reduction of the severity of an impact (Norrman & Jansson 2004). We explain these concepts in more detail below.

- Cause oriented, preventive guiding principle and related strategies

The *cause-oriented principle* attempts to reduce the probability a disturbance occurring by addressing its causes; this principle is preventive in nature (Wagner & Bode 2009; Vlajic et al. 2016). It is based on the premise that if possible, probable causes of disturbances need to be avoided or minimized (Waters 2007). General views associated with this principle are: 1) proactive redesign strategies are used in relatively more predictable environments (Ketokivi 2006) and 2) disturbance prevention should precede disturbance impact reduction (Kleindorfer & Saad 2005). However, as Lewis (2003) argues, the complexity of causal events and the variability associated with negative consequences suggest that prevention alone will never suffice. Some events can never be

predicted and some stakeholders will always face losses. Lewis also observed that too much reliance on prevention and mitigation actually results in a less effective overall recovery.

Typical strategies that belong to this group are assurance and reliability systems and proactive control and monitoring.

- *Assurance systems*. Generally, best practices in an industry represent strategies typically employed as assurance systems. For example, they typically tackle use of primary packaging to protect a products from a damage (Williams & Wikström 2011), or training staff to conduct proper material handling.
- *Proactive control and monitoring*. Proactive control is based on the consideration of supply chain risks in the decision-making process (Inman & Blumenfeld 2013), in such a way that vulnerability sources are avoided or probability of a detrimental unexpected events is minimized. Typical examples of proactive control are: strategic sourcing, vendor rating, strict supply contracts, information sharing and integrating practices, as well as monitoring suppliers and controlling business opportunities (Harland et al., 2003), product simplification and improved demand forecasts (Inman & Blumenfeld 2013). Proactive control relies on tools based on statistical process control and control charts (Christopher and Lee, 2004), data mining, intelligent web agents and expert systems (Blackhurst et al., 2005), as well as use of Internet of Things and Big data.

- Effect oriented, impact reductive guiding principle and related strategies

The *effect-oriented principle,* also known as the impact reductive principle (Kleindorfer & Saad 2005; Vlajic et al. 2016) attempts to limit or mitigate the negative consequences of disturbances (Wagner & Bode 2009). Generally, it is grounded on two ideas:

- To make supply chains sturdy and strong, so that their performances are not affected by disturbances (robust supply chains); the key strategy here is related to building *redundancy* in the supply chains (Sheffi & Rice Jr. 2005). This is typically ensured by increasing inventory or time buffers (Inman & Blumenfeld 2013), keeping multiple suppliers (Rice Jr. & Caniato 2003; Tang 2006), and adding capacity (Zsidisin & Wagner 2010; Chopra & Sodhi 2004)
- To enable fast recovery of supply chain performances after the disturbance occurred (resilient supply chains); the key strategy here is related to enhancing flexibility (Zsidisin & Wagner 2010), i.e. having ability to change elements of a supply chain scenario by ensuring that a disturbance is identified (Barker & Santos 2010) (information sharing aspect) and a response is put in place (responsiveness aspect). Key strategies related to flexibility are switching suppliers or transport modes in the case of supplier or transporter failure (Stecke & Kumar 2009), emergency deliveries (Inman & Blumenfeld 2013) postponement, multiple purpose resources (Hopp 2008) or flexible manufacturing systems (Gunasekaran et al. 2001)

While the first idea requires the high investment costs and tie capital into inventory, the second idea requires collaborative efforts to ensure fast recovery, information exchange (Bode et al. 2011) and it is more difficult to implement. Both approaches contain reactive redesign strategies, which are found more often in the relatively low predictability environments (Ketokivi 2006).

2.2 Contextual factors - Contingency theory lens

Contingency theory considers contingencies, i.e., contextual (or contingency) variables, response variables and performance variables. Sousa & Voss (2008, p.703) define *contextual variables* as "situational characteristics usually exogenous to the focal organization or manager", *response variables* as "the organizational or managerial actions taken in response to current or anticipated contingency factors" and *performance variables* as the dependent measures which represent "specific aspect of effectiveness that are appropriate to evaluate the fit between contextual variables and response variables for the situation under consideration". Similar to Blome et al. (2014) we consider product and supply business environment as contextual factors that shape the effects of the redesign strategies on the supply chain scenario.

Product characteristics. Product characteristics represent properties of raw materials or final products (Kirezieva et al. 2013) and we present characteristics reported in the literature. *Longevity and physical characteristics* of products indicate a complexity of its production and requirements for logistics processes in terms of packaging needs, storage conditions, material handling and warranty date and conditions. Generally, more fragile products, susceptible to environmental influences and less durable, the higher chance for product damage and disposal cost is. *Product assortment* represent external variety (Pil & Holweg 2004), i.e., a number of different stock keeping units or end-product configurations available to customers. Increased product assortment is typically consequence of variety in packaging sizes, labels and brands (Van Donk 2001). Though large product assortment results in increased inventory costs (Closs et al. 2010), it enables product substitution to avoid situations of inventory shortage, obsolescence and low customer service. *Product customization* might occur in any point of a supply chain and it requires certain type of processing, ranging from simple operations such as cutting or mixing to more complex operations that require specialized resources. (Olhager 2003) states that product customization might affect supply chain scenario as well. Both product assortment and customization have been identified as a means to achieve a competitive advantage (Scavarda et al. 2010). *The number of components* needed to build a product is strongly related to the number of production steps, which affects production complexity (Inman & Blumenfeld 2013) and indicates the type of a network structure. Inman and Blumenfeld found that the higher the number of parts, the higher the risk of a missing part is and the higher the risk of disturbance in production is.

Based on Blome et al. (2014), identified product characteristics indicate *product complexity.* Similar to Ketokivi (2006), they considered that the higher the customization, the number of components and assortment, the higher the complexity is. Though product complexity might affect effectiveness of redesign strategies on the supply chain scenario (Eckstein et al. 2015), it is rarely considered in relation to vulnerability, robustness and resilience of supply chains (Inman & Blumenfeld 2013).

Business environment. Business environments consider the supply and demand conditions. In this paper, we focus on supply conditions and its relevant characteristics. *Market capacity risk* occurs when there are only a few supply sources available (Zsidisin 2003), which exposes supply chains to a product shortage. This is especially the case of strong competition, when suppliers may switch customers. *Geographical dispersion* of suppliers (Brandon-Jones et al. 2015) might contribute to higher risks of disturbances, as internationally located suppliers require long shipping lead times due to border crossings,

consolidation/deconsolidation centers and mode changes (Inman & Blumenfeld 2013). Inman and Blumenfeld highlight that these environmental factors increase not only the probability of a disturbance, but also its impact. *Uncertainty in supply* occurs due to unexpected events that affect timing, quantity or quality of inputs, such as delays due to traffic accidents, supplier's failure or mistakes in order picking (Vlajic et al. 2013). As such, it affects inventory or supplier management procedures. Changes in domestic or international trading *regulations* can open or restrict sourcing possibilities, thus influencing efficiency of purchasing function, as well as supply chain and logistics operations. Moreover, regulations can impose the form of information exchange and communication between supply chain partners. For example, information exchange with suppliers can take the form of non-structured and structured communication. In make-to-order systems non-structured communication improves supply chain performances, while structured communication increase costs in a situation of a high supply complexity (Gimenez et al. 2012).

Based on (Gimenez et al. 2012) and related studies, identified characteristics of business environment indicate *supply complexity,* which may impact effectiveness of redesign strategies applied on the supply chain scenario. The literature suggests that the higher marker capacity risk, larger geographical dispersion of suppliers, higher uncertainty in supply and frequent changes of regulations contribute to higher complexity of the supply chains. Similar to (van Donk & van der Vaart 2004) who found that higher supply complexity results in higher integration of the supply chain and improvement of performances, we propose that a higher complexity in supply implies an increased effectiveness of redesign strategies applied to the supply chain scenario.

3. METHODOLOGY

Objective of this study is to investigate *how* contextual factors such as product and environment characteristics affect management of supply chain vulnerabilities, i.e. the effectiveness of redesign strategies to change the supply chain scenario.

'*How*' type questions are best answered by using a case study methodology (Yin 1994). As Eisenhardt (1989) and (Meredith 1998) advise, case selection should be based on theoretical sampling. Furthermore, to build a theory from case studies, researchers should collect specific data in a systematic manner (Mintzberg 1979). In this case, such data must refer to the supply chain scenario characteristics, product and business environment characteristics that would provide insights into the disturbances and resulting vulnerability of a supply chains, as well as redesign strategies to manage the vulnerability.

The literature calls for research on real supply chain disturbances, and supply and product complexity (Inman & Blumenfeld 2013). Thus, for the purpose of this study, we select a supply chain of a large retailer, perishable products and a business environment of a developing country for the following reasons:

- Large retailers typically source wide assortment of products, have complex supply chain structure, and they are in position to manage entire supply chains (Coe & Hess 2005).
- Fresh food is a challenging part of the retailers' assortment which might result in food loss and waste (Papadima & Bloukas 1999), loss of profit and loss of reputation. On the other hand, fresh food products can be customized (i.e.

processed) in relation to the size of product, weight, color, production type (e.g. organic or not) at the producer as well as in the retail outlets.
- Developing countries face multiple challenges that result from issues related to the infrastructure, institutional control, and trade (Vlajic 2015), and successful retailers must redesign their supply chains on a continuous basis to manage vulnerabilities.

3. EXPECTED FINDINGS AND CONCLUSION

The supply chain and operations management literatures suggest that supply chain designs are shaped by contextual factors, i.e. high-inertia contextual variables. In most cases these variables are possible to change only in the long term and with the substantial effort (Sousa & Voss 2008). However, there is a scarce literature that provides more insights how these contextual factors shape effectiveness of redesign strategies when applied to supply chains to manage their vulnerability. In particular, product complexity is not much studied in connection to supply chain vulnerability (Inman & Blumenfeld 2013), nor how to manage vulnerability. Though there are studies that analyze impact of supply complexity on supply chain integration (Gimenez et al. 2012; van Donk & van der Vaart 2004) or flexibility (Blome et al. 2014), only Brandon-Jones et al. (2014) explained how supply chain complexity factors affects redesign strategies aimed to increase robustness and resilience.

In this study, we propose the use of a case study methodology to test propositions that result from this literature review and contingency theory:

P1: Product complexity affects the effectiveness of redesign strategies to manage supply chain vulnerability by preventing or mitigating disturbances in supply chain processes.

P2: Supply (business) environment complexity affects effectiveness of redesign strategies to manage supply chain vulnerability by preventing or mitigating disturbances in supply chain processes.

Furthermore, more detailed research is needed to investigate:

- does the disturbance prevention or mitigation related strategies are more used in the case of high product complexity and/or high supply complexity;
- how specific product or supply environment related factors affect link between each redesign strategies and supply chain vulnerability.

REFERENCES

[1] Asbjornslett, B.E., Rausand, M., (1999). Assess the vulnerability of your production system. Production Planning and Control, 10(3), pp.219–229.

[2] Barker, K., Santos, J.R., (2010). Measuring the efficacy of inventory with a dynamic inputoutput model. International Journal of Production Economics, 126(1), pp.130–143.

[3] Blackhurst, J., Craighead, C. W., Elkins, D., Handfield, R. B., (2005). An empirically derived agenda of critical research issues for managing supply-chain disruptions. International Journal of Production Research, 43(19), pp.4067–4081.

[4] Blome, C., Schoenherr, T., Eckstein, D., (2014). The impact of knowledge transfer and complexity on supply chain flexibility: A knowledge-based view. International Journal of Production Economics, 147, pp.307–316.

[5] Bode, C., Wagner, S.M., Petersen, K.J., Ellram, L.M., (2011). Understanding Responses To Supply Chain Disruptions: Insights From Information Processing and Resource Dependence Perspectives. Academy of Management Journal, 54(4), pp.833–856.

[6] Brandon-Jones, E., Squire, B., Autry, C.W., Petersen, K. J., (2014). A Contingent Resource-Based Perspective of Supply Chain Resilience and Robustness. Journal of Supply Chain Management, 50(July), pp.55–73.

[7] Brandon-Jones, E., Squire, B., Van Rossenberg, Y.G.T., (2015). The impact of supply base complexity on disruptions and performance: the moderating effects of slack and visibility. International Journal of Production Research, 53(22), pp.6903–6918.

[8] Cao, M., Zhang, Q., (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. Journal of Operations Management, 29(3), pp.163–180.

[9] Chang, W., Ellinger, A.E., Blackhurst, J., (2015). A contextual approach to supply chain risk mitigation. International Journal of Logistics Management, 26(3), pp.642–656.

[10] Chopra, S., Sodhi, M.S., (2004. Managing risk to avoid supply-chain breakdown. MIT Sloan management review, 46, pp.53–61.

[11] Christopher, M., Peck, H., (2004). Building the resilient supply chain. International Journal of Logistics Management, 15(2), pp.1–13.

[12] Closs, D.J., Nyaga, G.N., Voss, M.D., (2010). The differential impact of product complexity, inventory level, and configuration capacity on unit and order fill rate performance. Journal of Operations Management, 28(1), pp.47–57.

[13] Coe, N.M., Hess, M., (2005). The internationalization of retailing: Implications for supply network restructuring in East Asia and Eastern Europe. Journal of Economic Geography, 5(4), pp.449–473.

[14] Van Donk, D.P., (2001). Make to stock or make to order: The decoupling point in the food processing industries. International Journal of Production Economics, 69, pp.297–306.

[15] van Donk, D.P., van der Vaart, T., (2004). Business conditions, shared resources and integrative practices in the supply chain. Journal of Purchasing and Supply Management, 10, pp.107–116.

[16] Eckstein, D., Goellner, M., Blome, C., Henke, M., (2015). The performance impact of supply chain agility and supply chain adaptability: The moderating effect of product complexity. International Journal of Production Research, 53(10), pp.3028–3046.

[17] Eisenhardt, K.M., (1989). Building theories from case study research. Academy of Management Review1, 14(4), pp.532–550.
[18] Gimenez, C., Van Der Vaart, T., Van Donk, D.P., (2012). Supply chain integration and performance: the moderating effect of supply complexity. International Journal of Operations & Production Management, 32(5), pp.583–610.
[19] Gunasekaran, A., Patel, C., Tirtiroglu, E., (2001). Performance measures and metrics in a supply chain environment. International Journal of Operations & Production Management (ABS2015:4), 21(1/2), pp.71–87.
[20] Hopp, W.J., (2008). Supply chain science, Long Grove, Illiinois: Waveland Press, Inc.
[21] Inman, R.R., Blumenfeld, D.E., (2013). Product complexity and supply chain design. International Journal of Production Research, 527, pp.1956–1969.
[22] Ketokivi, M., (2006). Elaborating the Contingency Theory of Organizations: The Case of Manufacturing Flexibility Strategies. Production and Operations Management, 15(2), pp.215–228.
[23] Kirezieva, K., Nanyunja, J., Jacxsens, L., van der Vorst, J.G.A.J., Uyttendaele, M., Luning, P.A., (2013). Context factors affecting design and operation of food safety management systems in the fresh produce chain. Trends in Food Science & Technology, 32(2), pp.108–127.
[24] Kleindorfer, P.R., Saad, G.H., (2005). Managing Disruption Risks in Supply Chains - ProQuest. Production and Operations Management, 14(1), pp.53–68.
[25] Lewis, M., (2003). Cause, consequence and control: towards a theoretical and practical model of operational risk. Journal of Operations Management, 21(2), pp.205–224.
[26] Lovell, A., Saw, R., Stimson, J., (2005). Product value-density: Managing diversity through supply chain segmentation. The International Journal of Logistics Management, 16(1), pp.142–158.
[27] Meredith, J., (1998). Building operations management theory through case and field research. Journal of Operations Management, 16(4), pp.441–454.
[28] Mintzberg, H., (1979). An emerging strategy of "direct" research. Administrative Science Quarterly, 24(4), pp.582–589.
[29] Norrman, A., Jansson, U., (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident. International Journal of Physical Distribution & Logistics Management, 34, pp.434–456.
[30] Olhager, J., (2003). Strategic positioning of the order penetration point. International Journal of Production Economics, 85(3), pp.319–329.
[31] Papadima, S.N., Bloukas, J.G., (1999). Effect of fat level and storage conditions on quality characteristics of traditional Greek sausages. Meat Science, 51(2), pp.103–113.
[32] Pil, F.K., Holweg, M., (2004). Linking product variety to order-fulfillment strategies. Interfaces, 34(5), pp.394–403.
[33] Rice Jr., J.B., Caniato, F., (2003). Supply chain response to terrorism: Creating resilient and secure supply chains. MIT Center for Transportation and Logistics, pp.1–59.
[34] Scavarda, L.F., Reichhart, A., Hamacher, S., Holweg, M., (2010). Managing product variety in emerging markets. International Journal of Operations & Production Management, 30(2), pp.205–224.
[35] Sheffi, Y., Rice Jr., J.B., (2005). A Supply Chain View of the Resilient Enterprise. MIT Sloan Management Review, 47(1), pp.41–48.

[36] Sousa, R., Voss, C.A., (2008). Contingency Research in Operations Management Practices. Journal of Operations Management, 26(October 2016), pp.697–713.
[37] Stecke, K.E., Kumar, S., (2009). Sources of Supply Chain Disruptions, Factors That Breed Vulnerability, and Mitigating Strategies. Journal of Marketing Channels, 16(3), pp.193–226.
[38] Tang, C., (2006). Robust strategies for mitigating supply chain disruptions. International Journal of Logistics, 9(1), pp.33–45.
[39] Vlajic, J. V, (2017). Effective Usage Of Redundancy And Flexibility In Resilient Supply Chains. In Proceedings of the 22nd International Symposium on Logistics. Ljubljana: Nothingham University, pp. 450–458.
[40] Vlajic, J.V., van Lokven, S.W.M., Haijema, R., van der Vorst, J.G.A.J., (2013). Using vulnerability performance indicators to attain food supply chain robustness. Production Planning and Control, 24(8–9), pp.785–799.
[41] Vlajic, J.V., (2015). Vulnerability and Robustness of SME Supply Chains. An Empirical Study of Risk and Disturbance Management of Fresh Food Processors in a Developing Market. In Organizational Resilience: Concepts, Integration and Practice. pp. 85–103.
[42] Vlajic, J.V., van der Vorst, J.G.A.J. & Haijema, R., (2016). Framework for designing robust supply chains. Developments in Logistics and Supply Chain Management: past, present and future, 1(317), pp.13–26.
[43] van der Vorst, J.G.A.J., (2000). Effective Food Supply Chains-Generating, Modelling and Evaluating Supply Chain Scenarios,
[44] Wagner, S. & Bode, C., (2009). Dominant risks and risk management practices in supply chains. Supply chain risk: a handbook of assessment, management and performance. New York: Springer, 271–290, pp.271–290.
[45] Waters, D., (2007). Supply chain risk management, Vulnerability and Resilience in Logistic, Kogan Page Ltd.
[46] Williams, H., Wikström, F., (2011). Environmental impact of packaging and food losses in a life cycle perspective: A comparative analysis of five food items. Journal of Cleaner Production, 19(1), pp.43–48.
[47] Yin, R.K., (1994). Case Study Research. Design and Methods Fifth., London: Sage.
[48] Zsidisin, G. A., Wagner, S.M., (2010). Do Perceptions Become Reality? the Moderating Role of Supply Chain Resiliency on Disruption Occurrence. Journal of Business Logistics, 31(2), pp.1–20.
[49] Zsidisin, G.A., (2003). Managerial Perceptions of Supply Risk. The Journal of Supply Chain Management, pp.14–26.