Performance Measurement in Supply Chains During Disruptions: Lessons from the COVID-19 Pandemic

1. Introduction

The COVID-19 outbreak has threatened and caused unprecedented disruptions to supply chains showing the supply chain management's inability to deal with Black Swan events. The unexpected COVID-19 event has deeply impacted the world in terms of health systems as well as the business environment. Supply chains have been challenged to avoid imminent disruptions in their upstream and downstream flows. Both practitioners and researchers have engaged in discussions to exchange knowledge and explore strategies to enhance the robustness and resilience of supply chains to minimise disruptions when subjected to events like that. According to Kumar, Basu and Avittathur (2017), unprecedented supply chain disruptions are low frequency-high impact events that result in the severance of one or more nodes of the supply chain leading to the unavailability of services or goods. Supply chain disruptions represent an opportunity to learn from their effects (Bode et al., 2011) and, in particular, learning from the COVID-19 event can improve future decision-making during disruptive situations (Van Hoek, 2020). That is relevant because disruption events cause a significant impact on both financial and operational performance (Macdonald and Corsi, 2013). The challenge is to improve or design new Performance Measurement Systems (PMS) to provide warnings regarding the risks of disruptions to better support decision-making processes during situations such as the COVID-19 pandemic. Furthermore, PMSs should also provide the impacts of decision-making to managers during unpredictable events.

Performance measurement systems provide meaningful information about past actions to decision-makers to help them make informed decisions regarding future performance (Neely, Gregory and Plats, 1995; Lebas and Euske, 2002; Rouse and Putterill, 2003). Furthermore, a supply chain PMS is “a set of metrics used to quantify the efficiency and effectiveness of supply chain processes and relationships, spanning multiple sorganisational functions and multiple firms and enabling SC orchestration” (Maestrini et al., 2017). Besides, the supply chain PMS encompasses both the internal and the external supply chain that includes the immediate supply chain (customers and first-tier suppliers) and other supply chain tiers (the entire supply chain) (Maestrini et al., 2017). Considering the environmental transformation due to the pandemic occurrence, some authors argue the importance of adapting PMS according to the environmental dynamics and changes of the business environment (Bititci Turner and Begemann, 2000, Kennerley and Neely, 2003). Yet, in the supply chain context, some authors also point out that Performance Measurement - PM must be adapted according to the sorganisational context and stakeholders’ requirements as well as to the dynamic of the environment where the supply chain is inserted (Cuthbertson and Piotrowicz, 2011, Mishra et al., 2018). Hence, it becomes essential to understand the Performance Measurement aspects in the face of emergency situations such as COVID-19.

Since the seminal article by Benita Beamon proposing new performance measures for evaluating supply chain performance, the literature has evolved. Many authors proposed many frameworks changing the focus from performance measures to PMS (e.g., Van Hoek, 1998; Beamon, 1999;

Holmberg, 2000; Brewer and Speh, 2000; Gunasekaran, Patel and Tirtiroglu, 2001; Chan and Qi, 2003; Park, Lee and Yoo, 2005; Bhagwat and Sharma, 2007; Reefke and Trocchi, 2013; Beske-Janssen, Johnson and Schaltegger, 2015; Liang, 2015; Laihonen and Pekkola, 2016; Dweekat, Hwang and Park, 2017; Nouri, Nikabadi and Olfat, 2019). More recently, following the context of the Fourth Industrial Revolution, Frederico et al. (2021) proposed a performance measurement framework for Supply Chain 4.0.

Although some proposals in the literature focus on risk dimensions and disruption management in supply chains (e.g., Kleindorfer and Saad, 2005; Macdonald and Corsi, 2013; Durach, Glasen and Straube, 2017). A relevant gap for a predictive PMS remains in the face of the COVID-19 occurrence when supply chains have been challenged to keep the continuity of their upstream and downstream flows.

2. Contributions to the Special Issue

Considering the huge impact of the COVID-19 outbreak on supply chains, significant lessons learned and the opportunity to better prepare organisations for the post-pandemic period, this SI aimed to identify papers that would bring relevant theoretical and practical contributions in terms of deeply exploring how to effectively measure the supply chains performance in disruption situations. Some suggestions of research themes that were proposed during the call for papers to be considered by the authors, but were not limited to, included:

- What Performance Measurement Systems (PMSs) can be used to evaluate supply chain performance during unexpected events;
- What performance measures should be considered to assess supply chains during emergency situations;
- How to effectively use supply chain performance measurement during emergency situations;
- How to effectively measure contingency strategies in supply chains amid the occurrence of emergency risks;
- How performance measurement contributes to the success of supply chain responses and relief amid pandemic situations;
- What is the contribution of Industry 4.0 disruptive technologies (e.g., Big Data Analytics, Cloud Computing, etc.) to performance measurement of supply chains during Black Swan events;
- How to measure resilience to better prepare supply chains before unexpected situations occur and to recover immediately;
- How to measure the maturity of supply chains' risk management in emergency events;
- How PMSs can be effectively and rapidly deployed as an initial strategy to counter significant disruption in supply chains due to emergency events.

After following a rigorous peer review process, ten articles have been finally accepted to be published in this special issue. These manuscripts bring different approaches regarding the theme of performance measurement in supply chains during disruption situations, especially in the COVID-19 context. The titles of these ten articles as well as their purposes are listed in Table 1. They are available to the readers in this special issue titled *Performance Measurement in Supply*

Chains During Disruptions: Lessons from COVID-19 Pandemic, which is published on the journal's website.

Table 1 – Articles published in this special issue

Article	***Title***	***Purpose***
1	Airline catering supply chain performance during pandemic disruption: a Bayesian network modelling approach	This study aims to consider the impact of implementing Bayesian network (BN) modelling to measure SC performance in the airline catering during the pandemic context
2	The role of Industry 4.0 technologies on performance measurement systems of supply chains during global pandemics: an interval-valued intuitionistic hesitant fuzzy approach	This study aims to investigate Supply Chain (SC) Performance Measurement Systems (PMSs) (SCPMSs) that are suitable and applicable to evaluate SC performance during unexpected events such as global pandemics. Also, it considers the contribution of Industry 4.0 Disruptive Technologies (IDTs) to implement SCPMSs during such Black Swan events.
3	A systematic literature review on supply chain resilience in SMEs: learnings from COVID-19 pandemic	This paper presents the state-of-art literature on supply chain resilience in SMEs in the context of the coronavirus (COVID-19) pandemic and provides a comprehensive view of insights gained, gaps identified and suggests potential areas of future research.
4	A proposed circular-SCOR model for supply chain performance measurement in the manufacturing industry during COVID-19	This study aims to determine which supply chain performance criteria come to the fore for the company under consideration to accelerate the transformation into

		high performance and circularity in supply chains, considering that the ability to analyse supply chain performances and ensure circularity in supply chains has become one of the factors whose importance has increased rapidly with COVID-19
5	How do food supply chain performance measures contribute to sustainable corporate performance during disruptions from the COVID-19 pandemic emergency?	This study aims to the development of the scale of supply chain performance measures (SCPMs), food supply chain resilience (FSCS) and sustainable corporate performance (SCP) in small- and medium-sized enterprises (SMEs) in an emerging market, considering the COVID-19 context
6	Performance measurement of e-commerce supply chains using BWM and fuzzy TOPSIS	The purpose of this paper is to persuade a hybrid framework, which can be used to assess the performance of various supply chains and can be further used to segregate supply chains concerning critical KPMs. The KPMs have been selected in the COVID-19 pandemic condition.
7	Lean performance measurement system for an Indian automotive supply chain	This paper aims to present a simple and innovative fuzzy methodology-based lean performance measurement system (L-PMS) for an Indian automotive supply chain. The paper also enlightens the influence of coronavirus disease 2019 (COVID-19) on supply chains and the practical

		implications of the unprecedented disruptions on the performance measurement systems
8	Barriers to supply chain performance measurement during disruptions such as the COVID-19 pandemic: A balanced scorecard-based analysis	This study explores barriers to supply chain performance measurement during disruptions such as COVID-19. It uses the DEMATEL fuzzy VIKOR method to analyse barriers in the Balanced Scorecard Framework basis
9	The Social Role of Supply Chain firms during the Pandemic Period	This study aims to investigate the social risk shift in supply chain management during the Coronavirus Disease 2019 (COVID-19) pandemic. For every organisation, social risk management is a vital component of its development that offers an advantage in the marketplace.
10	Empirical Benchmarking of Virtual Service Centers' Service Quality: A case of a large Telecom Service Provider in India	This paper aims to present a hybrid approach to measure the efficiency of Virtual contact centers (VCCs) started during the pandemic and benchmark them for service performance. The results are used to plot the VCC's efficiency score (performance) and customer perception (Importance) to propose appropriate strategies.

3. Acknowledgements

The guest editors are extremely grateful to those who contributed to publishing this special issue, including the anonymous reviewers who have provided constructive feedback and expert guidance through the rigorous peer review process to select the best papers for the issue. Also, the guest editors would like to especially thank the Editors of the International Journal of Quality and Reliability Management, Prof. Ton van der Wiele (Former Editor) and Prof. Jiju Antony (Current Editor-in-Chief), the IJQRM editorial office and Emerald Group Publishing for their full support given during all steps of the special issue, since the call for papers design until the publication of the issue. Finally, the guest editors would also like to thank the authors for their contributions and for choosing our special issue as a relevant platform to communicate their research works.

The guest editors hope that this special issue brings a real impact on both research and practice. In terms of impacts on research, the guest editors hope that the research findings published in this special issue stimulate and encourage new research deployments related to performance measurement in supply chains during disruptive events. This is mainly because supply chains are constantly being challenged with newer disturbing events besides the pandemic (e.g., the Russia-Ukraine war, geopolitical conflicts, climate-change events, and economic disturbances). From a practical standpoint, the content of the articles published in this special issue may support supply chain decision-makers involved in different industrial sectors. The insights drawn from this SI will provide them with effective guidance to help them design, implement and improve performance measurement systems capable of effectively measuring different supply chain processes and issues during unexpected and disruptive events.

Guest Editors

Prof. Guilherme F. Frederico

Professor of Operations and Supply Chain Management

School of Management

Federal University of Paraná – UFPR

Curitiba - Brazil

guilherme.frederico@ufpr.br

Prof. Vikas Kumar

Professor of Operations and Supply Chain Management

Faculty of Business, Law and Social Sciences

Birmingham City University

Birmingham, UK

Vikas.Kumar@bcu.ac.uk

Prof. Jose Arturo Garza-Reyes

Professor of Operations Management and Head of the Centre for Supply Chain Improvement

Centre for Supply Chain Improvement

University of Derby

Derby – UK

J.Reyes@derby.ac.uk

Prof. Roberto A. Martins

Professor of Operations Management

Industrial Engineering Department

Federal University of São Carlos – UFSCar

São Carlos – Brazil

ram@dep.ufscar.br

Dr. Anil Kumar

Senior Lecturer of Operations and Supply Chain Management

Guildhall School of Business and Law

London Metropolitan University

London – UK

a.kumar@londonmet.ac.uk

References

Beamon, B. (1999) “Measuring Supply Chain Performance”, *International Journal of Operations & Production Management*, Vol.19 No.3, pp.275-292 https://doi.org/10.1108/01443579910249714

Beske-Janssen, P., Johnson, M.P. and Schaltegger, S. (2015), "20 years of performance measurement in sustainable supply chain management – what has been achieved?", *Supply Chain Management: An International Journal*, Vol. 20 No. 6, pp. 664-680. https://doi.org/10.1108/SCM-06-2015-0216

Bititci, U. S., Turner, T. and Begemann, C. (2000). Dynamics of performance measurement systems. *International Journal of Operations & Productions Management*, Vol.20 No.6, pp.692-704. https://doi.org/10.1108/01443570010321676

Bhagwat, R. and Sharma, M. (2007). “Performance measurement of supply chain management: A balanced scorecard approach”, *Computers & Industrial Engineering*, Vol.53, pp.43-62. https://doi.org/10.1016/j.cie.2007.04.001

Brewer, P. and Speh, T. (2000) “Using the Balanced Scorecard to measure supply chain performance”, *Journal of Business Logistics*, Vol.21 No.1, pp.75-93.

Bode, C., Wagner, S.M., Petersen, K.J. and Ellram, L.M. (2011). “Understanding responses to supply chain disruptions: insights from information processing and resource dependence perspectives”, *Academy of Management Journal*, Vol. 54 No.4, pp. 833–856. https://doi.org/10.5465/amj.2011.64870145

Chan, F.T. and Qi, H.J. (2003) “An innovative performance measurement method for supply chain management”, *Supply Chain Management: An International Journal*, Vol.8 No.3, pp.209-223. https://doi.org/ 62"662.;6073.7820628.896

Cuthbertson, R. and Piotrowicz, W. (2011) “Performance measurement systems in supply chains”, *International Journal of Productivity and Performance Management,* Vol.60 No.6, pp.583-602. https://doi.org/10.1108/17410401111150760

Durach, C.F., Glasen, P.C. and Straube, F. (2017), "Disruption causes and disruption management in supply chains with Chinese suppliers: Managing cultural differences", *International Journal of Physical Distribution & Logistics Management*, Vol. 47 No. 9, pp. 843-863. https://doi.org/10.1108/IJPDLM-07-2017-0228

Dweekat, A.J., Hwang, G. and Park, J. (2017), "A supply chain performance measurement approach using the internet of things: Toward more practical SCPMS", *Industrial Management & Data Systems*, Vol. 117 No. 2, pp. 267-286. https://doi.org/10.1108/IMDS-03-2016-0096

Frederico, G., Garza-Reyes, J. A., Kumar, A. and Kumar, V. (2021). “Performance Measurement for Supply Chains in the Industry 4.0 Era: A Balanced Scorecard Approach*”, International Journal of Productivity and Performance* Management, ahead to print, https://doi.org/10.1108/IJPPM-08-2019-0400

Gunasekaran, A., Patel, C. and Tirtiroglu, E. (2001). “Performance measures and metrics in a supply chain environment”, *International Journal of Operations & Production Management*. Vol.21 No.1/2, pp.71-87. https://doi.org/10.1108/01443570110358468

Holmberg, S. (2000). “A systems perspective on supply chain measurements,” International Journal of Physical Distribution & Logistics Management. Vol.30 No.10, pp.847-868. https://doi.org/10.1108/09600030010351246

Kennerley, M. and Neely, A. (2003). “Measuring performance in a changing business environment”, *International Journal of Operations & Productions Management*, Vol.23 No.2, pp.213-229. https://doi.org/10.1108/01443570310458465

Kleindorfer, P. R and Saad, G.H. (2005) “Managing Disruption Risks in Supply Chains”, *Production and Operations Management*, Vol.14 No.1, pp.53-68. https://doi.org/10.1111/j.1937-5956.2005.tb00009.x

Kumar, M., Basu, P. and Avittathur, B. (2018) “Pricing and sourcing strategies for competing retailers in supply chains under disruption risk”, *European Journal of Operational Research*, Vol.265 No.2, pp.533-543. https://doi.org/10.1016/j.ejor.2017.08.019

Laihonen, H. and Pekkola, S. (2016). “Impacts of using a performance measurement system in supply chain management: a case study, *International Journal of Production Research*, Vol.54 No.18, pp. 5607-5617, https://doi.org/10.1080/00207543.2016.1181810

Lebas, M., and Euske, K. (2002). *A conceptual and operational delineation of performance*. In Neely, A. (Ed.), Business performance measurement: Theory and practice, pp. 65–79. Cambridge: Cambridge University Press.

Liang, Y. (2015) Performance measurement of interorganizational information systems in the supply chain, *International Journal of Production Research*, Vol.53 No.18, pp. 5484-5499, https://doi.org/10.1080/00207543.2015.1026614

Macdonald, J. R. and Corsi, T. M. (2013). “Supply Chain Disruption Management: Severe Events, Recovery, and Performance”, *Journal of Business Logistics*, Vol.34 No.4, pp. 270-288. https://doi.org/10.1111/jbl.12026

Maestrini, V., Luzzini, D., Maccarrone, P., Caniato, F. (2017) “Supply chain performance measurement systems: A systematic review and research agenda”, *International Journal of Production Economics*, Vol.183, p.299-315

Mishra, D., Gunasekaran, A., Papadopoulos, T. and Dubey, R. (2018). “Supply chain performance”, *Benchmarking: An International Journal*, Vol.25 No.3, pp. 932-967. https://doi.org/10.1108/BIJ-08-2017-0224

Neely, A., Gregory, M., and Platts, K. (1995). “Performance measurement system design: a literature review and research agenda”, *International Journal of Operations & Production Management*, Vol.15 No.4, pp. 80-117

Nouri, F.A., Nikabadi, M.S. and Olfat, L. (2019). “Developing the framework of sustainable service supply chain balanced scorecard (SSSC BSC)”, *International Journal of Productivity and Performance Management*, Vol.68 No.1, pp. 148-170. https://doi.org/10.1108/IJPPM-04-2018-0149

Park, J.H., Lee, J.K. and Yoo. J.S. (2005) “A framework for designing the balanced supply chain scorecard”, *European Journal of Information Systems*, Vol.14 No.4, pp.335-346. https://doi.org/10.1057/palgrave.ejis.3000544

Reefke, H. and Trocchi, M. (2013) “Balanced scorecard for sustainable supply chains: design and development guidelines”, *International Journal of Productivity and Performance Management*, Vol.62 No.8, pp.805-826. https://doi.org/10.1108/IJPPM-02-2013-0029

Rouse, P. and Putterill, M. (2003), "An integral framework for performance measurement", *Management Decision*, Vol. 41 No. 8, pp. 791-805. https://doi.org/10.1108/00251740310496305

Van Hoek, R. (1998). "Measuring the unmeasurable - measuring and improving performance in the supply chain", *Supply Chain Management: An International Journal*. Vol.3 No.4, pp.187-192. https://doi.org/10.1108/13598549810244232

Van Hoek, R. (2020) "Research opportunities for a more resilient post-COVID-19 supply chain – closing the gap between research findings and industry practice", *International Journal of Operations & Production Management*. Vol.40 No.4, pp. 341-355. https://doi.org/10.1108/IJOPM-03-2020-0165