Development of a semi-structured questionnaire to analyse supply chain resilience in the post-COVID business era

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Abstract: The COVID-19 pandemic has had and is having devastating effects on the health of the population, but also on the economic health of companies and their supply chains. The old paradigms of the commercial and industrial world have been inevitably disrupted: global supply chains have shifted from a system based on efficiency to one oriented towards resilience. To this regard, the present research paper aims at investigating how Supply Chain Resilience will evolve in the new paradigms of the post-COVID business era. In order to contribute to this investigation, a semi-structured questionnaire is developed, through a structured research approach. Future research lines will be based on conducting this questionnaire as a basis for a targeted survey, analysable through association rules.

Keywords: Supply Chain Resilience, System dynamics, Disruptions, COVID-19, Pandemic

1. INTRODUCTION

The COVID-19 pandemic has been labelled a black swan event (Mazzoleni et al., 2020), since it is considered a disruption with high-impact and low-probability characteristics (Taleb, 2007). During 2020 and 2021, many countries around the world were forced to close borders, apply travel restrictions, enforce quarantine and social distancing, for persons needing to work or to simply acquire food, medicines and other essential goods (Saez et al., 2020; Thunström et al., 2020). These limitations were essential, to limit the COVID-19 impact on human lives. Nevertheless, they caused unprecedented aftereffects for the global economy. COVID-19 has also had a major impact on the efficiency and effectiveness of Supply Chains (SCs) around the world. Fortune reported in the beginning of 2020 that 94% of Fortune 1000 companies have experienced supply disruptions due to COVID-19 (Fortune, 2020). The repercussions have affected not only raw materials, but also low-value items critical to production. The simultaneous search for alternative solutions by all companies generated turbulence in the markets not seen in decades. Additionally, given the global, multi-tiered and connected nature of today's SCs, the pandemic has unleashed a tremendous number of obstacles and difficulties. In this framework, disruptions which were localized in a specific company lead outcomes spreading to the entire SC, snowballing in magnitude and causing the occurrence of the Ripple Effect. Thus, impact was not incremental but exponential, generating a sudden collapse or an abrupt transition to a new, suboptimal status quo, which amplified the negative effects of the disruption (Bevilacqua et al., 2018; Bevilacqua et al., 2019; Dolgui et al., 2018; Ivanov, 2017; Marcucci et al., 2022).

Against this background, achieving resilience within the SC has become an imperative objective, in order to survive and thrive in this environment (Sanchis and Poler, 2019a, 2019b).

Supply chain resilience (SCR) can be defined as the ability of a system to return to its original state or move to a new, more desirable state after being disturbed (Christopher and Peck, 2004). Many authors highlighted SCR as a critical characteristics for SC players to survive in the short, medium and long term, especially in the context of the COVID-19 pandemic (Ali et al., 2021; Belhadi et al., 2021; Burgos and Ivanov, 2021; Modgil et al., 2021; Riglietti et al., 2021). In particular, the COVID-19 pandemic is triggering challenging circumstances, which require novel SC reconfiguration for achieving resilience. The research upon these dynamics is, by necessity, at its early stages. Only some studies have been conducted on a micro level, while those that do exist utilize a theorical attempt to describe the COVID-19 situation. Other researchers, instead, suggest investigation based on literature reviews (Raj et al., 2022). However, investigations related to SCR challenges that SCs will have to tackle in the coming years, to our knowledge, are largely missing in literature.

In this context, the present research aims at investigating how SCR will evolve in the new paradigms of the post-COVID business era.

In order to complete this investigation, a semi-structured questionnaire is developed, through a structured research approach. Semi-structured questionnaires are a particularly suitable method of gathering both quantitative and qualitative data. The overall goal of the semi-structured interview is to gather systematic information on a set of central topics, while also allowing for some exploration, as new issues or topics emerge (Adams, 2015).

To explain the research method, this paper is organised as follows: Section 2 reviews the extant literature and Section 3 explains the Research Approach, while in Section 4 the questionnaire development is exemplified. Finally, Section 5 presents the conclusions of the study.

2. LITERATURE REVIEW

A number of studies, both qualitative and quantitative, have been conducted in the last year, to analyse or evaluate the different perspective of SCR in the post-pandemic scenario. Meyer et al. (2021) study the role of the entrepreneurs in the economic recovery within the aftermath of the COVID-19 pandemic, analysing the drivers behind their ability to identify opportunities and new patterns of work. Such resilient entrepreneurship is researched upon, within its interplay between external disruptions, different types of entrepreneurships, and the consequences for resilience in emerging economies. May and Mentz-Coetzee (2021), in their study, analyse how the COVID-19 impacted the African food-system in terms of welfare, and discussing the implications of this evolving forms of risk and uncertainty for the future resilience of African food systems, comparing it with other systemic shocks. Saidani et al. (2021) research explores instead how the adoption of Circular Economy principles can be the drivers for a more robust resilient and sustainable SC in the post-COVID business framework. Frederico et al. (2021) explore how Industry 4.0 technologies, and their interoperability within SC, impact business performance and SCR. This investigation, in the context of the pandemic, provides relevant comprehension on how organization along a SC may tackle unexpected circumstances and disruption in the coming years. Ivanov (2021), in his work, uses a discrete-event simulation model, in order to explore SC exit strategies in the contest of the COVID-19 pandemic. Its model investigates SC disruption tails, and guides managers and decision makers on selecting the best post-pandemic recovery strategies. Yang et al. (2021) investigation also evaluates the above mentioned topics, analysing though SC risk management capabilities. Their study is focused on information processing theory, conceptualizing SC disruption orientation as an organic control and SC visibility as a mechanistic control.

3. RESEARCH APPROACH

As shown in Fig. 1, the research approach is composed of five steps:

1. ***Problem Identification*** – In order to define both scope and focus of the subsequent analysis, the phase "Problem identification" is addressed, setting all the relevant parameters of the model.

Subsequently, an experts panel is created, composing the group which will undertake the next three steps following the Delphi method criteria.

2. ***Preparation of preliminary questionnaire*** – The experts panel, following the Delphi method criteria, is required here to create a first draft of the questionnaire.

3. ***Questionnaire refinement*** – During this step, an input, in the form of a bibliometric map, is given to the experts panel. Using this aid, the expert panel is required to refine the preliminary questionnaire previously created.

4. ***Questionnaire validation*** – Minor modification are applied, if necessary. The questionnaire is then validated.

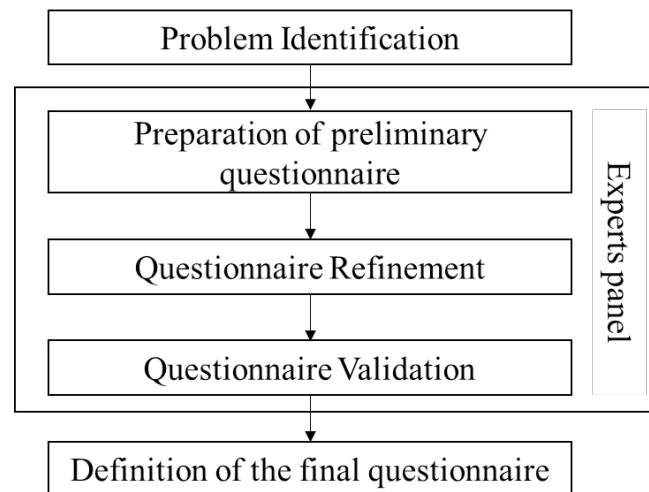5. ***Definition of the final questionnaire*** – The final version of the questionnaire is exemplified.

Fig.1: Research Approach

4. QUESTIONNAIRE DEVELOPMENT

After the widespread impact of COVID-19 became apparent, SCR management came into play. Many companies worked to ensure the well-being of their employees and society, while at the same time doing what they could to protect their businesses by establishing new baselines, reducing costs, and safeguarding liquidity. Most companies have been working harder than ever to ensure their survival, and SCR management have been fighting this battle on the front lines (Aigbedo, 2021; Ivanov and Dolgui, 2020). However, the identification of the signs and consequently the decision to act upon have come too late. On the other hand, maybe such timely and accurate actions could not be possible, due to deeply entrenched ways of working, poor flexibility, or panic-induced paralysis. As the business world is approaching a situation of undoubtedly fragile stability, two critical questions are needed to be asked: how will businesses and SCs get back on their feet? How will SCs adapt and thrive in this new normal, marked by the uncertainty induced by the pandemic aftermath?

Hence, the problem is identified with investigating the evolution of SCR in the post-COVID business era.

Following the problem identification, according to the research approach proposed in section 4, the experts panel is formed. In this work, the group is made up by 3 academics, whose research mainly focus on SC Management, and 3 managers. Taking into account the multidisciplinary skills necessary to develop the questionnaire, the three managers are selected from different company functions, as follows: SC

Fig. 2 Bibliometric Map

management, Resilience Management and Financial Management. The panel is thus created to envisage and promote communication and discussions, during which all the members can contribute with their know-how to the processes.

As per first task, the experts panel are gathered to provide a first draft of the questionnaire. After two iterations, a preliminary version of the questionnaire is developed, containing one topic and a set of 20 questions. Along with the draft, a list of instruction is presented, to aid the interviewer in the preparation and execution of the survey. For example, instructions on how the interviewers should put people at ease, being able to ask questions in a simple but interesting way. Moreover, the interviewer should listen carefully to the answers, acting in a way that develops trust support, without influencing participants to a particular position.

Before conducting the subsequent step, a bibliometric map is provided, as addition input during the questionnaire refinement. In order to do this, a bibliometric analysis has been conducted through the VOSviewer software. VOSviewer is a free software tool, designed to build and display bibliometric maps. Differently from other software used for bibliometric mapping, VOSviewer is particularly suited for the graphical representation of such maps. VOSviewer functionality, in fact, is mainly useful for exemplifying large bibliometric maps, while providing a comprehensive way to interpret the results (van Eck and Waltman, 2010). VOSviewer software is widely used in many research fields, e.g. Silver Economy (Marcucci et al., 2021), medicine (Huang et al., 2020), SCR (M. Bevilacqua et al. 2019) or sustainability trends (Wang et al., 2021).

In Fig. 2 the keyword co-occurrence bibliometric map created is shown. The keyword research parameters can be summarized by this Boolean expression: *"Supply Chain Resilience" AND (Covid-19 OR Covid OR Pandemic)*. The research was conducted on the Web of Science database on the 31st of January 2022 and 136 papers met these criteria. Moreover, to find an optimal trade-off between comprehensiveness and readability of the map, the keyword co-occurrence threshold has been set to 3. Thus, a total of 75 keywords are shown.

Table 1. Final questionnaire

Dear Madam/Sir We would like to ask you for a few minutes of your time to fill out the questionnaire, which will obviously be anonymous and used only for statistical purposes. Your answers are for us a valuable source of information and useful to investigate the evolution of Supply Chain Resilience. We would like to thank you for your availability and valuable collaboration. At the same time, we would like to notify you that we will be pleased to inform you of future initiatives to disseminate or present the results of the research that will be promoted at the conclusion of the survey. Regarding the closed ended questions, the Likert scale should be read as such: -5 Strongly Disagree 0 No answer +5 Strongly Agree											
PART A – Exogenous Supply Chain Resilience											
Government and institutions aided your sector during the COVID-19 pandemic.	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
In what way should government and institution aid businesses in the happening of the next major disruption?											
The communication from institutional entities, regarding the COVID-19 pandemic, was appropriate.	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
In what way should communication be improved in the happening of the next major disruption?											
The market in which you were operating was volatile during the COVID-19 pandemic.	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
In your opinion, will the market in which your company operates be volatile in the next 5 years?											
National and international restrictions due to COVID-19 negatively affected your business.	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
In the happening of the next major disruption, which restrictions would be affecting your business the most?											
PART B – Endogenous Supply Chain Resilience											
At the beginning of the COVID-19 pandemic, the product/ project portfolio of your company was diversified	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Will product/project diversification aid during the next major disruption? If yes, how?											
At the beginning of the COVID-19 pandemic, resilience culture was rooted along your Supply Chain.	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
In what way resilience culture should evolve in the next 5 years?											
During the COVID-19 pandemic, manpower availability was ensured along your Supply Chain.	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
In what way manpower availability should be ensured during the next major disruption?											
During the COVID-19 pandemic, Industry 4.0 technologies aided SC companies in tackling the impact the pandemic.	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
Which Industry 4.0 technology will be critical in the next 5 years for Supply Chain Resilience?											

Company Sector:	Food & beverages products Textile, leather & clothes products Electrical and mechanical machinery and equipment Pharmaceutical products Chemical products Furniture Transport products Rubber and plastics Other (specify: _____)
How many employees does your company have?	≤10 Between 10 and 50 Between 50 and 250 ≥250 Don't know/answer
Could you indicate your annual turnover?	≤2 M€ Between 2 me and 10 me Between 10 me and 50 me ≥50 Me Don't know/answer
What is your role within your company?	

Once the experts are provided with this input, the panel undergoes the questionnaire refinement step. After two iterations, an additional draft of the questionnaire is provided. Firstly, to lay a comprehensive basis for the questionnaire, two macro-areas are defined: exogenous SCR and endogenous SCR. This categorization is indeed in line with the research literature. Jüttner et al. (2003) classify as environmental risk sources the interactions between SC and the external environment, while the interactions amongst SC actors are classified as network-related risk sources and organizational risk sources, if deriving respectively from inter-partner or intra-partners relationships. Birkie et al. (2017) research exemplifies four kinds of capabilities related to this classification: proactive-internal, proactive-external, reactive-internal and reactive-external. Lastly, Christopher and Peck (2004) contribute to this study categorizing SC risks as internal to the firm, external to the firm but internal to the SC and external to the SC, i.e. the environment. Thus, the panel agreed on distinguish the questionnaire question in interactions between the SC and the external environment (exogenous) and dynamics within the SC players (endogenous).

Moreover, for each macro area, 4 open questions and 4 close-ended questions were defined, to allow the interviewer to optimally collect crucial information. In order to facilitate future interviews, a Likert scale have been designated as answer to the close-ended questions: from -5, meaning "strongly disagree" to +5, meaning "strongly agree"

Subsequently, during the questionnaire validation step, no more changes were agreed upon the questions. Nevertheless, a field report was included, to guide the interviewer into making necessary observations about the progress of the interview. Moreover, the order of the questions was modified: the question regarding the interviewer company were put at the end, in order not to deter the questionnaire compilation.

The final questionnaire is shown in Tab.1.

5. CONCLUSIONS

The spread of the COVID-19 outbreaks globally caught many companies by surprise. At the first signs of production shutdowns by their suppliers, purchasing and supply chain managers immediately had to take note of the vulnerability of their global SCs. The old paradigms of the commercial and industrial world have been inevitably disrupted: global SC shifted from a system based on efficiency to one oriented towards resilience, and now it is necessary to investigate how SCR will evolve in the post-COVID business era. The present paper starts this investigation by developing a semi-structured questionnaire, targeting SC managers and policy and decision makers. Future research lines will be based on conducting this questionnaire as a basis for a targeted survey, analysable through qualitative or quantitative methos, e.g., association rules. Moreover, the developed questionnaire could easily be adapted to other research areas, i.e. Enterprise Resilience (Andres and Marcucci, 2020; Sanchis et al., 2020; Sanchis and Poler, 2019c).

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