Chapter 6
Supply Chain Response: Proposal for a General Definition

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Abstract This research on supply chain response (SCR) is a topic of interest to academics and professionals that helps to meet customer expectations in a timely manner and contributes to the achievement of supply chain (SC) objectives. Various definitions of SCR are found in the scientific literature, each valid for the purpose of the research that proposes it. The wide range of definitions prevents from establishing a framework for analysis and improvement of the SCR that can be applied to any type of SC. For the study of the definitions of SCR, a qualitative content analysis methodology was applied. The level of analysis of the SC and the research method applied by the author of the definition were also taken into account in the analysis. The common characteristics of the various definitions, the differences between them, and the shortcomings of each have been determined. The main contribution of this research is the proposal of a general definition of SCR that has the common elements of existing ones and is useful for any type of SC. A general definition will allow addressing the supply chain response with a common framework for any type of supply chain and not only those mentioned in the academic literature.

Keywords Supply chain response · Supply chain responsiveness · Definition responsiveness

6.1 Introduction

Two major challenges facing supply chains (SC) today are responding to customer changes in the shortest possible time [5] and gaining competitive advantage [18]. In

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this sense, [27] defines the supply chain response (SCR) as the SC action capacity to respond to customer demand and market variability in a reasonable time, gaining and maintaining competitive advantage. In this definition, three aspects are combined: firstly, a change in some external element to the SC (change in customer demand), secondly, the modification of the behavior of the SC to adapt to the external change (action to give response), and thirdly, the objective pursued when modifying the behavior of the SC (gaining and maintaining competitive advantage). The current SC also has to adapt to various types of changes both external and internal of the SC itself and with different objectives. Thus, for example, humanitarian SC, often has to respond to natural disasters in order to meet the urgent needs of the affected people [13], or perishable food SC that must respond with delivery of product on time and fresh, and late arrival of an ingredient may affect other perishable ingredients by delaying product preparation and delivery to the customer [3]. SC of industrial and service products must respond to internal changes such as the unavailability of workers or changes in production scheduling [19]. According to [26], the internal changes of the supplier directly affect the response of the buyer to meet customer requirements.

The research carried out on the SCR aims at proposing improvements in SC management [24] and performance [12]. However, each research proposes a definition according to the improvement under investigation; for example, [30] propose a coordinated SCR definition with the aim of improving the coordination of different response strategies, and [7] define the SCR in relation to the demand that will be met in an area with the aim of improving the design of supplying networks. Therefore, in SCR research, there is no definition that can be applied to all SC or generalized for all processes and functions of the chain. A general definition should allow developing the theory, investigation, and practice of the SCR, thus facilitating to define and to establish relations between the managers of the answer.

The aim of this research is to provide a definition of supply chain response that is applicable to any type of SC that has to adapt to any type of change. The methodology applied to development this research was qualitative content analysis. According to Arbeláez and Onrubia [1] through qualitative content analysis, it is possible to "verify the presence of topics, words, or concepts in a content and their meaning within a text". Krippendorff [17] claims that content analysis allows determining patterns through secondary data. The content analysis methodology has been used in various areas of research and particularly that of SC. Three reference applications of the content analysis methodology in SC were carried out by [28, 23, 14]. The first applies content analysis in the measurement of the SC construct. The second is applied to document the use of content analysis in SC literature. The third one applies content analysis to innovation in SC.

This article is composed of the following sections: Sect. 6.2 details the methodology applied for the development of this research, Sect. 6.3 deals with the definitions of SCR and the description of its characteristics, in Section number 4, the general definition of the SCR is written, in Sect. 6.5, the general definition of the SCR is validated, and it finishes with Sect. 6.6 conclusion and future research.

6.2 Methodology

In order to carry out this research, the qualitative content analysis method proposed by Marying (2014) [21] was applied. The method was performed in several steps. First, identification of the mínimum unit of analysis. Second, selection of the documents that would be part of this investigation. Third, identification of the common characteristics, differences, and deficiencies of the analyzed definitions.

The minimum unit of analysis was identified in the academic literature on SCR corresponding to the period 1996–2019. The databases reviewed were Scopus and Web of Science.

Searches were performed combining the keywords *supply chain*, *supply chain responsiveness*, *definition responsiveness, and* 858 documents were obtained. The documents were filtered verifying that they addressed the SCR concept, and a list of 191 articles was generated. For each of them, the title, summary, introduction, and conclusions were reviewed to determine if they proposed a definition of supply chain response. Finally, 20 articles with SCR definitions that form the basis of this research were selected.

The common characteristics, differences, and dificiencies between the selected definitions were analyzed.

Also, the context in which the research was developed was analyzed. The context of the analyzed definitions of SCR is made up of the purpose of the research, the level of analysis of the SC in which it was defined and the research method that was applied. With the results of the analysis of the definitions mentioned above, the general definition of SCR was drawn up.

Finally, the proposed definition was validated. The validation was carried out following two steps. First, the general definition of SCR proposed here overlapped on the definition that was initially identified in the document. Second, the components of the general definition of SCR proposed here in the analyzed documents were identified..

6.3 Selected SCR Definitions

This section presents 15 definitions of SCR found in the 20 articles finally selected from the literature review. Taking into account that the definitions of the responsiveness, responsive supply chain, and supply chain responsiveness encompass the response to the supply chain, these terms have been consolidated as supply chain response. These definitions provide differentiating elements among them.

- Catalan and Kotzab [5] defined the SCR as “the ability to respond and adapt in a timely manner to current market signals based on the ability to read and understand in real time and back from the SC the changes in demand generated by the final user”.

- According to [15], the SCR is "the ability of a company together with the participants of the SC to respond to changes in the needs of the market and those of the competitive environment".
- For [25], the SCR is "the speed with which a system (manufacturing system or a SC) can adjust its outputs to achieve any of the four types of flexibility: product, volume, product combination, and delivery in response to external stimuli such as the order of a customer".
- Gunasekaran et al. [9] extend the previous definitions of SCR to "a network of companies capable of creating profit for shareholders in a competitive environment through rapid reaction and the effective cost to face changes in market requirements".
- Squire et al. [26] defined responsiveness as "the speed with which the supplier reacts to information from the buyer firm and more generally from the overall market".
- Klibi et al. [16] defined the SCR of an SC network as the ability to respond positively to changes in business conditions.
- Williams et al. [29] defined the response of the SC in terms of four external flexibilities: flexibility of new products, volume of production, variety in production and delivery, and flexibility to modify the product or service (customization). The four types of flexibility include changes in demand and the supply.
- Hum and Parlar [11] in their research related to SC measurement through optimization define responsiveness as the "probability that a placed order can now be fulfilled within t time units".
- Dreyer et al. [6] defined the SCR as the change of appropriate behavior of the system to respond to external stimuli.
- L'Hermitte et al. [20] in the context of agile humanitarian SC define the SCR as the ability to respond in a timely manner to the identification of operational risks and opportunities.
- Rajagopal et al. [24] defined responsiveness in the context of the supply chain as "the ability to react persistently and within an apt period to client's demand or changes in the marketplace, besides to generate or sustain a competitive advantage as the way forward".
- Fattahi et al. [7] researching the design of resilient and responsive supply chain networks define the SCR as a percentage of the potential demand of customers in an area that can attend a SC.
- Kristianto et al. [18] defined responsiveness as "the ability to dampen the effects of demand changes thorough purposeful reaction within a specified response time window".
- Cannella [4] defined the supply chain responsiveness as "the ability of a system to deliver the same product within a shorter lead time".
- Hum et al. [12] defined supply chain responsiveness "as the probability of fulfilling a customer order within a quoted lead time".

The SCR definitions of the selected articles have four characteristic elements: first, the occurrence of a change in some external element to the SC. External change

affects the operation of the SC. Second, the adaptation of the SC behavior to that change. The adaptation of the SC activities encompasses the change in the SC´s strategic, tactical, or operational planning. Examples of the activities that can be adapted are product design, the material acquisition, production, or delivery. The adaptation helps to reduce the impact of change in SC. Third, the objective pursued by the SC in modifying its behavior and respond to the change. Fourth, the criterion used to assess the response. The criterion applied to evaluate the SCR is the response time variable. Table 6.1 shows these elements to all definitions analyzed in this research.

Regarding the first element, external changes are beyond the control of the SC and direct the adaptation of SC activities. To refer to these changes, generic terms are applied for instance: changes in demand, changing business, and market conditions

Table 6.1 SCR definition features

Article	External change	AT	Obj	RA	Al	Rm
Catalan and Kotzab [5]	Current market signals	E		X	Ch	I
Kim et al. [15]	Needs of the market	E			Fm	Su
Reichart and Holweg [25]	Stimuli	E/I		X	NA	Sd
Gunasekaran et al. [9]	Market requirements	E	X	X	Fm	Sd
Squire et al. [26]	Overall market	E		X	Dy	Su
Klibi et al. [16]	Business conditions	E			Net	Sd
Williams et al. [29]	Demand and the supplier	E		X	Fm	Su
Hum and Parlar [11]	Placed order	E		X	Ch	Om
Dreyer et al. [6]	External stimuli	E		X	Ch	Cs
L'Hermitte et al. [20]	Operational risks and opportunities	E/I		X	Fu	Sd
Rajagopal et al. [24]	Demand or marketplace	E	X	X	Fu	Su
Fattahi et al. [7]	Potential demand	E	X		Net	Om
Kristianto et al. [18]	Demand	E		X	Fu	Sd
Cannella et al. [4]	Deliver the same product	E		X	Ch	Om
Hum et al. [12]	Customer order	E		X	Net	Om

Caption
External Change: External changes that occur outside the SC.
Adaptation type: adaptation type (AT) of the SC external (E) or internal (I).
Objective: objective of the supply chain (Obj).
Assess: response assessment (RA).
For each definition, the external change that takes into account is shown in the column external change, if the adaption of the SC is internal (I) or external (E) in the AT column, if it includes any objective of the SC (marked with X) in the Obj column, and if it includes an evaluation factor of the answer (marked with X) in the RA column.
Analysis level (Al): Function (Fu), Firm (Fm), Dyad (Dy), Chain (Ch), Network (Net), Does not apply (NA)
Research method (Rm) Case study (Cs), Interview (I), Optimization models (Om), Secondary data (Sd), Survey (Su)

[16, 24]. Respecting the second element, the adaptation of SC activities to external changes, it was identified in the definitions of SCR analyzed that the adaptation of the SC behavior is associated with the flexibility of the SC either internal [25] or external [29]. Concerning the third element, the objectives pursued by the SC in adapting to external changes are varied in the different definitions. Thus, we find objectives such as satisfying the client [7] or gaining and maintaining competitive advantage [24, 27].

Regarding the fourth element, the assessment of the response, it is observed that it is always done by means of the time variable. Time is described with the following terms: in a timely manner [5], quick reaction (Gunasekaran et al. [9]), speed [25, 26], adequate period or reasonable period [24, 18, 27], t time units [11], and agreed delivery time [12].

The context in which the characteristics of the previously analyzed SCR definitions were identified is described below. The description of the context allowed us to recognize for which specific level of SC, the analyzed definitions were proposed. According to [10], the levels of analysis of the SC are function, firm, dyad, chain, network. The function level covers a specific area of the organization, for example, manufacturing. Dyad includes two or more companies, e.g., supplier–buyer. Chain groups are different component of the chain such as supplier, buyer and consumer. Net connects several links in the chain, that is, to say several suppliers connected to a buyer [8]. The analysis level column in Table 6.1 shows at which level of analysis the definition was proposed. The proposed definitions of SCR have been generated for particular cases and referring to a specific level of SC.

The research method applied in the documents containing the definitions of SCR that were analyzed is also part of the context. The research method allows us to understand how knowledge has been generated in SCR and how the SCR was evaluated in each investigation. Research in SCR has been characterized by applying different research methods. The research methods that have been used the most are the survey and secondary data analysis. The surveys have been carried out via email and telephone. The respondents have been supervisors and managers from various areas of the SC. Secondary data is data that has not been generated by the author of the research, such as academic documentation, books, organization manuals, among others. The secondary data analysis research method has made it possible to propose conceptual models for SCR management. Followed by optimization models and case studies, the optimization models have addressed topics such as the optimization of inventory levels, queuing theory applied to the design of SC networks, multi-objective programming, stochastic, linear, and simulation. The variable that is optimized is time in the different terms discussed above. The case studies developed in the SCR research have addressed the integration and coordination issues of the SC. Information and demand flows are addressed mainly with the interview method in SCR research. The research method column in Table 6.1 shows the research methods that were identified in the analysis of the SCR definitions performed. Table 6.2 shows the relationship between the research methods at the level of SC analysis in which

Table 6.2 SCR research context

		Research method				
		Survey	Optimization model	Secondary data	Case study	Interview
SC analysis level	Function	1		3	1	
	Firm	2			1	
	Dyad	1				
	Chain	1	2		2	2
	Network		2	1		
	N/A			1		

the SCR has been investigated. It highlights that most of the definitions of SCR have been proposed by researching at the SC level and applying the survey application research method.

6.4 A General Purpose Supply Chain Response Definition

The definitions of SCR studied are applied to SC that have to adapt to the external changes mentioned in each of them. However, on the one hand, there are other types of external changes to the SC that require a response from the SC, which do not appear in the analyzed definitions. For example, natural disasters and events that cause humanitarian emergencies require an immediate response. On the other hand, the definitions set out in the literature do not take into account that SC often has to respond to internal changes such as an unplanned machine shutdown, a change of inventory, or a change of information system. In addition, to respond to external changes, SC generates internal changes, to which they must respond as well. Hence, SC presents external and internal changes that must be answered. Kritchanchai and MacCarthy [19] propose the term stimulus to refer to them. Regarding the adaptation of SC activities to the stimuli it receives, whether external or internal, it was identified that not all definitions include this component. Not recognizing the adaptation component as part of the definition of SCR contributes to increasing the negative impact of stimuli on SC. Highlighting the importance of this component, [2] state that SCR is associated with the timely change of activities in the presence of stimuli.

The objectives of the humanitarian SC are related to the satisfaction of urgent needs caused by natural disasters [13] and to save lives [22]. These objectives are not taken into account in the proposed definitions of SCR. With the exception of the definition of Gunasekaran et al. [9], which includes aspects of cost and profit, there is no evidence in the definitions proposed regarding the objective of the response and the fulfillment of the objectives of the SC.

The results described above are summarized by stating that there is no general definition of SCR in which all the SC or results that can be achieved with the identification of the response. Additionally, they do not take into account the fulfillment of the objectives of the SC. Taking into account the characteristics of the SCR definitions analyzed and their deficiencies, a general definition of supply chain response is proposed which generalizes the previous ones, as follows:

The supply chain response is the adaptation of the supply chain activity to the stimuli it receives, to simultaneously meet certain objectives and those of the supply chain, assessing the adaptation for the time elapsed between the occurrence of the stimulus and the fulfillment of the determined objective.

6.5 Validation of General Definition of Supply Chain Response

This section presents the result of the validation by superimposing the general definition of SCR proposed in Section 4 of the definition initially identified in the articles selected for this research. The validation of the definition was carried out by recognizing the inclusion of the external and internal stimuli, the adaptation of SC activities, the objectives of both the SC and the stimulus, and the evaluation of the response in the articles analyzed. All four components are contained in the proposed general definition of SCR.

Regarding the inclusion of external and internal stimuli in the researches carried out on SCR, it was observed that all the investigations explicitly include external stimulus. The second column on Table 6.3 shows the external stimuli that were identified in the validation. The response to internal stimuli of SC is not explicitly mentioned in the researches analyzed. However, [12] address the response to internal stimuli by investigating the impact of placing an order throughout the SC.

Regarding the adaptation that the SC must make of its activities to respond to the stimuli, it was identified that the most frequent adaptation is made on the strategies and manufacturing processes. The supplier´s processes, transportation, distribution, and information processing systems are also adapted. The third column on Table 6.3 shows the adaptations mentioned above.

Regarding the objectives of the SC, it was identified that the researches have included goals of the SC and the SC processes. However, SCR investigations must ensure compliance with other SC objectives that are also important, such as social and environmental responsibility objectives and civil liability objectives. Also, they ensure the fulfillment of the objectives that depend on the stimulus to which it is responding, such as meeting urgent needs, saving lives, adjusting production to a change of raw material, and modifying the delivery route due to a road closure. In any case, the response to one stimulus must guarantee the fulfillment of strategic, tactical, and operational objectives of the entire SC.

Table 6.3 Stimuli and adaptation of activities of the supply chain response

Article	Stimuli	Adaptation of activities
Catalan and Kotzab [5]	Demand in mobile phone	Strategic suppliers Vendor management inventory Postponement
Kim et al. [15]	Needs of the market	Information systems processes
Reichart and Holweg [25]	External flexibility and demand changes	Manufacturing process Manufacturing flexibility Adjust upstream supply chains
Gunasekaran et al. [9]	Market requirements	Product models Between productlines
Squire et al. [26]	Customer specifications	Supplier process
Klibi et al. [16]	Variations in business conditions	Based on capabilities
Williams et al. [29]	Changes in business environment Changes in demand and supply	Production/delivery quantities and qualities
Hum and Parlar [11]	Meet a given demand	Adjust the speed of machines
Dreyer et al. [6]	Market dynamics	Postponement
L'Hermitte et al. [20]	Operational risks and opportunities	Operating routines Delivery location The mode of transport used The transport routes
Rajagopal et al. [24]	Demand or marketplace	Postponement
Fattahi et al. [7]	Demands of customer	Manufacturing and warehouse operations
Kristianto et al. [18]	Demand changes	Shift manufacturing operations
Cannella et al. [4]	Customers' changes in the demand volume	Smoothing replenishment rules
Hum et al. [12]	Customer order	Make to order
Sundram et al. [27]	Customer demand and market	Lean process strategies

Finally, the goal that is implicit in all investigations is to achieve a response in time for the stimulus. The SC objectives column of Table 6.4 shows the SCR research objectives discussed on this paragraph.

The researches analyzed have evaluated SCR mainly through lead time. Other evaluations have been carried out in the new product development, supplier, and manufacturing processes. In addition, the key perfomance indicators have been used in the evaluation of the response. Column 3 of Table 6.4 shows how the SCR has been assessment in the researches analyzed. Also, in column 3 of Table 6.4 is observed

Table 6.4 Supply chain objectives and response assessment in the supply chain response

Article	SC objectives	Response assessment
Catalan and Kotzab [5]	Sustainable competitive advantage	Lead time, postponement, bullwhip effect, and information exchange
Kim et al. [15]	Sustainable competitive advantage, new products, and market development	Demand changes, development of new products, and relationships with partners in the chain
Reichart and Holweg [25]	Competitive advantage Cost-efficient supply chains	
Gunasekaran et al. [9]	Competitive advantages Minimum total cost	
Klibi et al. [16]	Maximization of the present value of the cash inflows Minimization of total network costs	
Squire et al. [26]	Reducing costs	Supplier abilities
Williams et al. [29]		
Hum and Parlar [11]	Meet placed order	
Dreyer et al. [6]	Competitive advantage	Base on external and internal factors proposed by [25]
L'Hermitte et al. [20]	Competitive advantage	
Rajagopal et al. [24]	Competitive advantage, lessen costs, increase quality	
Fattahi et al. [7]	Minimizing lateness of products' delivery, minimizing customers' service time, and maximizing fill rate of customers' demands in addition to economic objectives	Delivery lead time
Kristianto et al. [18]	Competitive advantage Maximize responsiveness	
Cannella et al. [4]	Customer satisfaction	Volume responsiveness
Hum et al. [12]	Satisfy customer demand	Expected lead time
Sundram et al. [27]	Competitive advantage	KPI-based measurement

that the SCR evaluation component has not been taken into account in all the research analyzed.

6.6 Conclusions and Future Research

In this work, a review of the literature on definitions supply chain response has been carried out. Twenty SCR definitions have been analyzed to define the common elements, the differences between them, and their deficiencies. Four elements have been identified that are part of most of the existing SCR definitions, and one has been proposed that contains them all. The supply chain response general definition proposal encompasses the partial definitions of this concept focused on external stimuli from the client or the market and allows to include other external stimuli (responses to various types of disasters) and internal (changes in technology or personnel). Also, the proposed definition includes the adaptation of SC activities in response to the stimulus that impacts the SC. Additionally, this definition links the response with the fulfillment of the objectives of the SC, guaranteeing the benefit for the parties involved in the response. Finally, time is included as a valid response evaluation parameter in all cases.

Regarding the elements that make up the general definition of SCR, the validation allowed identifying that both the previously proposed definitions and the research carried out cover partial aspects of SCR. Also, the applicability of the general definition of SCR was validated at various levels of SC analysis and for different research purposes according to the articles analyzed.

Future research topics are the integration of the four elements of the SCR. First, external and internal stimuli. Second, adaptation of the activities of the SC. Third, fulfillment of the objectives of the SC and those of the response. Fourth, evaluation of the answer. Also, the characterization and planning of the SCR system. To explore how the analysis of mass data contributes to improve the SCR. In addition, investigate the differences between SC and SCR management.

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