

# **An Evolutionary Concept Analysis of the Supply Chain Response**

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## **Abstract**

Supply chain managers are challenged to respond quickly and efficiently to external and internal changes. A review conducted with regard to how the concept of supply chain response (SCR) is applied in suppliers' and manufacturing processes, as well as in flexibility, agility, and resilience strategies, confirms that the concept is ambiguous and lacks pillars that guide complete application in any process of the supply chain. The purpose of this research is twofold. The first goal is to identify the attributes, antecedents, and consequences of an SCR. The second is to establish the pillars of a general definition of an SCR that is applicable to all situations in which a supply chain must respond. This study applied Rodgers' evolutionary approach to analyze the concept of SCR. Literature published in English between 1996 – 2020 dealing with SCR was used to apply the phases of Rodgers' evolutionary method. We identified the following four pillars: (1) the stimulus to which the supply chain responds, (2) the adaptation of supply chain activities, (3) the objectives that the supply chain intends to achieve with its response to the stimulus, and (4) the evaluation of the response to the stimulus. Based on these four pillars, we propose a general definition of SCR. This definition contributes to the groundwork for reaching a consensus on the concept of SCR.

**Keywords:** supply chain response, pillars of supply chain response, response definition, evolutionary concept analysis

## **1. Introduction**

Supply chains (SC) today respond quickly and effectively to external and internal changes, such as those related to demand, natural disasters, or production line failures. Although researchers have proposed several supply chain response (SCR) definitions, they only serve to achieve the particular goals of the research in question. For example, Jahre and Fabbe-Costes

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(2015) define SCR as the speed with which aid is provided to meet the changing demand and urgent needs created by sudden and unpredictable disasters. Sundram et al. (2018, p.1) define it as “the capability to persistently act in response to and in a reasonable time-scale to the demand of customers and also to adapt to the variability that exists in the Marketplace in bringing out sustaining competitive advantage.” Furthermore, Rabbani et al. (2020 p.3) define it as “a chain’s ability to react and fulfill the purchaser’s interests within a predefined time span.”

Although the definitions proposed in the literature have facilitated field application of the SCR concept, there is still a lack of formal analyses that identify SCR’s attributes, antecedents, consequences, and pillars. Therefore, this study aims to fill this explanatory gap in the literature by conducting an evolutionary concept analysis of SCR.

Identification of the attributes, antecedents, consequences, and pillars of SCR was conducted using the following steps: (1) application of Rodgers’ evolutionary method of concept analysis, (2) identification of the pillars of the SCR definition, and (3) proposal of a new SCR definition.

Concept analysis methods have been widely applied in the field of nursing since Wilson (1963), but more recently, these methods have emerged in other fields, such as decision-making (Johansen & O’Brien, 2016) and international service (Kaartemo, 2018). Specifically, a concept analysis involves identifying the definitions, attributes, antecedents, and consequences of the concept being analyzed. According to Raiesifar et al. (2019), this analytic process can develop, clarify, and describe a concept, while allowing the expansion of the scope and the concept’s generalization.

The rest of this paper is structured as follows. Section 2 presents the results of applying the evolutionary concept analysis method, and section 3 identifies the four pillars required for a proper SCR definition. Section 4 proposes a new definition based on these pillars, and Section 5 concludes with potential future research topics related to this work.

## 2. Applying the evolutionary concept analysis method to SCR

In this study, the evolutionary method proposed by Rodgers’s (2000) was applied to analyze the concept of SCR. The purpose of Rodgers’s method is to add new knowledge; it is based on performing an inductive analysis of the academic literature that deals with applying in different contexts the concept being analyzed. Applying Rodgers’ method suggests following these steps: (1) identify and name the concept of interest; (2) determine surrogate terms and relevant uses for the concept; (3) select an appropriate sample for data collection; (4) identify the concept’s attributes; (5) determine the concept’s references, antecedents, and consequences, if possible; (6) identify concepts that are related to the concept of interest; and (7) choose a model case for the concept. Some of these activities can be executed simultaneously; consequently, the process of applying Rodgers’ method is not linear, but iterative and flexible (Brilowski & Wendler, 2005).

## 2.1 The concept of interest

Toftthagen and Fagerstrøm (2010) suggest that the selected concept should raise a human objective in practice, contribute to problem-solving, and provide an adequate characterization of a phenomenon. The concept may belong to a particular discipline, or it might be interdisciplinary and may be either at the theoretical or practical development stages. In this study, the concept selected for analysis is SCR, which meets these criteria. The human objective of a supply chain (SC) is to satisfy a customer request related to providing a service or product. The SCR contributes to solving the SC's problems by quickly responding to changes in the environment and simultaneously being more competitive. It can also contribute to saving the lives of people affected by disasters. Overall, the SCR's characterization contributes to SC competitiveness and performance improvements.

## 2.2 Surrogate terms and related concepts

According to Rodgers (1989), surrogate terms are words that can replace the concept being analyzed. In this sense, potential surrogate terms for SCR are supplier response, manufacturing response, retailer response, and consumer response. Regarding its relevant uses, researchers have employed the concept for several purposes, such as developing a conceptual or theoretical model, proposing a framework, discussing concepts and results, and evaluating an SC's responsiveness. Related terms are those that have something in common with the analyzed concept, but do not possess the same characteristics. Terms related to SCR are SC flexibility, agility, and resilience. Flexibility is a requirement for an SCR (More & Babu, 2008), while SCR agility is achieved by applying response and flexibility strategies (Lee, 2002). Finally, responsiveness is the main characteristic of SC resilience (Kamalahmadi & Parast, 2016).

## 2.3 The appropriate sample for data collection

The document selection used for SCR concept analysis influences both the research rigor and findings. Relevant data sources include academic literature, interviews, or other information media, while the selected sample must include information from areas of knowledge related to the selected concept. Including various research areas can help identify differences and similarities within the concept while revealing historical developments. Accordingly, we conducted a review of the SCR literature between 1996 and 2020 using the Scopus and Web of Science databases. The keywords applied to find the base documents were "responsiveness definition," "response definition," "responsive definition," "response," and "responsiveness." We obtained 2,197 documents, which were filtered by applying inclusion and exclusion criteria. The inclusion criteria were: (a) the articles were published in journals that use a peer

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review process, (b) the documents deal with terms subrogated or related to SCR, (c) the documents deal with a definition of the SCR concept, and (d) the article was written in English. The exclusion criteria applied were: (a) articles published in languages other than English, (b) extended abstracts, and (c) letters and editorials. After applying the inclusion and exclusion criteria, 58 articles were read to analyze the SCR concept. Rodgers et al. (2018) further explain that a concept's context can lie in how it is used within a discipline, during a certain time, or within a certain theoretical tradition. They also suggest that a word can have different meanings, depending on the context in which it is defined. Based on our literature review, the topics that dealt with SCR were classified as SC responsiveness, responsive SC, SC flexibility, SC agility, or SC resilience. In this classification, we considered the definition of every concept that included the words "response," "responsive," or "responsiveness."

## 2.4 Attributes of SCR

Identifying a concept's attributes facilitates its application and development. Tofthagen and Fagerstrøm (2010) specify that attributes are responses to the question: what are the concept's characteristics? The identified attributes of SCR are a strategy, adapting SC activities, time, and the ability to respond. These attributes are explained in detail below.

- Reactive and proactive SC strategies related to stimuli responses. According to Bernardes and Hanna (2009), when the SC imposes change on the environment, the response is proactive. Conversely, if external forces impose changes on the SC, the response is reactive.
- Adapting SC activities to respond to stimuli. The SC adapts its activities by increasing or decreasing production units to respond to increasing or decreasing demands and hiring or firing human resources to meet manufacturing needs. Also, it adapts the transport, distribution, and supplier processes.
- Measuring the time elapsed from the stimuli's occurrence to the SC's response. The terms related to the response's assessment include respond rapidly, respond fast, quickly respond, time-effectively, react promptly, quickly adapt, right time, timely manner, a response time window, speed, and promptness.
- Ability is important in the management process to adapt, integrate, and reconfigure internal and external organizational skills, resources, and functional competencies to the changing environment.

## 2.5 References, antecedents, and consequences of SCR

According to Rodgers (1989, p. 5), references can be defined as follows:

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The facts, situations, or phenomena on which the application of a concept is considered appropriate. Description of the antecedents and consequences favors the clarity of the concept analyzed. The antecedents of a concept are the events or phenomena that generally precede an instance of the concept. Consequences follow an occurrence of the concept.

Greenway et al. (2019) clarify that antecedents are factors that cause the phenomenon to occur, while the consequences are the results obtained after the concept's application. Furthermore, Tofthagen and Fagerstrøm (2010) suggest asking the following questions to identify the antecedents and consequences. Regarding antecedents, which events or phenomena have been associated with the concept in the past? For consequences, what happens after or as a result of the concept?

## 2.5.1 Antecedents

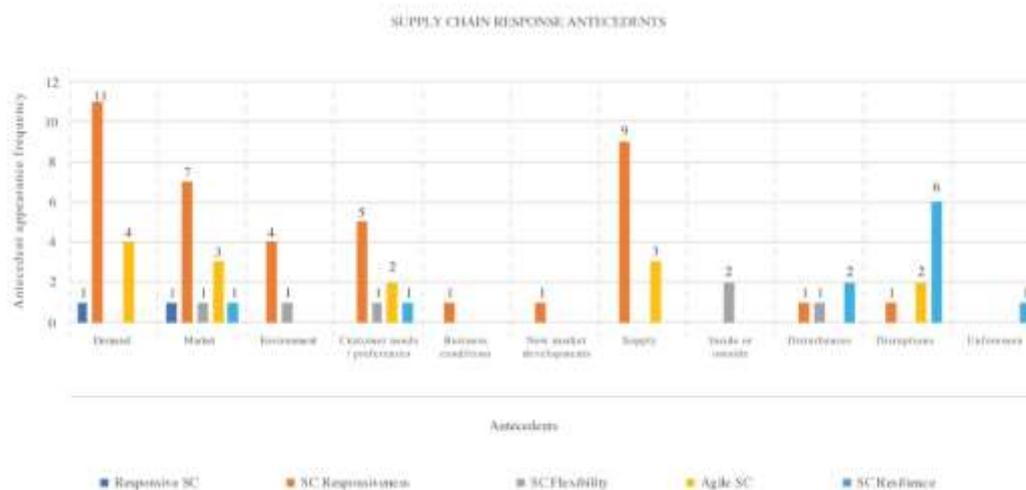
The antecedents that allow for adequate application of the SCR concept include events or situations that are either external or internal to the SC (Garavelli, 2003; Nehzati et al., 2014). The external antecedents the SC responds to are variations in demand, natural calamities, political changes, unforeseen events, new competitors, and new products. The internal antecedents are lower backorders, lost sales, adjustments in periods of low manufacturing performance, and poor delivery. Antecedents were identified with general terms, such as opportunities and threats, external stimuli, significant events, predictable and unpredictable changes, changes in a business environment and customer demand, and market, supply, and other unforeseen changes. Other terms that imply antecedents of SCR are disturbances and disruptions. Antecedents examples are:

- Changes in demand/market: Apple's company response to changes in demand for cell phones was through changes in the color of LCD screens and the use of wireless networks in cell phones.
- Environmental changes are changes that occur in the economic, political, or demographic sphere.
- Change in customer needs/preferences: the green supply chain encourages the satisfaction of the customer's need to obtain eco-friendly products.
- Variations in business conditions: number of product- types, and the time window for delivery.
- Newmarket developments: the Tata Ace company created a new market for small commercial vehicles that had previously not existed and introduced the mini-truck concept in India.
- Supplier changes: suppliers make changes in quality, cost, and safety for employees.
- Internal or external changes: the change in the order quantity has two points of view. First, the order quantity change is an internal SC change when the order quantity change occurs between the marketing and production processes. Second, the change in order quantity is an external change to SC when the customer changes the purchase order.

- Aggressive competitive maneuvers; hurricanes; and pandemic are disruptions.

Fig. 1 shows the antecedents identified in the terms related to the supply chain’s response. Consequently, the responsiveness of the SC and the receptive SC mainly treat these antecedents as changes external to the SC. SC agility and flexibility address external and internal antecedents, while SC resilience deals with the response to internal SC changes.

Figure 1. Antecedents identified in the terms related to SCR.



## 2.5.2 Consequences

The consequences identified in the SCR concept analysis are both positive and negative. The positive consequences provide wealth to shareholders in the supply chain (Gunasekaran et al., 2008), increase agility and competitive advantage (Sundram et al. 2018), meet performance indicators, improve customer satisfaction, and meet urgent needs for people affected by a disaster (Jahre & Fabbe-Costes, 2015). The negative consequences are excessive use of resources invested in the response and, therefore, an increase in the chain’s costs. The chain members interest in responding to a stimulus at any cost produces negative consequences such as loss of competitiveness and non-compliance with objectives related to environmental conservation. If the chain responds late, the negative consequences are the loss of brand image and credibility.

## 2.6 A model case for the concept

As Rodgers (1989) explains, a model case can clarify analytic results by providing an everyday example that includes the concept’s attributes. It is also important that the model case be identified, rather than constructed. Thus, we present a case based on a sanitary mask production SC in Korea. This case model stems from Lee et al.’s (2020) research on this SC. Sanitary

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masks, as personal protective equipment, have been instrumental in reducing the spread of COVID-19. The related SC structure is composed of raw materials, stemming from spun-bonded or fused non-woven producers, distributors delivering the product to retailers, and retailers delivering it to consumers.

Several SC functions were involved in the response to the increased demand for sanitary masks, including product research and development, SC management, suppliers, production, distribution, packaging, human resources, and information systems (IS). The research and development area prepared new filters for sanitary masks. Then, SC managers applied reactive and proactive strategies. Two reactive strategies were used by SC managers. The first was to obey governmental orders not to export more than 10% of the daily production of sanitary masks and the second was to send more than 50% of the daily production to points of sale. Consequently, the SC managers reviewed their contracts with international customers, representing a proactive strategy. Then, the suppliers provided the materials equitably to the buyers. To meet the objective of supplying points of sale with sanitary masks at least every two days, production capacity was increased by 12 new production units. Also, the government issued sanitary mask manufacturing licenses to companies that make clothing and similar products. SC distributors and government logistics operators participated in distributing sanitary masks to all regions of Korea.

The packaging process contributed to the SCR by repackaging masks either in packages of 100, 1, or 2 units of sanitary masks. The human resources area agreed with workers to increase the number of working hours from 40 to 50 hours per week, and the SC's information managers shared information with other SCs and government health entities. Additionally, the costs of responding to COVID-19 were twofold: (1) government subsidies for maintaining new production lines and paying overtime and weekends, and (2) the immeasurable cost of not being able to save the lives of Korean people. Furthermore, the SCR's evaluation was carried out at different times during the pandemic. For example, in March 2020, the effectiveness of the measures was evaluated. One such measure was that the distributors were required to deliver 80% of their sanitary mask production within a maximum of two days from the production date. Finally, the IS connection of distributors, retailers, and hospitals was evaluated through the Health Insurance Review and Assessment Service portal. This IS connection contributed to distributing masks to both medical personnel and ordinary people.

The SCR attributes identified in the case described above are response strategy whether reactive or proactive, adapting of SC activities, response measurement, and ability to respond of the SC. According to Bernardes and Hanna (2009), the reactive strategy is executed when external factors impose changes to the SC, and the proactive one is when the SC uses its knowledge to impose changes in the environment. In this sense, the reaction of the SC to the government orders issued to mitigate the effects of COVID-19 on society was to make changes in the quantity of production and distribution of sanitary masks. Regarding the proactive strategy, the SC used the knowledge it gained about the effects of the pandemic on both society

and SC to renegotiate mask export contracts.

Eckstein et al., (2015) stated that the SC adapts its configuration to respond to changes in the environment. The adaptation of the activities carried out by the SC of Korea in the response to COVID-19 is evident in areas such as production, human resources, IS and packaging. The SC measured and evaluated the response based on the rapid and timely delivery of sanitary masks to the community. According to Nehzati et al., (2014) speed and opportunity are characteristics that affect SCR. Supply chain responsiveness was developed based on the coordination and integration of SC members, logistics service providers, government, and health institutions, confirming Ghosh et al., (2015) who ensured that the SCR depends on the effective coordination of activities within the chain and between companies. Based on Nehzati et al., (2014) the antecedents to which the SC responds can be internal or external, in this study, we identified 3 antecedents. (1) the COVID-19 pandemic is proclaimed, (2) demands for healthcare masks increase, and (3) changes in supplier, manufacturer, and human resource capacities caused disturbances. The identified consequences are related to meeting the SC's objectives, such as minimizing costs and increasing order fulfillment in the production of healthcare masks, and fulfilling non-SC goals, such as the government's goal of maintaining an open and safe democratic society while saving lives. The authors of this study believe that the consequences of the response depend on the context where the response is given. For example, in the context of the response as a weapon to increase competitive advantage, the consequences are increased shareholder profit, cost reduction, increased speed and flexibility (Gunasekaran et al., 2008). While in the response to a natural disaster the consequence is to save lives (Jahre and Fabbe-Costes, 2015). Overall, the model case shows that the SC responded in a coordinated manner to the stimuli created by a pandemic. The case also confirms that the response to stimuli implies the adaptation of activities to achieve the fulfillment of the objectives of SC and other goals, in this case, humanitarian objectives. Finally, this case model example substantiates the use of concept analyses to describe and explain the concept being analyzed.

### 3. Pillars of an SCR definition

Based on the attributes, antecedents, and consequences, we can conclude that a general SCR definition must have four basic ideas or pillars. The first pillar is the stimulus to which the SC responds. Any SCR definition must contain external or internal stimuli. These include all the SCR antecedents, such as changes, events, disruptions, and disturbances. Overall, stimuli drive the SCR. The second pillar is the adaptation of SC activities. The second pillar involves SC managers applying a response strategy, defining how to respond, as well as the time constraints and cost of the response. They also define which activities must be adapted to respond correctly to a stimulus. Adapting activities is a skill that the SC develops further in each response. The third pillar involves the objectives to be achieved with the response. The SC managers propose these objectives, which include both the SC's goals and the environment-, society-, and

customer-centered objectives. The fourth pillar is the response's evaluation. An SCR evaluation includes two factors: (1) the time it takes for the SC to adapt the activities it performs to respond to a stimulus, and (2) fulfillment of the objectives that the SC intends to achieve with the response. Next, the components of the four pillars are described.

The SC responds to stimuli such as changes in demand and customer preferences, the appearance or disappearance of a new competitor, changes in the value of the currency the chain uses to make financial transactions, unforeseen machine stoppages, information system crashes, labor absenteeism, natural disasters, manufacturing plant fires, and product distribution route closures. An SC responds to any of these stimuli by adapting one or more of the following activities: marketing and sales, finance, research and development, manufacturing, purchasing, and logistics. According to Lambert and Enz (2017) the SC adapts management processes like customer relationships, supplier relationships, customer service, demand management, order fulfillment, manufacturing flow management, product development and commercialization, and product return to respond to a stimulus. The objectives that the SC intends to achieve with the response include, on the one hand, the classic objectives of maximizing profits, minimizing costs, and meeting customer expectations. On the other hand, the response contributes to the fulfillment of objectives such as producing and consuming products responsibly. It also helps achieve the objectives linked to social and fiscal responsibility. The response evaluation is performed by checking for compliance with economic, performance, and other indicators specific to each area. It is also done by examining the requests, complaints, suggestions, and the claims made by both customers and the society at large.

#### 4. A new definition of SCR

Considering the previous results and discussion, we propose a new general definition of an SCR: an SCR is the ability to respond to stimuli received by one or more members of the chain by applying reactive and/or proactive strategies to adapt their activities within a particular time frame, in a way that allows the evaluation and achievement of certain goals. This proposed definition implies that when using the term SCR, the following aspects must be specified: (1) the stimulus being responded to, (2) the activities that are adapted to respond to the stimulus, (3) the SC's objectives that are met with the response, and (4) the SCR's assessment based on response time and achievement of objectives. This general definition expands the factors that should be considered in related theoretical and practical research, and provides a new development stage for the concept, based on the four pillars identified.

The proposed definition of SCR is applied by simultaneously identifying and analyzing the four pillars in the response to a stimulus. For example, the SC of the energy sector in Europe that faces the challenge of guaranteeing in the last four months of the year 2022 the availability of gas both in homes and industries can apply the previously proposed definition of the SCR by identifying the following pillars. (1) The stimulus to which the supply chain responds is

anticipating gas shortages in Europe; (2) the SC adapts the gas production and distribution processes, as well as the supplier and customer relationship management processes; (3) the objectives that the SC intends to achieve with the response are to ensure the availability of gas, control production costs and sale price, and continue to comply with the objective of reducing gas emissions, and (4) achieving the indicators associated with the objectives that the SC intends to achieve will facilitate the evaluation of the response. Furthermore, the gas consumers will evaluate this response by expressing their satisfaction or dissatisfaction with the availability of gas to carry out daily activities and the price to pay.

## 5. Conclusions

This study analyzed the concept of SCR by applying the evolutionary concept analysis method and identified the SCR attributes, antecedents, and consequences. Consequently, we were able to describe the four pillars that an SCR definition must contain and propose a new SCR definition. This definition is applicable for responses to any stimulus from any area of the supply chain. Overall, as this study established the foundations of a general SCR definition, it contributes to the literature by laying the groundwork for reaching an agreement on this concept and promoting the development of research in this area.

This study's main limitation is as follows. The selection of the surrogate and related terms that revealed an adequate application of the concept, was made at our discretion. This may have resulted in excluding documents that could contribute to a better evolutionary analysis application for the concept. In this regard, future research may focus on applying artificial intelligence techniques to identify surrogate terms and terms related to SCR. Furthermore, future studies can extend the evolutionary concept analysis method to other SC concepts, such as SC sustainability, robustness, and redundancy. Moreover, based on the proposed SCR definition, several future lines of research can be suggested. For instance, future studies can attempt to determine the relationships between the four pillars of the SCR definition. Additionally, scholars can propose a general framework that considers the four described pillars, to ensure that an SC can respond properly to the stimuli that it receives. Finally, future research should examine the usefulness of the pillars, both in SC research and practice.

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