Supply chain resilience strategies: the case of pharmaceutical firms in Morocco

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Abstract:

The current environment is featured by disruptions such as fluctuations in demand, risks of relations with suppliers,…. Accordingly, the company needs resilience to alleviate these risks and continue operating its activities through main strategies that are underlined broadly by recent researches such as flexibility, redundancy and agility. This research aims to minimize the dearth of empirical researches in the realm of supply chain resilience strategies by investigating empirically the *proactive* and *reactive* strategies that improve resilience in pharmaceutical firms. In this research, the supply chain resilience strategies are basically related to. An empirical study was conducted in 33 the pharmaceutical firms. Afterwards, the response rates of participants were calculated for each of the supply chain resilience strategies (in "very great extent"). Accordingly, the results demonstrated that most of the strategies related to supply flexibility, demand flexibility, redundancy and the supply chain risk management process are applied very frequently. However, the strategies formulating the production flexibility are applied frequently (very extent) but not very intensively (not in "very great extent"). On the other side, these strategies aim to achieve resilience through proactive or reactive ability. Then, the analysis of results demonstrates that a large part of supply chain resilience strategies used by pharmaceutical firms are proactive and appertain to all elements of supply chain resilience (supply flexibility, demand flexibility, ….).

Keywords: supply chain resilience (SCRES), supply chain resilience strategies, pharmaceutical industry, proactive, reactive.

JEL Classification: M11, M16, L25, I11,

Paper type: Empirical research,

I. Introduction:

The current practices expose businesses to a huge range of unexpected disruptions. For example, firms focus on lean strategies (Kilgore 2003) through reducing inventory holdings, cutting the number of suppliers to achieve efficient operations. In addition, supply chain is become more complex and vulnerable due to some practices as globalization (Christopher and Peck 2004) and outsourcing of noncore activities (Purvis et al., 2016). In addition, the supply chain carries out several activities that can induce disruption and unintended consequences (Andotra and Gupta, 2016). These disruptions could include loss of a critical supplier, shorter product life cycles, production problems and increasing customer demands (Ponomarov and Holcomb, 2009), malfunctions of information technology (Baylis et al., 2015), capacity constraints, demand uncertainty for products and variety of products. Furthermore, several events occurred beforehand have exposed the supply chain to disruptions such as natural events (Wagner and Bode, 2008) and incident of Hurricane Sandy in 2012 (Creighton et al., 2014).

These disruptions can generate undesirable operational and financial impact to businesses (Ponomarov et Holcomb, 2009). They can cause rise of costs and increase in the lead time. As a result, the supply chain needs resilience to maintain the capacity of rapid risk reduction (Christopher and Peck, 2004) and the capacity to sustain operations even during disruptions (Mandal and Sarathy, 2018). Thus, practitioners and academics stressed the prominence of resilience that is regarded as an essential strategic capacity (Sheffi and Rice 2005) to absorb the impact of crises and perform a prevailing role in restoring operations.

Resilience refers to the company's ability to respond quickly to operational risks (Sheffi and Rice, 2005) or risks that are beyond the control of companies, such as natural disasters. It relates to the ability of companies to survive and adapt to these changes in the environment (Scholten et al., 2014). Furthermore, resilience is defined as the capacity of the company to react to risks in order to rapidly and efficiently return to normal operation state and normal or desired level of performance after the disruptions (Ponomarov and Holcomb, 2009).

As a result, the resilience of the supply chain is attained through different dynamic capacities of the supply chain (Mensah and Merkuryev, 2014) that ensures the adaptation to environmental changes and the turbulence through constant integration, recombination and alignment of firm resource base (Yao and Meurier, 2012).

Therefore, many recent researches raised the prominence of the different strategies (practices) that improve and develop resilience (Mensah and Merkuryev, 2014). These strategies such as collaboration between supply chain partners, flexibility, redundancy and agility are also designated as "antecedents of supply chain resilience" as they deal permanently with change in environment through recognize, anticipate, respond to disruptions and recover from.

These strategies are studied theoretically, however as Mandal and Sarathy (2018) state, the field of supply chain resilience has dearth in empirical studies. In addition, Mandal (2012) argues that most studies of supply chain resilience rely on conceptual rather than empirical researches. Similarly, Juttner and Maklan (2011) and Ambulkar et al., (2015) argue that the strategies for resilience are not sufficiently explored (Ambulkar et al., 2015).

As a result, this article intends to address the following research question: What are the paramount supply chain resilience strategies deployed by the pharmaceutical industry?

In the objective to deal with this question, the aim of this research is to investigate empirically the dominant (essential) supply chain capabilities undertaken by the Moroccan pharmaceutical industry which benefit from a growing interest. It aims to identify and assess the amplitude of implementation of these resilience strategies in this industry. These various strategies capabilities are intensively brought out and recommended by the literature to cope with the disruptions (Ambulkar et al., 2015). This research focuses on three potential strategies that strengthen resilience namely: flexibility, redundancy and "the

supply chain risk management process" which are relevant strategies emphasized in the literature on resilience (Rice and Caniato 2003). The flexibility strategies used are divided into: flexibility of supply, flexibility of demand and flexibility of production (internal processes). The literature underlined the prominent impact of these three strategies on supply chain resilience. Consequently, these strategies build resilience through their ability to prepare for unexpected risk events and disturbances, responding and recovering quickly from events. These capacities constitute the practices that preserve the capacity to offer value to end customers (Bhamra et al., 2011). They create all beyond the adaptive ability to reduce disruptions the probability and impact, the capability to return to the original state or achieve a new growing state.

As a result, and firstly, this research contributes to theory as well as practice by spotlighting the most applied and essential supply chain resilience practices in the pharmaceutical industry which benefit from a growing interest. The pharmaceutical firms are exposed to disruptions such as interruptions for critical raw materials, competition from foreign laboratories, risk of information technology and long lead times of delivery. Hence, firms must be resilient to survive disruptions and restoring operations to continue the supplies of medicines to pharmacies and patients. Thus, this research will show how the organizational ability can adapt and modify its resources and capacities to deal permanently with change in the environmental and with optimal allocation of resources.

In the second place, this research classifies with explanations the proactive and reactive supply chain resilience strategies in the pharmaceutical industry. In this way, we evinced the strategies that improve resilience by the ability to prepare for unexpected events (proactive strategies) and those that respond to risk effect (reactive strategies), as the resilience is determined as a set of organizational capabilities to face immediate and unexpected changes in the environment with proactive and reactive actions (Kamalahmadi & Parast, 2016; Ali et al., 2017). In third place, the paper gives a glance on how the supply chain resilience strategies are practiced in the pharmaceutical industry.

The article is organized as follows. we first present in section 2 an overview of the concept of supply chain resilience as well as the literature review relating the strategies that build supply chain resilience. The section 3 intend to set out the methodology of research. The results of empirical research are displayed and discussed in the section 4. Finally, we conclude and main directions for future research.

2. Literature review:

The resilience of the supply chain requires capacities to respond, recover and transform after a disruption. Therefore, this section exhibits first the concept of resilience. Afterwards, it describes the previous researches related to strategies or antecedents of resilience as well the literature on proactive and reactive supply chain resilience strategies.

2.1. Definition of the resilience :

The resilience is defined as : the ability of supply chain to achieve its original stable situation or to a new stable situation (Wieland et Wallenburg, 2013). Likewise, resilience is "«the ability of a supply chain to return to normal operating performance, within an acceptable period of time, after being disturbed» (Brandon-Jones et al. (2014). Furthermore, some authors refer the resilience to the ability to react to disruptions that are unpredictable (Kamalahmadi and Parast, 2016). Thus, besides that resilience endures reactive capabilities that are used to recover after disruption, it is also considered as proactive capability to prepare for unexpected events (Ponomarov and Holcomb, 2009). Additionally, the supply chain resilience fosters the ability to restore operations to the previous level of performance or even to a new and better level of performance (Christopher and Peck, 2004). Thus, resilience has been defined in the literature by referring to stages of anticipating, adapting, responding and rapidly, recovering from unforeseeable events (Blackhurst et al., 2011; Jüttner and Maklan, 2011). Hohenstein et al. (2015) added

another stage after recovery from disruptions that is growth after disruptions. In that way, the supply chain resilience aims to attend businesses to withstand disruptions so as to maintain continuity and recovery of operations. Therefore, it confers to the company the ability to sustain a competitive advantage from disruptions by positioning themselves better than its competitors (Sheffi, 2005), by surviving and continuing to respond to customers' expectations (in product and services) that have an unstable and unpredictable impact (Roberta Pereira et al., 2014).

2.2. Strategies of the resilience:

Several authors described empirically the strategies that reinforce resilience. Supply chain resilience strategies are mandatory to attend businesses in minimizing vulnerability to disruptions and to manage expected and unexpected turbulences. For example, Agigi et al. (2016) drawn the different supply chain resilience strategies that restrain vulnerability to disruptions. The authors pull out several resilience strategies from empirical research that invoked case studies of 12 South African grocery manufacturers. These are typically supply chain design strategies, specifically, flexibility and redundancy which encompass strategies of global sourcing, selecting suppliers according to quality, price and service criteria, factory redesign to create additional capacity and flexible transportation. Christopher and Peck (2004) highlighted certain resilience strategies in a bid of reducing threat in the United Kingdom such as: supply chain design strategies, supply chain collaboration initiatives, understanding the network that associates the company to its suppliers and customers, a focus on supply chain agility and the creation of a supply chain risk management culture, low-cost sourcing from different countries, centralized distribution centers and outsourcing and the identification of essential points in the supply chain for supply chain operations.

Researches holds that resources and capabilities provide better outcomes for building resilience while taking into account the supply chain risk factors. In this sense, Brusset and Teller (2017) opted for Resource-Based View theory and dynamic capability theory to introduce a model that exhibits the relationship between lower capabilities that should be deployed to raise resilience in accordance with the context of the risk factors in the supply chain. They drew up a distinction between three types of capabilities that develop resilience: integration through information sharing among partners, collaboration with partners and flexibility. The results of their empirical testing pointed out that supply and external risks diminish the positive impact of capacity on resilience.

For the purpose of reducing the risk of global sourcing, Gunasekaran et al (2015) described the risks linked to the complexity of global sourcing which curtail the resilience of the supply chain and illustrated the various proactive strategies to deal with the complexity of the global sourcing. These strategies which combine between flexibility-efficiency are: the selection of suppliers who dispose of the production capacity, suppliers who set out the ability to develop new products, quality, flexibility, responsiveness, early involvement of suppliers, responsiveness, efficiency, close relationship and communication with suppliers, the assessment of the supplier associations, continuous monitoring, transparent supply chain and supply chain collaboration.

Some researches focuses on managing the compromise between capabilities deployed and their costs risks to achieve resilience. In this context, Pettit (2010) denotes that the targeted level of resilience is achieved when capacities are aligned with vulnerabilities and the balance between capacities and disruptions is attained. In other words, he considers that the capabilities that investing in excess capacity harms profit. In the same vein, he explains that the supply chain, which does not evolve sufficient capacity to reduce disruption is exhibited to risks.

Despite the fact that resilience is perceived costly, current research pointed out that efficiency is a component of resilience (Pettit et al., 2010). Thereby, the research of Adobor and McMullen (2018) looked into other types of resilience which form synergies between them and are an inherent compromise between them. These types of resilience strategies are ecological resilience, evolutionary resilience and

engineering resilience. They set out a summary of the conceptual framework that associates the capacities of supply chain resilience to the diverse types of resilience which in turn upgrade the four phases of supply chain resilience. For example, to uphold ecological resilience, he suggests functional redundancy. For engineering resilience, he propounds the visibility strategy and the contingency planning (CP) and postponement, supplier risk assessment, supplier control and lean manufacturing. Likewise, Purvis et al. (2016) integrated the lean strategy as a component of resilience. They construct a conceptual model that encompasses the various capacities to establish resilience. The authors presumed that interaction and integration between robustness, agility, lean and flexibility strategies develop resilience and reduce costs.

Jain et al. (2017) applied another approach of the interpretive structural modeling model (ISM) to model the relationship between practices or "enablers" that build resilience such as : collaboration, sustainability, market sensitiveness, trust, visibility, risk and revenue sharing, supply chain structure, risk management culture and technology capability. The model hierarchically incorporates the most important capacities of the supply chain resilience and that must be practiced sequentially to achieve resilience. The hierarchical model test showed that information sharing is the basis of the hierarchical model, it generates then, visibility and trust between partners.

Ribeiro and Barbosa-Povoa (2018) realized the state of the art on the diverse strategies employed in previous models to quantify resilience. For example, they cited the strategies of Soni et al. (2014) who proffered the graph theory model to study the relationship between resilience capacities such as agility, collaboration between actors, risk management culture, structure supply chain, trust between partners and sustainability in the supply chain. They presented the importance of different capacities that promote the resilience of the supply chain against disruptions. The objective of their research is to assess and quantify the resilience of the supply chain utilizing the numerical index.

Other supply chain resilience strategies have been mentioned by authors such as redundancy, innovation and leadership (Kamalahmadi and Parast, 2016), redesign of the supply chain (Christopher and Peck, 2004; Ponomarov and Holcomb, 2009), learning capabilities (Blackhurst et al., 2011; Jüttner and Maklan, 2011), flexibility in production, flexibility in order fulfillment (Fiksel et al., 2015), insurance, preventive maintenance and the flexible supply of suppliers (Mäkilä, 2014). Ambulkar et al. (2015) pointed out that "supply chain disruption orientated firms" involve new resilience strategies, for instance, the infrastructure for risk management (such as the presence of the disruption management department, information systems, the establishment of key performance indicators (KPI) and metrics to monitor the supply chain risk management) and the ability to reconfigure resources in compliance with the environment context.

2.3. Proactive and reactive SCRES strategies:

The supply chain resilience strategies create all beyond the adaptive ability to reduce disruptions the probability and impact, the capability to return to the original state or achieve a new growing state. Accordingly, the supply chain resilience is compounded by strategies that prepare for disruptions, respond to disruptions and recover from disruptions.

In this setting, the *proactive strategies* focus on the implementation of ex-ante (preventive) measures before the occurrence of an incident. On the other hand, *reactive strategies* are actions taken when the disturbance has occurred and detected.

Scholten et al., (2014); Tukamuhabwa et al. (2015) and Hohenstein et al. (2015) ranked resilience strategies into pre-disruptions and post-disruptions strategies. The pre-disruptions phase which pertains to the preparation and mitigation of disruptions. The second post-disruption phase which refers to the actions performed to alleviate the impact or effects of a risk that has already occurred to sustain business performance. Some researches arranged resilience strategies according to these phases of resilience: before disruptions (preparation), during disruptions and after disruptions. For example, Ali et al. (2017)

assembled a systematic literature reviews of 100 articles written between 2000 and 2015 on the supply chain resilience where they concluded the relevance of studying in an integrative view the relationship between constructs (components) of resilience such as phases, strategies, capabilities, elements and their practices to elevate the knowledge in the realm of supply chain. They suggested through this analysis of the resilience literature 27 managerial practices that maintain the resilience capacities of the supply chain. They also showed up a conceptual framework which attributes the different practices underlined in the literature for each of the five capacities that compound resilience, namely: the ability to anticipate, to adapt, to respond, to recover, and to learn. Chowdhury and Qaddus (2016) also synthesized the different resilience strategies that are specific to each stage of resilience (pre-disruptions and post-disruptions) for the mitigation of disruptions. They suggested for the pre-disruptions phase strategies of : flexibility, redundancy, visibility, financial robustness, diversity, reactivity and early warning signal analysis. On the other hand, they outlined strategies for the post-disturbance phase (reactivity and recovery) such as: recover within less time, efforts and costs. Plenert et al. (2012) also divided resilience strategies into proactive, reactive and post-recovery strategies, except that each of these stages is in turn subdivided into operational and strategic actions or strategies. Consequently, he incorporates proactive strategies, for example, the construction of continuity plans, the assessment of the company's vulnerabilities, assessing the company's ability to respond to risks, control of the supply chain as well as the control of suppliers. For the reactive stage, it advocates strategies for assessing the impact of disruptions on the supply chain and adopting core measures for managing disruptions and thinking about decisions regarding supply and demand during disruptions. Finally, for the recovery stage, the authors recommend to reassess the disturbance detection systems. Hohenstein et al. (2015) conducted a literature review on articles published between 2003 and 2013 to provide a synthesis on the different concepts of resilience in the supply chain and determinate the antecedents of resilience. The strategies of resilience are split into proactive and reactive strategies. Proactive strategies encompass strategies such as collaboration, human resource management, management of inventory, contingency plans and the multiplication of suppliers and additional production resources. As for reactive strategies, they are associated to the post-disruptions phases which comprises the response, recovery and resilience growth phases which are used after disruptions in the supply chain. They imply flexibility strategies, management human resources, redundancy and agility, velocity, quick supply chain redesign, information sharing. On the other hand, Datta et al. (2017), proposed to assign different strategies for different types or situations (contexts) of uncertainty, namely: either unexpected events or operational vulnerability or complexity of the supply chain. Thus, they set out proposals that encompass strategies that have to be established so as to build resilience for these three types of uncertainty.

2.4. Supply chain resilience strategies definition:

These strategies foster resilience by responding effectively to risks in a bid to absorb variations and unexpected events and even more restore the supply chain to its normal state or a more desired state after the disruptions.

2.4.1. Flexibility:

Flexibility is a crucial strategy to up against the unstable environment and to address several risks such as the risks of unavailability of raw materials, risk of flexibility in the quantity of products, ….

Furthermore, Elcio and Cristina (2007) described the flexibility of the supply chain as the ability to respond to the uncertainty of the environment with minimum penalty in time, effort, cost and performance. Day (1994) outlined that flexibility is the ability of the business to uphold quickly and efficiently the fluctuating customer needs for delivery, support and internal and external services.

2.4.1.1. Supply flexibility:

Supply is a strategic function that confer the competitiveness of companies (Carter and Narasimhan, 1996), inasmuch as any type of disruptions stemming from the flow of goods can have an impact on all the companies linked together along the supply chain (Christopher and Holweg, 2011). For example, Ericsson lost 400 million euros due to the failure of its supplier Philips to deliver components. This incident is caused by factory of supplier's semiconductor that caught fire in 2000 (Norrman and Jansson, 2004).

2.4.1.2. Demand flexibility:

The customer flexibility refers to the ability to respond rapidly and cost effectively to unpredictable changes in markets needs and increasing level of environmental turbulence, both in terms of volume and variety (Agarwal et al., 2007; Wieland and Wallenburg,2013). The rapid responsiveness to changing market is realized through development of responsiveness capabilities quality improvement, delivery speed, cost minimization, centralized and collaborative planning, use of IT tools, trust development and new product introduction (Carvalho et al., 2012).

2.4.1.3. Production flexibility:

The role of Manufacturing flexibility is to recombine resources, reduce switching costs, speed resource recombination and foster synergy creation (Seebacher and Winkler, 2014). The manufacturing flexibility increases the reaction to uncertainty of dynamic market (Mendes et Machado, 2015).

2.4.2. Redundancy:

Businesses need to bolster redundancy as a result of the practices resilient supply chain that cannot prevent injurious events throughout the supply chain.

Consequently, we advance two crucial strategies of redundancy influencing resilience (Sheffi and Rice, 2005). However, redundancy not just encompasses the multiplication of suppliers and the building of stocks, it refers, furthermore, to all the resources kept in reserves that serve as capacities to quickly absorb future disruptions such as increased demand, lack of raw materials, production interruption, etc.

The types of redundancy are: buffer time, additional machines, additional transport capacities, multiplication of roads and multi-carrier, additional production lines or facilities, additional warehouses.

Likewise, an additional buffer time afford the reaction to disturbances. Some authors affirm that the redundancy contributes to "buy time" so as to manage disruptions (Zsidisin and Wagner, 2010).

2.4.2.1. The stocks:

Redundancy stand for reducing the risk by securing the availability of solutions in the event of an interruption and promotes flexibility, so that the reaction time to these disruptions is mitigated and the propagation time of the risks is reduced. In the case of redundancy, resources are in advance available are used to create the agility to quickly identify disruptions.

2.4.2.2. The multiplication of suppliers:

Multiple sourcing strategies are used when the buyer systematically uses several suppliers for each product or service. This strategy is enforced to reduce the effects of supply risks as well as to shrink the stock out.

2.4.3. Supply chain risk management process:

Supply chain risk management focuses on identifying sources of risk, their assessment and control throughout the supply chain to implement congruent strategies. Managing supply chain risks is crucial for continuous improvement process for firm's risk management. It reduces the risks which negatively induce the operational and financial performance of the company. There are four types of risk

management strategies: accepting, avoiding, mitigating and transferring risk. Risk management is an important tool for dealing with security threats.

3. Research method:

In order to investigate the different resilience strategies of the supply chain, we structured the questionnaire to collect data in Moroccan pharmaceutical laboratories. This section clarified how the items (supply chain resilience strategies) in the questionnaire were developed and how the survey data were collected.

3.1. Measures development and data analysis :

For the purpose of examining the diversity in scope and research tools, our multimethod field research study is based on the following three steps:

3.1.1. Analysis of the literature review :

Firstly, the questionnaire is formulated from the literature (research documents) substantially reviewed to grasp the strategies that create resilience. Thus, the questionnaire comprises selected items from previous studies (Tachizawa and Thomsen, 2007; Urciuoli et al., 2014; Mandal and Sarathy, 2018) as well as others that were added following interpretations of the respondents on the different items of the questionnaire and on the questions we raised. The subjects drawn up in the literature are associated to strategies or antecedents of resilience, the definition of resilience in the supply chain, the phases of resilience, the relationship between resilience and lean. A set of elements composed the questionnaire such as: supply flexibility, demand flexibility, production flexibility, the risk management process and the redundancy. Each element is constituted and measured by a set of items (supply chain resilience strategies).

3.1.2. Test of the questionnaire:

In a second phase, the questionnaire was tested with managers in the pharmaceutical laboratory. We submitted the questionnaire to a minimum sample of 10 participants who are supply chain decision makers. At the same time, they replied to questionnaires and were encouraged to comment the relevance or "content validity" of the questions (items) in the survey. In addition, we had the opportunity to pose some questions that are related to the resilience of the supply chain to managers such as: drug manufacturing processes, how you realize the speed of recovery of disruptions, how you prepare the supply chain to disruptions, how you accomplish the trade-off between cost and efficiency, are strategies like planning, control, redundancy, … Could the capabilities prevent disruption and absorb the impact disruptions?

Therefore, taking into account the responses on the questionnaire, certain items which were marked by managers as applied in "little extent" or are "not at all" applied. (i-e are not used by the pharmaceutical industry) have been eliminated as strategies associated with "postponement" which is not commonly used in the pharmaceutical industry.

Moreover, other items were incorporated in accordance with the authors' clarifications on the strategies addressed in the pharmaceutical industry to absorb disruptions.

3.1.3. Administration of questionnaire:

Ultimately, the questionnaire was attributed to supply chain managers. In this phase, we primarily contacted the respondents to arrange an appointment with them. Likewise, we displace to the location of companies for which we got an appointment in order to fill out the questionnaire. Consequently, we definitely elicited a number of 33 responses from a total number of companies of 40, a response rate reached almost 69%.

Data were collected making use of a four-point Likert scale consisting of: "Very great extent", "great extent", "moderate extent", "little extent" and "not at all". Respondents are requested to use the measures so as to express the extent the strategies of supply chain resilience are deployed in their businesses. They assess the degree of deploying of supply chain resilience strategies.

3.1.4. Data analysis:

After data collection, response rates are calculated in the form of percentage for each resilience strategy and for each option (from "Very great extent" to "not at all"). The rates are shown in figures 1, 2, 3, 4 and 5.

3.2. Data collection and sampling:

The context of this research is the pharmaceutical industry in Morocco. Consequently, the population of this study involves the producers of the medicines. The table 1 depicts the size and turnover of companies.

The list of laboratories for this study was extracted from the database administered on the site of the "pharmacy and medicinal products directorate" in Morocco. The database encloses 40 Moroccan pharmaceutical laboratories. We contacted the companies by phone for an appointment. In the interest of collecting relevant information, the interviewees targeted was the supply chain managers who were selected due to their knowledge and their comprehensive visibility on all the crucial risk management, manufacturing, distribution, storage, planning,… Participants possess a strategic and operational knowledge of the company's supply chain, disruptions and the resilience strategies operated.

Before starting the interview or the answer to the questionnaire, we give clarifications on the objective and the research question as well as we ensure to the participants that the name of the company will be confidential. The interview duration was 1 h and 10 min on the average.

Table 1 and 2 display the characteristics of the participating pharmaceutical companies: annual revenue sales and size of companies.

Table 1 : Revenue sales of pharmaceutical companies

Revenue sales in MAD (millions)	Number of firms	Percentage
Less than 1	0	0
From 1 to 20	2	6.7%
From 20 to 50	3	10%
From 50 to 100	1	3.3%
More than 100	24	80%

Source: *Authors*

Table 2 : Number of employees of pharmaceutical companies

Number of employees	Number of firms	Percentage
Less than 10	0	0%
Between 11 to 50	1	3.2%
Between 50 to 100	9	29%
Between 100 to 200	5	16.1%
Between 200 to 300	6	19.4%
Between 300 to 400	2	6.5%
Between 400 to 500	2	6.5%
More than 500	6	19.4%

Source: *Authors*

3.3. Measurement validation:

Table 3 : KMO, Cronbach's alpha, Eigenvalues and variance.

Supply chain resilience startegies	Kaiser-Meyer-Olkin (KMO)	Cronbach's alpha	Eigenvalues	Cumulative % of variance
Supply flexibility	0.594	0.598	2.103 1.810 1.615 1.186	74.606%
Demand flexibility	0.638	0.752	2.873 2.212 1.681	61.506%
Production flexibility	0.571	0.639	2.387 1.897 1.325	70.098%
Supply chain risk risk management process (SCRMP).	0.730	0.809	2.930	59.596%
Redundancy	0.594	0.690	1.928 1.832	62.667%

Source: *Authors*

A factor analysis was applied to summarize the data affiliated to the variables into a smaller number of factors. The factor analysis was accomplished with SPSS Statistics 21. As a result, this analysis allowed to obtain the results in table 3. Table 3 shows that the values of "Kaiser-Meyer-Olkin" for all variables are greater than the threshold value 0.5 as recommended by Hair et al. (1998). Consequently, the measure of sampling adequacy for all variables exceeded the 0.5.

Cronbach's alpha assesses the scale reliability or consistency of the items. The analysis demonstrates that the Cronbach 's alpha values surpass the threshold point of 0.7 for the both variables « demand flexibility » and "Supply chain risk risk management process ». Moreover, the Cronbach's alpha value is close to 0.7 for the variable « production flexibility ».

Regarding the two variables "supply flexibility" and "redundancy strategies", they attain a Cronbach's alpha value below 0.6. Nevertheless, might be accepted as Griethuijsen et al. (2014) indicates that Cronbach's alpha values equal to or above 0.6 are acceptable. In addition, the evoked items in the variable "supply flexibility strategies" are newly introduced in this research and aren't analyzed or mentioned in a previous researches for this variable. On the other hand, from the analysis of the table « total variance explained » resulted in four factors that explain 74.606 percent of the variance of all strategies of « supply flexibility ». In addition, the eigenvalue for the four factors are greater than 1. All factors for each variable have an eigenvalue exceeding the value1.0.

4. Results and discussions:

This section displays the rates of responses for each items that compose the three elements : flexibility, supply chain risk management process and redundancy. In this research, the importance of deploying supply chain resilience strategies that draw the attention of previous researches is tested.

The resilience attempts to restore the supply chain to its initial state after disruptions through strategies that prepare the supply chain for unexpected events, respond to disruptions and recovering from. In this respect, this section divides the strategies of supply chain resilience into *proactive* or *reactive* to obtain supply chain resilience. Furthermore, this section clarifies the reason of this classification and give glimpse how some strategies are applied in the pharmaceutical industry.

4.1. Flexibility:

Flexibility generates resilience, as several authors have endorsed (Sánchez et Pérez, 2005; Park, 2011). This section presents the rate of responses concerning the strategies deployed in the proactive and reactive phase of resilience. These strategies are related to supply flexibility, demand flexibility and production flexibility.

4.1.1. Supply flexibility:

Figure 1: Supply flexibility strategies
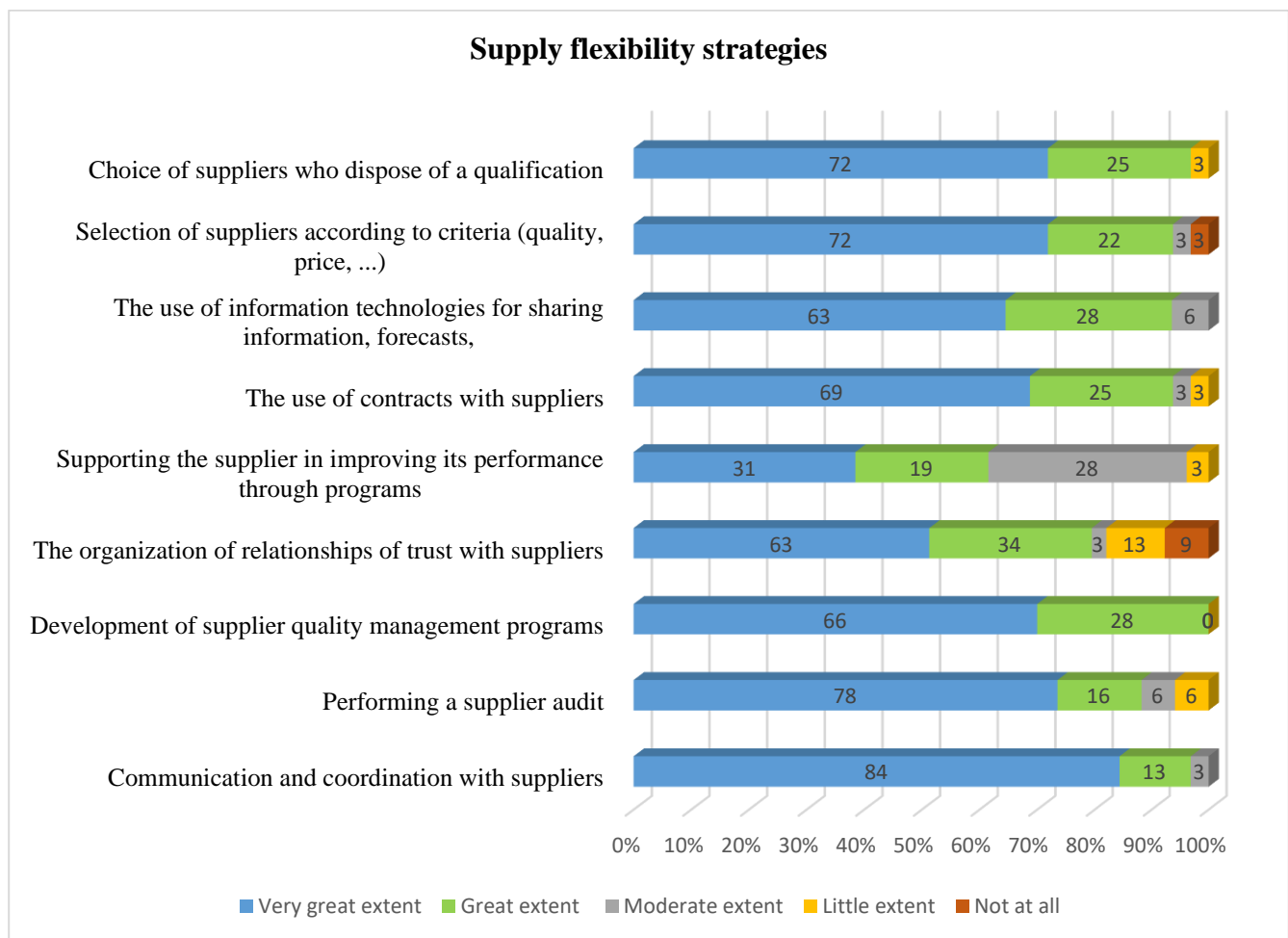
Source: *Authors*

The figure 1 displays that the major part of the strategies were marked with the " very great extent " option, which means that they are predominantly and frequently practiced in pharmaceutical companies.

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On the other hand, for the options "Moderate extent agree", "little extent" and "not at all" were feebly mentioned by the participants, which means that a minority of the respondents pointed out that these strategies are performed infrequently or are not practiced at all. Apart from the strategy "Supporting the supplier in improving its performance through programs" which was emphasized by 28% of the respondents moderately used.

4.1.1.1. Communication and coordination with suppliers:

The strategy of "Communication and coordination with suppliers" is utilized significantly by 84% of companies and 13% of respondents ("great extent") ascertain that they carry out this strategy, while no participant replied that this strategy is not exerted. It is used before *the occurrence of risks*, *during the disruptions* and *after the disruptions*. In the pre-disruption phase, the collaboration enables the shrinking of disruptions by sharing information on risks between partners in the supply chain that increases the visibility (Soni et al., 2014). Furthermore, collaboration spurs the supply chain partners to jointly solve problems *during disruptions*. On the other hand, collaboration bolster the *post-disruption stage* through sharing information on the future disruptions that could occur among the partners. Additionally, it reinforces learning among partners and helps to deploy jointly plans to reacts to future disruptions.

In the context of pharmaceutical industry, the collaboration between departments and partners refers to exchange information on demand planning, on medicines quality, the information on market, …. The information or feedback on the new launched medicines to the market are provided by pharmacies and sales representatives in order to find out if the product is successful or failed in the market. The information provided by pharmacies and sales representatives includes further the customers' preferences (shape of medicines as effervescent, tablets or capsule).

4.1.1.2. Performing supplier audit:

"Performing a supplier audit" is largely sustained by pharmaceutical firms as 78% of respondents underscored that this practice is put out in "very great extent" and 16% responded "great extent".

As a result, the supplier audit is a *proactive strategy* since it helps to diminish or eliminate risk sources related to suppliers and to preempt an adverse effect on the firm. For example, Simba et al. (2017) raised that supplier auditing is used to assess supplier risks and to obtain feedback in terms of financial risks and raw materials disruptions. The supplier audit embodies the evaluation of supplier with respect to a set of criteria fixed by the manufacturer as: quality, regulatory certificate, environment management system, customers claims, rates of return, …

In pharmaceutical industry, the audit of supplier integrates the evaluation of stocks, supplier delivery, the supplier documentation, the supplier production, …. The manufacturer performs a supplier auditing in each period to insure that the supplier preserves the quality of raw materials, as the manufacturer is in turn inspected by Ministry of Health. The manufacturer takes into account these precautions and choose qualified suppliers that comply with industry standards. These suppliers are certified because they fulfill dimensions as quality, technical aspects, flexibility and they comply with GMP (Good Manufacturing Practices). In addition, the supplier must detain agreement and authorizations of pharmaceutical industry as well as certificated factory, lines of production and production facilities. Furthermore, the supplier must meet the requirements of the pharmacopoeia, the certification of EHF (environment, hygiene and quality for ISO) and possess the compliance of raw materials and articles bulletins. Thereby, each manufacturer of medicines has a laboratory of quality monitoring that detect quality failures.

4.1.1.3. Selection of suppliers according to criteria (quality, price, …):

The supplier selection is a *proactive strategy* deployed intensively by pharmaceutical firms since 72% of respondents quoted that they are "very great extent" and 22% mentioned "great extent". It is undertaken to prepare for unexpected events and minimize risks of products as quality, advanced technological capability of supplier, risk of flexible quantity and of customization of raw materials.

Additionally, the pharmaceutical firms use the supplier selection based on criteria to opt for proper suppliers such as supplier's quality performance, price and lead time, *knowing the relations of the suppliers, if he works with acknowledged companies and the importance of the supplier on the market.*

In the same direction, Trent (2008) and Zsidisin et al. (2010) argue that managers allot time and effort for the supplier selection process for the purpose of examining supply disruptions and pick out suppliers who dispose of robust processes to manage these risks.

4.1.1.4. Development of supplier quality management programs:

The development of supplier quality management programs is executed to avoid medicines recalls and deliver effective and safe medications to consumers. Sanchez-Rodrigues et al. (2008) advanced that proactive supplier quality management avoids problems with customers, since, the supplier's continuous performance measurement identifies deviations from standards in order to implement improvement actions.

The pharmaceutical industry is regulated by the Ministry of Health. In this setting, the Moroccan code of the medicinal product impose the manufacturing of medicines products in accordance with requirements of Good manufacturing practices. The raw materials monitored by the laboratory of quality must comply with "the European pharmacopoeia industry standard". On the other side, the raw materials and the produced batches must comply with the specifications described in the marketing authorization (MA) of the pharmaceutical product. The marketing authorization (MA) confer to the laboratory the approval to sold the medicines after the assessment of dossier filed with the Ministry of Health. This later validates or disapproves the launch of the new medicine in the market (color, shape, composition, etc.) after evaluating quality, security, efficacy of medicines and product fabrication. Moreover, the pharmaceutical sold firms hold performance indicators regarding criteria to improve supplier performance. For these reasons, the supplier quality management is categorized as *proactive strategy* to manage and prevent risk of quality and recall as well as to keep functioning of system, therefore, this strategy reinforces resilience. Moreover, from this perspective of compliance with quality regulation, the results show that the strategy is frequently performed as 66% rated "very great extent " and 28% rated "great extent".

Thereafter, if the tests described by the supplier is in accordance with the results of laboratory tests, the raw materials get into the production process for the mixture and are then tested and verified. After verification, the company begins to produce industrial batches. The final products are stored in quarantine after their manufacture to control their quality, then if quality is consistent, the drug is deliberate.

The medicines are approved by the qualified person, typically the pharmacist responsible for medicines delivery them to clients. The pharmacist in charge is responsible for ensuring the quality of the sold medicines. This involves quality control of all the manufacturing process, i-e raw materials, bulk products, finished products and packaging items to ensure the quality of medicines.

4.1.1.5. The organization of relationships of trust with suppliers:

The relationships of confidence with suppliers is considerably stressed by the respondents (rate of 63% for "very great extent" and 34% for "great extent"). The trust is classified in this research as a *proactive strategy* as it diminishes risk by sharing information between partners in the supply chain (Faisal et al., 2007). It is a path towards long-term stability for the company and throughout the supply chain (Spekman et al., 1998). Furthermore, the trust between partners in the pharmaceutical industry allows the continuous improvement of the service.

4.1.1.6. Supporting the supplier in improving its performance through programs:

Companies assist their suppliers with a "supplier development program" in order to remain competitive. Nowadays, suppliers are perceived as a critical partner influencing product quality, delivery times and costs. Supplier support includes, for example, training and education programs for supplier personnel, problem solving assistance, know-how transfer and supplier quality assessment (Modi and Mabert, 2006).

Therefore, this strategy is *proactive* as it focuses on improving supplier process to evict supply risk problems and evict the medicines reshuffle. It is also reactive action that aid to resolve jointly problems of medicines. The result highlight further that this strategy covers a rate of response of 49%.

Un other approach to attend supplier is the development of new products in collaboration with suppliers. The development of new products in collaboration with suppliers is a strategy largely adopted by pharmaceutical. It is a prominent strategy deployed to deal with the fast changing environment. It alludes to the implication of the supplier with the manufacturer in an early stage of product development which is the stage of product design (Bidault et al., 1998). For example, the manufacturer request specifications in terms, for example, of packaging color, package leaflet, …

4.1.1.7. The use of contracts with suppliers:

The utilization of contracts for suppliers is a strategy that ensures flexibility in the quantities furnished from suppliers during unexpected changes in demand variation (Ghadge et al., 2017). This strategy is used by pharmaceutical industry (rate of 69% for "very great extent"+ 25% for "great extent") during the fluctuation of demand. Then, *it is a proactive strategy* aiming to preserve capacity that prevent the risk of delay in product delivery and stock-out.

4.1.1.8. The use of information technologies for sharing information and forecast:

The set-up of information technology is a *proactive* and *reactive strategy*. It facilitates the information sharing, the delivery of urgent products (Agrawal et al., 2008), the visibility, the diminution of time delivery, the product quality and allows the traceability of products from planning until the delivery of products. The information technology enables the quick identification of risks as the breakdown of supplier production.

On the other side, the supplier integration upgrade supplier service level in terms of urgent products delivery.

4.1.2. Demand flexibility:

This section brings into light the results of responses rates are described in the figure 2 and classify the different strategies related to demand flexibility according to proactive and reactive strategies. Typically, most of respondents marked the options "very great extent" and "great extent", unlike the three remaining options: "Moderate extent agree" applied, "little extent" applied and "not at all" applied.

Figure 2: Demand flexibility strategies
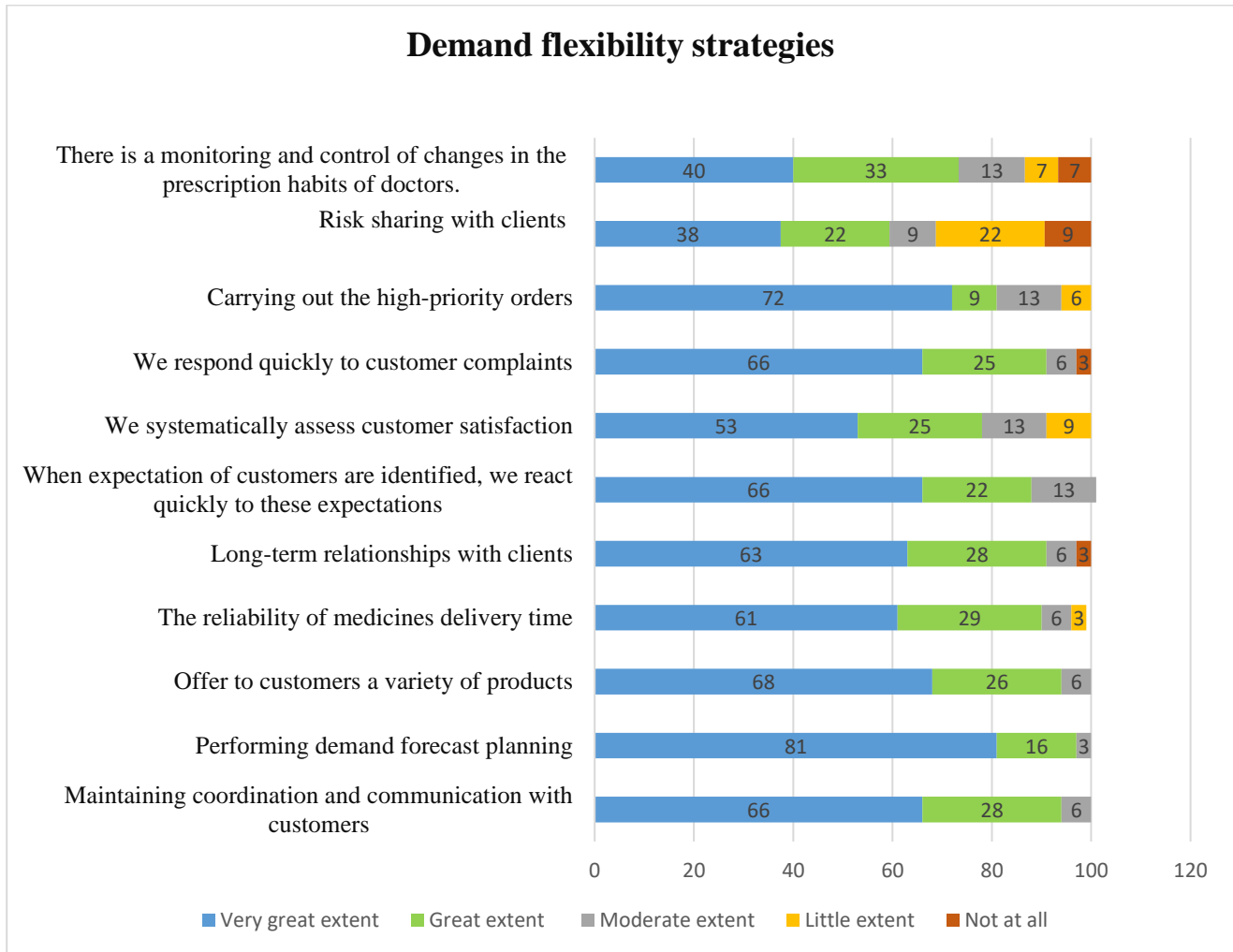
Source: *Authors*

4.1.2.1. Maintaining coordination and communication with customers:

The collaboration of pharmaceutical companies with their customers (wholesalers or pharmacists) is also highlighted as a highly practice put on by pharmaceutical firms (66% "very great extent" +28% "great extent"). Collaboration with customer is *a proactive strategy* comprising practices that helps avoid unwanted risks such as: sharing knowledge and experiences, joint-decision making, supplier quality management programs, supplier certification and jointly solving problems (Braunscheidel and Suresh, 2009).

Likewise, the collaboration between pharmaceutical companies and their customers, whether wholesalers or pharmacists is a *reactive strategy* involving sharing information and establishing joint efforts to solve problems. The information on demand that is exchanged between the pharmaceutical laboratory and customers encloses information on orders, inventory level, production and demand planning (Zhao et al., 2013). Furthermore, orders are collected from wholesalers, pharmacies, public and private hospitals and communicated to the supply chain manager. Hence, the firms need to coordinate between supply and demand to achieve the optimal stock level for both raw materials and finished products. The internal coordination is also prominent, it commits commercial department, internal pharmacist of firm, the production workshops, …

Brandon-Jones et al. (2014) and Christopher and Peck (2004) stated that sharing information among supply chain partners diminishes risks and amplifies visibility and hence improves resilience. Besides,

4.1.2.2. Performing demand forecast planning:

We notice that the planning of product forecasts was is in a large part put in place and manipulated in these companies as stated by rates of respondents rated as relevant strategy by respondents, that (81%"very great extent" +16%"great extent"). Forecasting demand alleviates uncertainty in demand and enables more optimal deployment of resources. Forecast planning reduces the risk of lost sales and the risk of over-storage. In that respect, the planning of demand forecast is a *proactive strategy* as it preventive measures that absorb demand variations.

Pharmaceutical firms upgrade and adjust the demand forecast based on the previous year or months. It includes the sales number, the products sales period, products seasonality, the market destination (hospitals, export, …). Hence, this strategy is also *reactive* since it reacts to restrain the risk of demand fluctuation by improving forecast that rely on previous demand.

4.1.2.3. Offer to customers a variety of products:

Resilience is reinforced by the diversification of products and markets. Product diversification, which was strongly highlighted by respondents (68% "very great extent" +26%"great extent") contributes to fulfill the customer's need and surpass competition. It's a *proactive strategy* since it reinforces the ability of firms to offer different product to a different levels of customers composing different segments of the market and reduce the risk of customer preference change. It is also a *reactive* strategy leading to the quick response to the customers' needs through improving their strategy of products sales after finding out a low product through product variety (Hohenstein et al., 2015).

4.1.2.4. The reliability of medicines delivery time:

"The reliability of medicines delivery time" is a *proactive strategy* as it aims to shrink response time to customer request (Alexandre Augusto Karl et al., 2018) which enhances customer satisfaction. If the organization as well as its supply chain, can deliver a product much faster than its competitors, in this case, the customer satisfaction will certainly increase (Alexandre Augusto Karl et al., 2018).

Additionally, we remark that more than the half (61%) of participants replied "very great extent" regarding their practice of reliability of delivery time.

4.1.2.5. Long-term relationships with clients:

Long term relationship is a *proactive strategy* as it contributes to significantly reduce supply chain risk *tied to supplier.*

The manufacturer maintains a long relationship to build a close relationship with key supplier that can afterwards, yield values and **benefits** for the two partners during the disruptions (changing condition and environmental uncertainty) that results an impact on performance. This long-term supplier relationship encourages the supplier to collaborative problem solving in this difficult time of disruptions to satisfy the customer requirement by reducing time-to-market and costs.

This strategy results from a long time of communication between the manufacturer and his supplier, investment sharing between the supplier and the buyer, developing trust and commitment, early supplier involvement and commitment.

This strategy consolidates the supply chain integration between the partners lead to the processes, to optimizing the flows of products and services, information, financial and increase value to the customer (Flynn et al., 2010). For this reason, more than half of participants (63%) asserted that they adopt this strategy and 28% quoted that they aim to set up this strategy.

4.1.2.6. When expectations of customers are identified, we react quickly to these expectations:

This *reactive strategy* is risk management initiative that refers to the firm agility. The agile approach induces the ability to deal quickly and cost effectively with the unpredictable variability in customer needs both in terms of volume and diversity in order to generate competitive advantage (Agarwal et al., 2007; Carvalho et al., 2012). The result displays 88% (66 % +22%) of pharmaceutical firms react intensively to the expectation of customers.

4.1.2.7. We systematically assess customer satisfaction:

The assessment of customer satisfaction is a proactive strategy since it controls the satisfaction of customer in order to prevent the risk of customers lost and recourse to another concurrent. It is vital to know the customers' needs in order to control their variable preferences and to keep them loyal.
As a result, the supply chain must opt for innovative strategies to meet customer demand in an uncertain environment (Carvalho et al., 2012).78% (53% "very great extent "+25%" great extent") of respondents confirmed that they deploy this strategy.

4.1.2.8. We respond quickly to customer complaints:

The response to customer complaints is a *reactive strategy* as it mitigates problems in medicines by improving service quality and keeping a convenient relationship and brand image. The responsiveness to customers means the importance conceded by the supplier to the customer (Stevenson,2009).

The after sales service in pharmaceutical firms is in charge of customer complaints. It is a compulsory service for pharmaceutical firms and which the role is to receive the customer complaints on product specifications and quality deficiency. In this way, the complaints enable the improvement of adverse effects of medicines. The firms possess the Pharmacovigilance Department that maintain the adverse effects of customers.

4.1.2.9. Carrying out the high-priority orders:

The prioritization for some customer orders is maintained by several companies in different industries for customers who differ in their importance (Lacey et al., 2007; Zeithaml et al., 2001). Accordingly, primary orders are for potential customers who dispose of a large sales volume or for situations that require urgent medicines. This strategy strengthens the relationship with top-tier customers but does not undermine the relationship with most important customers. The result demonstrates that more than 70% opt extensively for the preparing high-priority orders.

4.1.2.10. Risk sharing with clients:

This strategy is deemed as a collaboration strategy that maintain resilience (Tukamuhabwa et al., 2015). The risk sharing is performed, for example, through the use of supply contracts that share the risks between the supplier and the buyer as "the revenue sharing contract", where the buyer shares the income with his supplier. In addition, the contract guarantees the delivery of a certain quantity to manage variations in demand. Other facets of risk sharing are the pooling of "inventory and capacities" and the transfer of risk to another entity inside or outside the supply chain such as the insurance. According to these arguments, this strategy is useful for mitigating the occurrence of events as well as their impact.
More than half of companies (38% + 22%) opt for this strategy, while more than a third (31%) don't use this strategy.

4.1.2.11. There is a monitoring and control of changes in the prescription habits of doctors:

The medical representative tries to convince the doctor to prescribe the medicines by providing information about the products regarding its advantages, scientific tests and schemes. Furthermore, he controls the prescription of new medicines to patients. He generates an insight on the sale status of the medicines (Fiksel et al., 2015). Pharmaceutical companies present their products to doctors and continue to monitor the sales performance of the medicines launched in the market. Thereafter, the sales monitoring is a proactive action

to identify and monitor the development of medicines prescription variation to introduce, afterwards, improvements in medicines.

The monitoring and control of changes in the prescription habits of doctors is held by 73% (40%+33%) of pharmaceutical firms. However, 14% (7%+7%) of firms don't apply this practice.

4.1.3. Production flexibility :

It is noteworthy to clarify that the production is in accordance with the "Good Manufacturing Practices" that is an international quality standard. In this setting, this latter is defined as a set of regulatory texts that regulate production and control operations to ensure the quality of a product". On the other hand, the "Good Manufacturing Practices" indicates that the pharmaceutical firms have to comply with the "marketing authorizations" describing the quality requirement standards of medicines. GMP depicts the instructions regarding the sampling, personal training, the conditions of fabrication in the areas and materials, the conditions of storage, lighting and temperature. The fabrication flexibility has an impact on resilience which improve the ability to respond and to adapt to changes in the business environment.

Figure 3: Production flexibility strategies
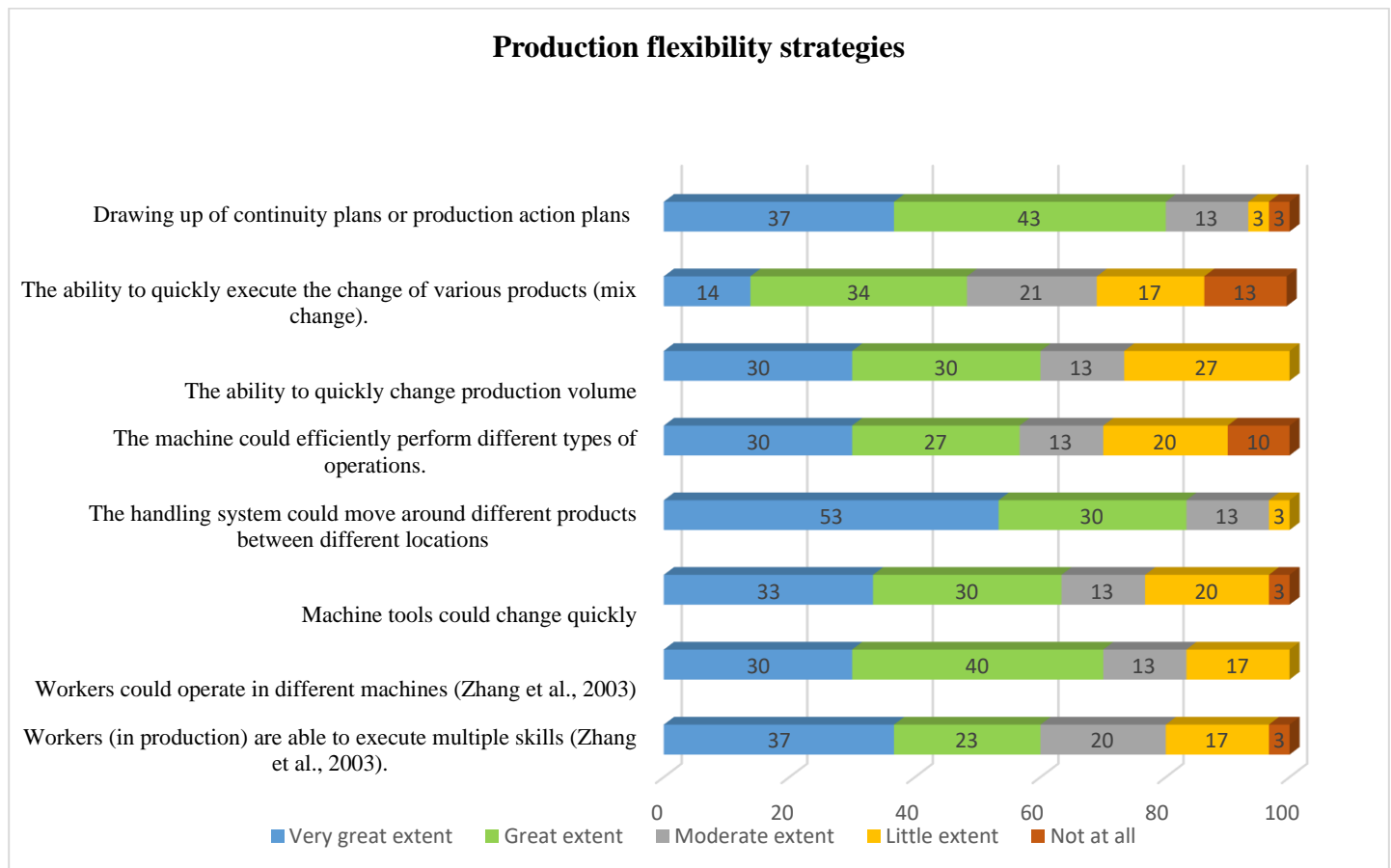
Source: *Authors*

The figure 3 demonstrates that most of the strategies are practiced by more than 50% of pharmaceutical firms. In this sense, the respondents underscored "very great extent" and "great extent", which alludes that pharmaceutical firms put in place strategies related to production flexibility. On the other hand, in contrary to the supply flexibility and demand flexibility, the fabrication flexibility holds strategies of production for which the participants noted that they don't practice by responding "little extent" and "not at all".

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4.1.3.1. Workers (in production) are able to execute multiple skills:

Worker flexibility is a reactive strategy since it restrains time of tackling the manufacturing disruptions through the ability of workers to perform a set of tasks in the manufacturing process. Accordingly, worker flexibility reacts to variability in customer orders and diminishes the uncertainty in demand by alleviating the uncertainty in the manufacturing. Afterward, the flexibility of workers is measured by the ability of workers to execute several operations without triggering production penalties (Koste and Malhotra 1999), their celerity of tasks fulfilment and their ability to learn quickly (Zhang et al., 2003). In the context of pharmaceutical industry, the workers in the workshop carry out a specifics tasks due to the fact that if the worker switch from one location to another, he is compelled to change his industrial work-clothing to evict the risk of contamination. In this end, a moderate rate of firms (37%) possess largely workers that couldn't execute different operations in the workshop.

4.1.3.2. Machine tools could change quickly:

This strategy is proactive due to its mitigating of manufacturing time and costs (Schonberger, 1986). Therefore, it prompts the ability of a system to prepare and adapt in dynamic demand change. Furthermore, a moderate number of respondents, that is 33% ("very great extent"), quoted that they hold flexible machine tools and 30% ("great extent") of respondents backed that they have frequently this capability.

4.1.3.3. The handling system could move around different products between different locations:

Flexibility of handling equipment is the capability to move around different products between different locations in the manufacturing system. Consequently, flexibility of handling equipment is a *proactive strategy* due to its efficient improving of market responsiveness during fluctuations in demand. Duclos et al. (2003) state that the ability to ramp up production quickly led to the ability to adopt processes and then customer needs change.

"The handling system" is the most strategy practiced by pharmaceutical firms among other strategies of production flexibility. More than half (53%) of participants marked that they practice intensively this strategy, while 30% contend that they establish this strategy in "great extent".

4.1.3.4. The machine could efficiently perform different types of operations.

It is a capacity which leads to the accomplishment of multiple operations with quick machine changeover time from one operation to another and with minimum set-up costs (Mileham et al., 1999) and without inducing penalties of production outcomes (Koste and Malhotra 1999). In that sense, the machine flexibility is *a proactive strategy* to deal with the risk of demand variability, since it contributes to the reduction of manufacturing operations lead-time (Mileham et al., 1999) and elevates volume flexibility and mix flexibility.

The machines in the pharmaceutical firms can carry out multiple products within one machine, but in order to swift from one product to another, a deep scrubbing of production lines is mandatory to avert the risk of contamination. The flexibility of machines is considerably used by pharmaceutical companies. The capability of machine to execute different operations occupied a rate of 30%.

4.1.3.5. The ability to quickly change production volume:

This practice is chiefly brought about by pharmaceutical companies to ensure resilience (30% "very great extent" and 30% "great extent"). It handles change volumes according to customer demand and therefore lessens the risk of unavailability of quantities and competitive threats. Therewith, the volume flexibility is a proactive strategy permitting to react promptly to changes in requirements of customers thanks to the rapid modification of production capacity. As a result, this manufacturing flexibility

strategy creates the ability to operate various batch sizes while guarding profitability (Zhong, 2015) and in a timely manner.

4.1.3.6. The ability to quickly execute the change of various products (mix change).

"The ability to quickly execute the change of various products (mix change)" is slightly marked as strategy that is strongly practiced (14%), despite that the researches outlined the relevance of this strategy. Mixed flexibility is the ability to produce a variety of products and the ability to modify different products at low cost (Chod et al., 2012).

Therefore, the mix flexibility is a proactive strategy that react to variations in demand by providing different types of products to customers, without additional capacity, with less time and cost of different products transfiguration.

4.1.3.7. Drawing up of continuity plans or production action plans:

The figure 3 illustrates that a great part of firms draws up the contingency plans as it reduces vulnerability in the supply chain. Contingency planning (CP) is a valuable tool for engineering resilience by *pre-disruption* and *reactive* actions. The Business Continuity Plan (BCP) is "a plan developed to be resilient, prepare to respond and restore operations after an unforeseen major disruption occurs" (Rice and Caniato, 2003). In the first place, the prepared plans enable the handling of the risks associated with unknown (unidentified) events (Skipper and Hanna, 2009). Secondly, the strategies designated in the plan are applied when facing the disruptions. In the third phase, the effectiveness of strategies associated to plan are reassessed.

In effect, companies give more importance and develop action plans to circumvent disruptions related to storage, transport and for the processing of disruptions suppliers. In second place, the plans adopted are the employee safety plans and the plans for the manufacturing units. In addition, regulations on Good Distribution Practices imposes compliance the choice of the relevant means of transport for some medicines, like vaccines that necessitates specific transport conditions in terms of temperature, protection against shocks, ….

4.1.4. Supply chain risk management process :

The stages of supply chain risk management are constituted by risk identification, analyze, risk management and control of risks. The strategies of supply chain risk management process are broadly brought about in pharmaceutical firms by a majority of participants mentioned that they apply these strategies in "very great extent" or "great extent".

The risk management process consists of stages which each influence the other stages of the risk management process to reduce these risks. Identification influences risk assessment which in turn leads to risk mitigation. The figure 4 describes the degree of deployment of strategies tied to Supply chain risk management process by pharmaceutical companies.

Figure 4: Supply chain risk management process strategies
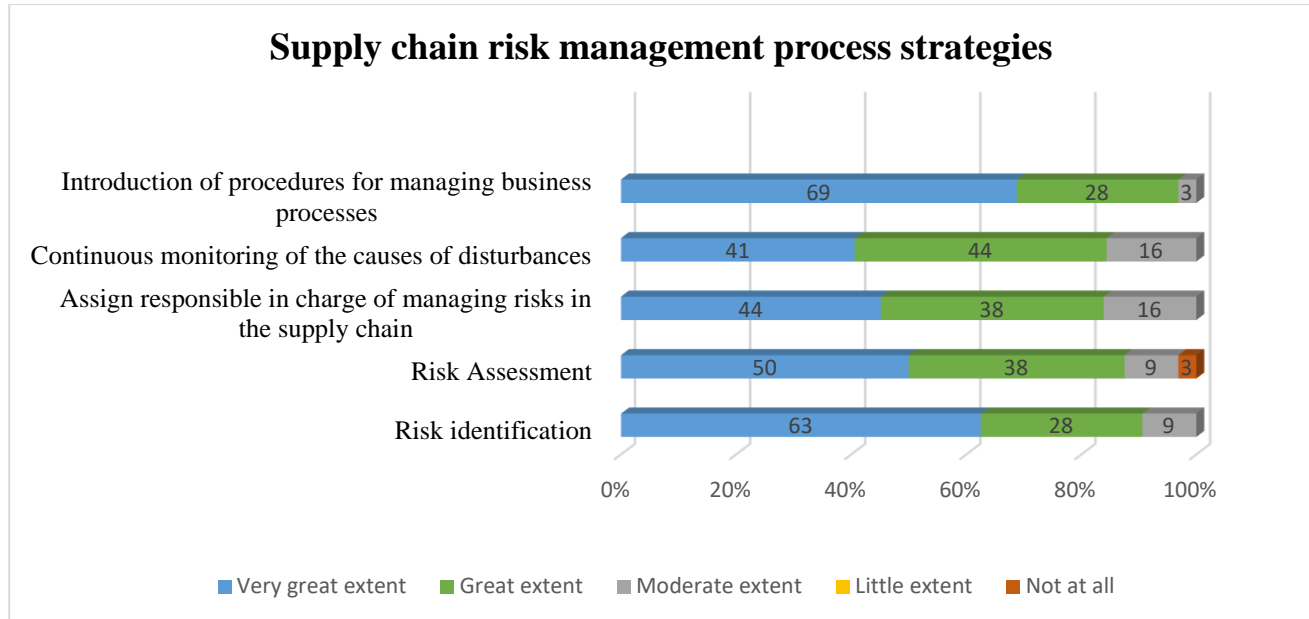
Source: *Authors*

4.1.4.1. Risk identification:

The figure 4 showed that 63% of respondents underscored that the identification of risks in supply chain is hugely performed as well as 28 % marked that risk identification is frequently deployed, while 9% indicated that it is feebly deployed.

The risk identification is the first important step in managing supply chain disruptions. This practice is proactive strategy, as it involves discovering potential threats and vulnerabilities in the supply chain in order to develop rapidly risk management measures. The identification and management of risks in the supply chain are carried out to establish the capacity to absorb and adapt to change and variation. The information extracted from the risk identification and assessment are used to implement risk management strategies (Kern et al., 2012). In that regard, companies collect information between their departments and partners to pull out internal and external risk sources in the supply chain and their evolution. In so doing, risk detection promotes continuous monitoring to detect new risks.

4.1.4.2. Risk assessment:

Regarding the risk assessment, 50% of participants backed that the assessment of risks in supply chain is largely applied, 38% responded that is practiced in "very extent" and 9% mentioned that is weakly practiced. Risk assessment is intensively used by pharmaceutical firms, since it is a pivotal element for prioritizing risks and for the choice of essential strategies to be implemented especially for priority risks. It facilitates the categorization and prioritization of risks according to their frequency and their impact (Jüttner et al., 2003). As a result, this risk measure helps to better invest resources in the risks that are important to the business. Accordingly, risk assessment is a proactive strategy allowing a company to improve its understanding of the risks of a process and to identify the appropriate approaches for dealing with risks (Shafqat et al., 2019).

4.1.4.3. Continuous monitoring of the causes of disruptions:

Risk control is extremely performed by 41 % of firms and 44% of participants confirm that they practice monitoring of risks. This strategy is a *proactive* measure adopted to prevent risk through overseeing the risk evolvement, obtaining visibility (Fiksel et al., 2015) into supply chain operations and intervene

proactively to implement the necessary adjustments at each stage of the supply chain management process. It relies systematically on controlling the operational risks of the company such as problems of inventory management or controlling unpredictable risks that are difficult to foresee. Likewise, monitoring of risks is a *reactive strategy*, as it is an important strategy performed continuously to analyze the effectiveness of risk management strategies.

4.1.4.4. Assign responsible in charge of managing risks in the supply chain:

"Assigning persons who ensure the risk management process" is a strategy that determines tasks that must be done, by whom, who take decisions as well as the emplacement where the decisions must be made (Mensah et Merkuryev, 2014). This is a *proactive strategy*, giving that it assigns roles to managers and employees who prepare and react quickly to a disruption and engage an effective business continuity planning. In doing so, managers must develop a risk management culture in the supply chain by integrating the employees in the risk management activities and organizing training programs of risk management for employees to deal with environmental changes.

 In this end, pharmaceutical manufacturers are compelled to set up a quality assurance system which involves the participation of staff and managers to ensure quality.

4.1.4.5. Introduction of procedures for managing business process:

  Procedures describe the personnel who will perform the analyzes, make risk decisions, prepare documents and determine specific training requirements (Swanson. Et a., 2010). AMBER (2009) argues that organizational resilience encompasses the principles of "principles, policies, procedures and practices". Thereby, the figure 5 delineates that almost all the firms wield procedures, since 69% indicated that they use procedures for risk management in a "very great extent" and 28% mentioned "great extent". Therefore, this strategy is *proactive* and *reactive*, as companies develop a risk management policy formalized by procedures that define roles and responsibilities contributing to prepare and react immediately to unexpected threats.

4.1.5. The redundancy:

Figure 5: Redundancy strategies
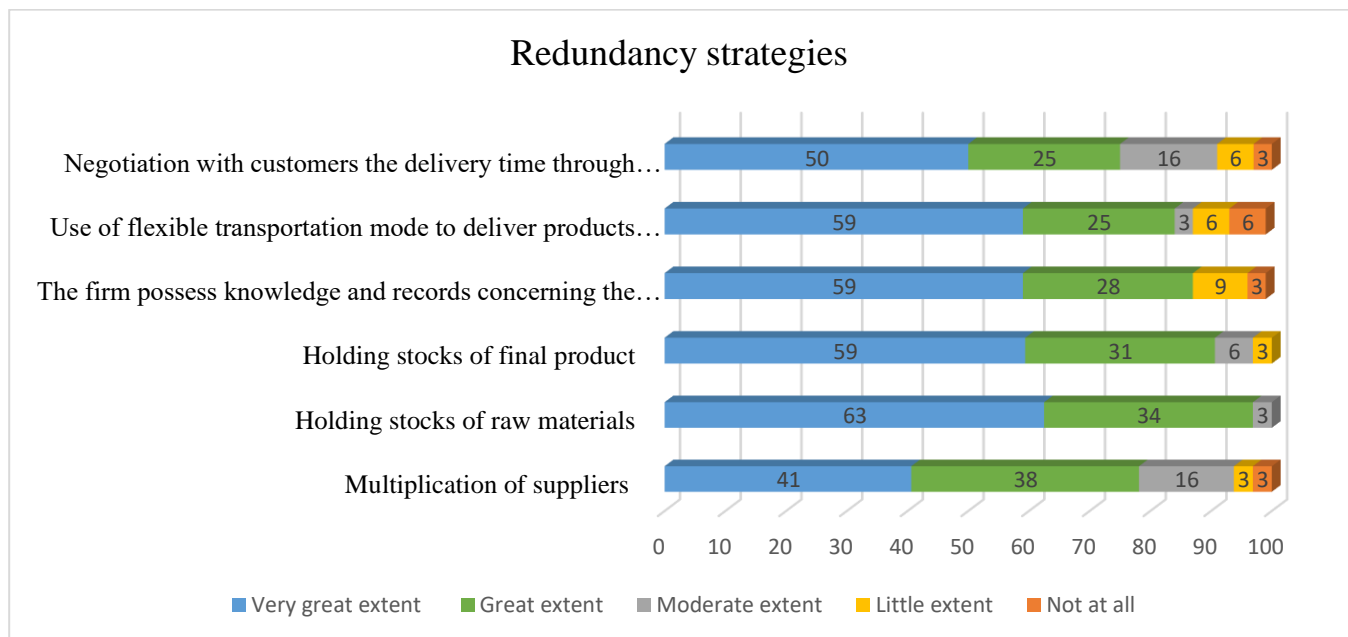
Source: *Authors*

The figure 5 illustrates the amplitude of using strategies relied to redundancy in pharmaceutical firms. The figure 5 shows, typically, that the firms opt extensively for redundancy.

4.1.5.1. Holding stocks:

We state that the strategies for building inventories of raw materials and finished products are the most utilized with, respectively, response rates of 59% and 63% for the "very great extent" option and respectively 34% and 31%, for the "Great extent" option (see figure 5).

The inventory in supply chain has a great leverage for securing and responding quickly to disturbances (Tang, 2006), such as fluctuations in demand, as natural disasters, the shutdown of ports, strikes, production problems, etc. The lack of stocks limits the flexibility of the system to cope with disruptions and leads to sales losses. Moreover, the dearth of the goods provokes a significant impact on customer satisfaction that may merely look for other suppliers or other brands. Thus, it fosters the flexibility of the buyer to respond in turn to the needs of his customers. The storage also serves to reduce the uncertainty of lead time and delivery time for raw materials. According to these arguments, the stock construction is a *proactive* and *reactive* strategy.

Managers keep stocks taking into account three main criteria: according to the predictability of the products, according to the importance and criticality of the drugs and thirdly according to the due date of the products. Medicines associated to chronic diseases should be affordable to obviate a significant impact on the patient's health service and financial loss. Another criterion imposed by Moroccan law is the construction of stocks for three months by pharmaceutical companies.

4.1.5.2. Multi-sourcing:

The inventory reduces the company's exposure to harmful consequences by absorbing shocks, but other strategies are displayed to restrain the impact of unexpected disruptions such as supplier redundancy (Tang, 2006; Zhu et al., 2013).

Flexible supply base *a reactive strategy* as it assists the company to change its orders (or part of orders) to other suppliers in the event of an interruption (Wagner and Bode, 2006). On the other hand, multi-sourcing is a *proactive strategy* because it diversifies suppliers to mitigate the risk of supplier delivery failure disruptions and to hold out business continuity. Thus, this practice upholds a quicker response to demand in a turbulent business environment. As for "the multiplication of suppliers", 41% of the participants answered that they use this strategy intensively, while 38% that they frequently use this strategy.

4.1.5.3. Use of flexible transportation mode to deliver products on time:

Transport is an additional capacity to diminish the effect of transport disruption, customer variation, long distance risk, dearth of coordination between supply and demand…..

We note that the strategy of "Use of flexible means of transport" is commonly ("very great extent") used by 59% of pharmaceutical companies and is in "great extent" deployed by 25% of pharmaceutical firms. Transport flexibility includes the diversification of means of transport, diversification of carriers and multiple routes. This strategy is *proactive* since it is adopted to prevent delay of medicines delivery triggered by events such as the seasonality or demand rise of product or production breakdown. Tiwari et al. (2015) contend that the proper mode of transport with reasonable cost upgrade flexibility during environmental changes.

4.1.5.4. The firm possess knowledge and records concerning the quantities and locations of the delivered products:

This strategy is a type of redundancy in so far as it minimizes the delivery lead time and saves time in order to react quickly to customer orders.

This strategy is *a reactive strategy* reinforcing the information acquired by the company from previous deliveries of customers to define plans for customers and product inventory. Data warehouse includes integrated data used to maintain the management decision (Chen, 2002). The information relative to customers' quantities and historical exchange with customers are recorded in the information system of the firms. In that way, the participants largely replied that they use this strategy (59% "very great extent"+ 28% "great extent").

4.1.5.5. Negotiation with customers the delivery time through long-term relationship:

This strategy is a type of redundancy that allows to guard more void time delivery in order to coordinate and organize the deliveries for customers. It is used to improve the company's ability to deliver multiple customers. The negotiation between partners contributes to the coordination of physical flows between the sourcing, fabrication and distribution and entails coherent plans throughout the logistics chain (François, 2007). This strategy is used by the supplier as *reactive strategy* to prepare an urgent order for another customer. Consequently, it increases customer responsiveness and customer loyalty. The graph 4 exhibits that more than half of pharmaceutical firms (59%) perform very frequently this strategy.

Summary and conclusion:

This research has spotlighted the resilience strategies that are most used by the pharmaceutical industry. Consequently, by examining the analysis of participants' responses, this article identifies the resilience strategies where these companies deploy their resources. In addition, the response rate for each strategy is to a certain extent accurate assessment of the important strategies in this industry. This research also exhibited how these companies adapt to changes in the environment.

The strategies investigated refer to ; flexibility strategies, redundancy and the risk management process. Flexibility strategies are divided into supply flexibility, demand flexibility and production flexibility.

The results of respondents rolled out that most of respondents underlined that they practice in "very great extent" and 'great extent" a numerous strategies related to elements of supply flexibility, demand flexibility, supply chain risk management process and redundancy. Most of strategies related to these elements surpass a rate of 50% regarding their practice in the pharmaceutical firms. These strategies, in general, allows to respond to the changing environment and to cope with several risks by avoiding possible future unwanted events (proactive strategies) or by counteract risk effects (reactive strategies). The supply flexibility strategies that are frequently practiced comprise, "organizing relationships of trust with suppliers", "choosing suppliers who have a qualification", "communication and coordination with suppliers", "Performing supplier control", "using supplier contracts". Regarding flexibility of demand, several strategies are brought about by pharmaceutical companies such as: planning product forecasts, maintaining and coordinating with customers, rapid response to customer complaints, and placing priority orders. Risk management strategies which are risk identification, risk assessment, risk control and "Introduction of procedures for managing business processes" are strategies that are commonly used by pharmaceutical companies.

The redundancy strategies that refer to the use of stocks and the multiplication of suppliers are also broadly approved by the participants.

However, some strategies of the production flexibility were indicated to a certain extent as not largely applied in the pharmaceutical industry. Most of strategies associated to fabrication flexibility are not applied in 'very great extent" with a moderate rate of more than 30%. Additionally, great part of strategies deployed by the pharmaceutical industry are proactive. Nonetheless, other strategies are simultaneously proactive and reactive, while others are uniquely reactive.

Limits of research and perspectives for future research:

This research is conducted within the one specific industry and in one country. Then, other research will explore resilience strategies used in other industries and in several countries. On the other hand, the

research exhibited how the supply chain resilience strategies are deployed in the pharmaceutical industry. Therefore, we suggest to explain heavily how the exposed supply chain resilience strategies are operated in the pharmaceutical industry.

In addition, quantitative models that examine the relationship between these supply chain resilience strategies could be subject to future research. We also suggest that models be developed to understand the interactions between resilience strategies and efficiency so as to achieve resilience optimally. Furthermore, we suggest to conduct empirical study that identify, separately, each of proactive and reactive strategies that impact supply chain resilience.

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