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The Impact of Integration Strategy on Supply Chain Resilience: A Quantitative Study of Automotive Industry Companies in Morocco

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Abstract:

Supply chain resilience has become a subject of growing interest for both academia and business, due to the multiplicity of disruptive events affecting global supply chains, which make them highly vulnerable. The literature highlights that integration plays a central role in strengthening supply chain resilience. However, few empirical studies have explored this relationship in the automotive sector.

This study aims to analyze the impact of integration on supply chain resilience within this sector. A survey was conducted among companies operating in the Moroccan automotive industry, and the data were processed using exploratory and then confirmatory factor analyses, based on Structural Equation Modeling (SEM) under the PLS approach.

The results confirm that integration represents a major strategic lever for strengthening the resilience of automotive supply chains.

Keywords: Supply Chain Resilience, Integration, Automotive Industry, PLS-SEM.

1-Introduction

Over the past two decades, supply chains have faced a series of major disruptions of health, economic, climatic, and geopolitical nature, revealing their high vulnerability and highlighting the need for increased resilience. The resilience of the supply chain (SCRES) thus emerges as a central theme in operations management and logistics research, as it not only conditions the continuity of activities but also the sustainable performance and competitiveness of companies (Santanu et al., 2016). The literature highlights that supply chain resilience is manifested through reactive and proactive approaches, and that its development depends on the implementation of appropriate strategies (Hamma, N. et al., 2023). Among these, the integration of the supply chain, through its internal and external dimensions, appears as a key determinant of resilience. Integration promotes the smooth flow of information, reduces uncertainty, and strengthens the collective adaptive capacity in turbulent environments. Indeed, several theoretical and empirical studies have confirmed the importance of this relationship, without, however, having sufficiently explored it in certain specific sectoral and geographical contexts.

It is from this perspective that the present work is situated, which aims to empirically analyze the impact of integration on the resilience of the supply chain in the automotive industry in Morocco. Through a quantitative approach using the structural equation modeling (PLS) method, the study aims to make a theoretical and managerial contribution by confirming the strategic role of integration as a lever for strengthening logistical resilience.

For this, we first begin with a synthesis of the literature to highlight the link between the resilience of the supply chain and integration. Then, we will outline the methodology followed and the main results obtained. Finally, we will discuss some limitations and perspectives of the research.

2- Literature Review

2-1 The resilience of the supply chain

The concept of resilience has been studied in various scientific disciplines; it is a multidisciplinary concept with applications in several fields, including ecology, psychology, economics, and organizational management.

In the field of supply chain management, research on resilience has significantly increased over the years, and researchers and practitioners have shown great interest in it due to its potential impact on business continuity and corporate competitiveness (Christopher and Peck, 2004; Sheffi, 2015; Hamma, N., 2023).

Given that resilience is an emerging field in Supply Chain Management (SCM), there is no generally accepted and commonly used definition for this multidisciplinary and multidimensional approach (Juttner and Maklan, 2011; Hohenstein et al., 2015; Azadegan & Jayaram, 2018).

Indeed, two major currents stand out: a reactive vision, which considers resilience as the ability of a chain to respond, adapt, and resist unforeseen disruptions (Rice & Caniato, 2003; Pettit & Fiksel, 2010; Wu et al., 2013; Tukamuhabwa et al., 2015; Pettit et al., 2019), and a proactive vision, which conceives it as the ability to anticipate and prepare in advance of disruptions (Klibi et al., 2010; Priya et al., 2007; Biedermann et al., 2018).

Recent research highlights the need for an integrated approach, simultaneously articulating proactive and reactive dimensions. From this perspective, supply chain resilience is understood as both a proactive (pre-ante) and reactive (post-ante) strategy, allowing not only for an effective response to disruptions but also for the restoration of an equivalent, or even more desirable, level of functioning (Hohenstein et al., 2015; Iyengar et al.; 2021; Kovačić, M.et al., 2022; Shishodia et al., 2023; Beaulieu, M., & Ruel, S., 2024).

In the same vein, Moukadem, K. and Elkharraz, A., (2019), on their part, following a qualitative study with companies in the automotive industry, proposed a synthetic definition of resilience adapted to our research context as follows: "Resilience is the ability of the supply chain to anticipate disruptions, respond to these disruptions, and recover after being disrupted." The objective is to enable the supply chain to return to its original state or a more desirable state after experiencing a disruption, while capitalizing on the knowledge gained from the experiences to anticipate their recurrence in the future.

Furthermore, the analysis of the literature review regarding the factors or strategies that enable supply chain resilience has identified a wide range of different strategies for the context of resilient management.

According to the research we conducted, the integration of the supply chain is one of the most frequently cited determinants of resilience, exerting a greater influence on supply chain resilience (Moukadem, K. and Elkharraz, A., 2019; El Bichri et al., 2023; Kakou and Houssaini, 2023; Senkel and Frăţilă, 2023; Beaulieu and Ruel, 2024).

2-2 The integration of the supply chain

The integration of the supply chain corresponds to the "coordination and management of upstream and downstream products/services; financial and information flows; business processes between a focal company and its main suppliers (and potentially the main suppliers of the suppliers) and its main customers (and potentially key customers of the customers)" (Naslund and Hulthen, 2012, p. 496). The literature review reveals two main dimensions of supply chain integration: Internal integration and external integration (Zhao et al., 2011; Chang et al., 2007; Flynn et al., 2010; Ghariani R., 2024).

Internal integration refers to the degree to which a company can collaboratively and synchronously organize and conduct its practices, procedures, information, decisions, and various activities, in order to meet the demands of its customers and interact effectively with its suppliers (Zhao et al., 2011; Topolsek, 2011; Muntaka et al., 2017; Kakou & Houssaini, 2023).

External integration refers to the degree to which a company understands its customers' needs and collaborates with

customers and/or suppliers to develop inter-organizational strategies, shared practices, and processes, in order to meet its customers' needs (Flynn et al., 2010; El Bichri et al., 2023). External integration includes integration with customers and integration with suppliers (Zhao et al., 2011; Ganbold & Matsui, 2017; Rosa Hendijani, R., and Reza Saeidi, 2020).

2-3 The integration and resilience of the supply chain

Numerous studies have confirmed the positive influence of integration on the resilience of the supply chain (Christopher and Peck, 2004; Jüttner and Maklan, 2011; Petti et al., 2013; Wieland and Wallenburg, 2013; Brusse and Teller, 2017; Singh et al., 2019; Moukadem, K. and Elkharraz, A., 2019). Integration translates into the sharing of information within and between organizations to enhance decision-making in a turbulent environment (Zinn and Pinrasuraman, 1997; Senkel & Frăţilă, 2023). Sharing information in advance or in real-time about any event likely to occur, or that has occurred in a specific part of the supply chain, can help managers anticipate, react quickly in case of disruptions, and consequently develop the resilience of the supply chain (Wieland and Wallenburg, 2013; Brandon-Jones et al., 2014; Ambulkar et al., 2015; Kamalahmadi and Parast, 2016; Urciuoli et al., 2014; Rochdi, H., 2022).

Indeed, effective internal integration between the company's departments not only increases visibility but also reduces uncertainty; both effects are important in the resilience of the supply chain (Christopher and Peck, 2004; Vanpoucke, E., et al., 2017).

Besides reducing the probability of disruptions, the effects of disruptions can also be effectively managed through coordination between departments (Liu & Lee, 2018). Similarly, external integration improves the flow of information about disruptions among supply chain partners, allowing them to stay attentive to environmental changes (Hohenstein et al., 2015). Integration also allows partners to respond quickly to disruptions thanks to information sharing, preparation, planning, and coordinated operations (Christopher and Peck, 2004; Hang, Q. and Cao, M., 2018). Integration allows a supply chain to have, on one hand, a proactive capacity to facilitate the detection (and even anticipation) of disruptions, and on the other hand, a reactive capacity to facilitate decision-making and collectively find solutions to respond to disruptions (Blackhurst et al., 2005; Craighead et al., 2007; Idrissi, K., 2020). Moreover, integration also involves sharing experiences among supply chain partners after responding to disruptions (Sheffi, 2001; Rochdi, H., 2022).

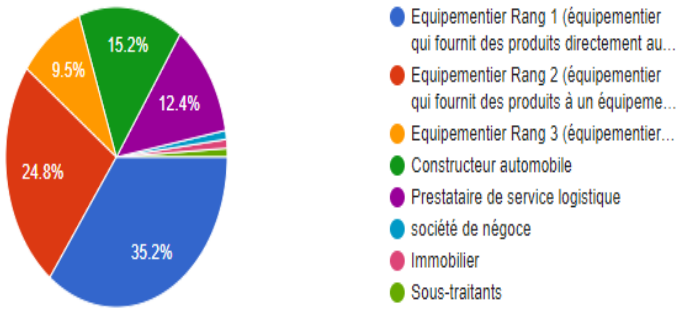
Based on this discussion, we formulate the following hypothesis:

H: There is a positive and significant relationship between integration and the resilience of the supply chain.

3- Methodology

Our sample consists of companies operating in the automotive sector in Morocco, we distributed 240 questionnaires and collected 105 responses from the logistics managers of companies in the automotive industry.

The figure below presents a statistical description of the companies in relation to the nature of their activity.



Distribution of companies according to the nature of activity
The participants were asked to respond on a five-point Likert scale, ranging from "Strongly disagree" to "Strongly agree," to assess their perception of the impact of integration on the resilience of the supply chain.

The collected data was then analyzed in two stages: an exploratory factor analysis using SPSS software was conducted to verify the validity and reliability of the chosen measurement scales, and a confirmatory factor analysis was performed to test the research hypothesis using Structural Equation Modeling methods under the PLS approach.

4- Data Analysis And Results

4-1 Results of the exploratory factor analysis

According to Igalens and Roussel (1998), the exploratory phase of research, as described in step 4 of Churchill's paradigm (1979), aims to achieve refined measurement instruments.
Before proceeding with the refinement of all the measurement instruments used in our study, we will identify the items of the different constructs as well as the codes assigned to each item.

4-1-1 Factor analysis of the "Integration" variable

During the operationalization phase of the constructs, we identified nine items to measure the perception of integration. In order to conduct a PCA, we study the ability of the variables to be factorized. To do this, we use the KMO index and the Bartlett test.

The following table summarizes the results of the purification phase regarding the variable "Integration."

Table 1: Summary of the purification results of the "Integration" scale

Items	Nbre d'items	Quality of representation	Factorial contribution	Reliability
Int1	9	0,621	0,788	0,927
Int2		0,738	0,859	
Int3		0,656	0,81	
Int4		0,603	0,776	
Int5		0,61	0,781	
Int6		0,541	0,736	
Int7		0,796	0,892	
Int8		0,559	0,748	
Int9		0,587	0,766	
Eigenvalue			5,712	KMO = .894
Test of Bartlett : Significant			Varimax	P= 0.000
Variance explained in %			63,47%	N= 91

The first step in exploratory factor analysis is to examine the conditions for factorizing the data.

The Bartlett test is significant, and the KMO index is commendable (KMO=0.894), so the items are factorable. The Kaiser criterion allows us to observe the presence of a single factor accounting for 63.47% of the total variance. The internal consistency of this scale is excellent (0.927). No item removal would improve it.

4-1-2 Factor analysis of the variable "Supply Chain Resilience"

During the operationalization phase of the constructs, we identified seven items to measure the perception of the overall supply chain resilience.

In order to conduct a PCA, we examine the ability of the variables to be factorable. To do this, we use the KMO index and the Bartlett test.

The following table summarizes the results of the purification phase concerning the variable "Supply Chain Resilience."

Table 2: Summary of the purification results of the "Supply Chain Resilience" scale

Items	Nbre d'items	Quality of représentation	Factorial contribution	Reliability
ResCL1	7	0,75	0,866	0,948
ResCL2		0,783	0,885	
ResCL3		0,579	0,761	
ResCL4		0,774	0,88	
ResCL5		0,858	0,927	
ResCL6		0,809	0,899	
ResCL7		0,814	0,902	
Eigenvalue			5,366	KMO = .922
Test of Bartlett : Significant			Varimax	P= 0.000
Variance explained in %			76,65%	N= 105

It is necessary, first of all, to ensure that the elements are factorable, the Bartlett's test of sphericity is significant; it allows us to reject the null hypothesis regarding the correlation coefficients between items. Furthermore, the KMO test, with a value of 0.922, is commendable, which allows for factorization.

The measure of supply chain resilience indeed consists of a single factor that accounts for 76.65% of the total explained variance. This result indicates that this variable is unidimensional, composed of seven items.
The Cronbach's alpha of the scale is excellent (0.948). This scale will therefore be retained and tested during the confirmatory analysis.

4-2 Confirmatory factor analysis

After the purification of the elements through an exploratory factor analysis using Principal Component Analysis, our hypothesis is ready to be examined.
To do this, we opted for the Partial Least Squares (PLS) structural equation modeling method. In order to conduct our data analysis, we used the Smart PLS 3.0 software developed by Ringle et al. (2005).

The study first examined the measurement model in order to assess the internal consistency and convergent validity of the two constructs.

The reliability and the level of internal consistency of the model are measured using the main indicators, which are the reliability coefficients (Loadings), Cronbach's alpha, and composite reliability. While convergent validity is measured through the analysis of the average variance extracted (AVE). The table below summarizes the results we obtained for the reliability coefficients (Loadings), internal consistency (Cronbach's Alpha), composite reliability (CR), and convergent validity (AVE):

Table 3: Reliability and convergent validity

Variables	**Cronbach's Alpha**	**Composite Reliability**	**AVE**
Integration	0,911	0,929	0,652
Supply chain resilience	0,944	0,955	0,781

Following the results of the table, we observe that both variables have a consistent and reliable measurement scale. The corresponding measurement variables thus accurately measure what they are supposed to measure.
In order to evaluate the convergent validity of our model, we relied on the average variance extracted (AVE) index. For there to be convergent validity, the AVE must have a value greater than or equal to 0.50 (Fornell and Larcker, 1981). The results show values greater than 0.50 for the AVEs corresponding to each variable. The convergent validity is therefore satisfied.

Finally, since the evaluation of our measurement model has proven satisfactory, it is appropriate to study the existing links between the two latent variables in order to approve the research hypothesis through the evaluation of the structural model.
Structural relationships can be estimated by performing replication analyses (Bootstrapping) on the sample. This allows for the evaluation of the sensitivity of the items' contributions to the sample size.

The relationships between the constructs are estimated by examining the t (1) t-values obtained following Bootstrapping analyses (n= 105, 500 iterations).

The purpose of this operation is to identify coefficients related to the links connecting the indicators to the measured constructs (path coefficients). These coefficients range between 0.1 and 1. Their level of significance, according to (Chin, 1998), becomes significant starting from 0.2. A correlation relationship is significant if the "t" value is greater than the threshold of 1.96. (2)

The screenshot of SMART-PLS presents a table summarizing the original regression coefficients between the two variables and the regression coefficients using the Bootstrap technique, the t and p values.

Table 4: Estimation of causal model parameters using the bootstrap method

Hypothesis	Échant. initial	Boostrap	Valu e t	Value p	signifi cance
Int → ResCLG	0,474	0,476	9,024	0.000	signifi cant

The results obtained confirm the positive link between integration and the resilience of the global supply chain (β = 0.474 t=9.024 p=0.000). The hypothesis is therefore validated.

5- Discussion Of The Results

Several theoretical and empirical studies have confirmed the positive influence of integration on the resilience of a supply chain. The quantitative analysis demonstrated a positive and significant relationship between integration and the resilience of the global supply chain (β = 0.474; t = 9.024; p = 0.000). This result perfectly aligns with several previous research studies (Christopher and Peck, 2004; Jüttner and Maklan, 2011; Liu & Lee, 2018; Singh et al., 2019; Rochdi, H., 2022; Senkel & Frăţilă, 2023).
Internal integration and external integration can improve the resilience of the supply chain (Liu & Lee, 2018). Effective integration between the company's departments not only increases visibility but also reduces uncertainty; both effects are important in supply chain resilience (Christopher and Peck, 2004). The internal integration of a company allows for sufficient flow of information about disruptions between its departments. In addition to reducing the likelihood of

disruptions, the effects of disruptions can also be effectively managed through interdepartmental coordination. In the same vein, Hohenstein et al. (2015) showed that greater collaboration among supply chain actors is associated with shorter response times to disruptions.

External integration improves the flow of risk information among supply chain partners, allowing them to stay attentive to environmental changes and respond quickly to disruptions (Christopher and Peck, 2004; Wieland and Wallenburg, 2013).

Moreover, integration also involves sharing experiences within and among the partners of the supply chain after responding to disruptions.

In summary, integration through its internal and external mechanisms allows companies in the automotive industry to strengthen the resilient capabilities of the supply chain (Anticipation, response, recovery, and learning).

Conclusion

The study empirically confirmed the existence of a positive and significant relationship between integration and the resilience of the supply chain in the Moroccan automotive sector. These results corroborate previous studies and highlight that integration, through its internal and external dimensions, is a major determinant of the ability of supply chains to anticipate, react, recover, and learn. On the managerial level, this study encourages companies to invest more in interdepartmental coordination, collaboration with external partners, and information sharing to better cope with disruptions. On the theoretical level, this research enriches the literature by highlighting the central role of integration in building a resilient supply chain. Nevertheless, the limitations related to the sample call for future research to expand into other sectors and to integrate new explanatory variables of supply chain resilience.

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(1)-The higher the Student's t value and the lower the p value, the more the explanatory variable contributes to the model.

(2)- The critical values are 2.57 (p = 0.01) and 1.96 (p = 0.05) for a two-tailed test and 0.98 (p = 0.05) for a one-tailed test.

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