IMPACT OF INNOVATION ON THE SUPPLY CHAIN PERFORMANCE: CASE OF THE AUTOMOTIVE INDUSTRY IN MOROCCO

Azdod Mohamed, Acharki Hakim, Bakhat Rim and Rajaa Mohammed
Université Abdelmalek Essaadi, Laboratoire : Management Logistique Gouvernance et Economie appliquée, Tétouan - Maroc

ABSTRACT: *In Through the Looking-Glass famous incident from the book of Alice in Wonderland, known as the Red Queen's race, it involves the Red Queen and where Alice is constantly running, but remaining in the same point. The Red Queen said: "Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!"This story is used in real life to illustrate the idea of running after capital and market share accumulation in order to maintain relative economic position. This idea cannot represent better the main purpose of our study: "The innovation and its impact on supply chain performance and competitiveness".In this paper, we attempt to corroborate, based on an empirical study of Moroccan multinational firms specifically in the automotive industry, the relationship between the supply chain innovation and performance through the Supply Chain Integration.*

KEYWORDS: Innovation, competitiveness, Supply Chain integration, Supply Chain performance

INTRODUCTION

The management performance has become the new trend in the organization's vision. Too many works have tried to explain how an organization proceeds enhance or, at least, insure its performance. In our work, we will attempt to reveal how automotive industry companies enhance their performance by optimizing their innovation through the supply chain integration. This field will help us to understand how much tougher is the link between the integration, the innovation process, the integration process and the supply chain performance".Some works talk about the assessment of the supply chain performance through the supply chain integration by adding the capability as a constraint and making the innovation process the correlation link between the first two variables. In our case, we will choose the innovation variable as a stimulating variable for our model. The correlation and regression formulas will help us to assert it.

Firstly, this paper is subject to the ILMRD method commonly used on management and economics researches. This means that we will start by presenting a theoretical background about our research variables. Secondly, we will reveal the methodology followed to achieve our objective which is to prove the relationship between innovation and supply chain performance through the supply chain integration. By presenting the methodology, we will explain the basic model and how the survey will try to answer to our main problem. Thirdly, once the questionnaire is statistically treated, we will present the results that help us to corroborate or refute our model. Finally, the last step concerns the discussion around the results that prove if innovation is correlated or not with the supply chain performance through the supply chain integration.

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It is very important to note that this paper is just a reduction of the supply chain reality. In fact, we avoid some variables and some constraints which are not part of this study by reason of the causal links simplification, and preserving only the explanatory variables deemed to have a "weight" on the model.

THEORETICAL BACKGROUND:

✓ The Supply Chain integration

In a multi-actor's enterprise network, the firm runs after reducing the variability and standardize practices. The supply chain integration can take different forms: technological integration, cultural integration or integration by Process (**Hillion; 2007**). The objective is to converge toward the extended enterprise concept.The technologically integration can be illustrated by the use of a management information system that allows integrating the information flow such as the commands, inventory levels, etc., with trading partners. The organizational integration can be done by adopting a common culture between different organizations, standardize the structure internally, by establishing a centralized function of tactical and/or operational management…etc. With regard to the process integration, it is relative to the methods integration and processes between organizations. In this paper, we focus on the technology integration of an information system in order to show the innovation impact on the supply chain performance.

✓ The Supply Chain integration

There are several reasons that justify and constitute the practice of integration in the supply chain management. We present four strongest reasons that push the company to integrate a supply chain in order to face the challenges of the multi-actor business network:

- **The logistics chains multi-actor's complexity**

Recently, the new logistical typology chains comparison found in the industry, precisely the automotive industry, with the classic and linear logistics chain. It allows us to assume that the logistics chain complexity has become topical. Obviously, a logistics chain with three actors will not have the same level of complexity in terms of management as a chain with six actors.

A supply chain complexity can be assessed by two components:

- The number of stakeholders in the logistics chain.
- The nature of the relationship that exist between these stakeholders.

Here, the reader can note that an analogy may be cleared with the system concept. In effect, a system may be defined as a set of organic and non-organic compounds (relations) in interaction with a common objective. The mission of each chain logistics, as a complex system, remains the satisfaction of the final customer.

The logistics chain actors may have different purposes. However, they must contribute to the ultimate purpose: adaptation of the logistics chain to the overall chain of value.

Therefore, we can prove that greater the number of intervening in a logistics chain in network increase, more the number of possible connections between these actors increases proportionally.

Now, we suppose that a connection between the two companies may include two different relationships, in time, that a command link differs from a supply link or more broadly, and then we can differentiate between customer-supplier relationships with a relationship supplier-customer.

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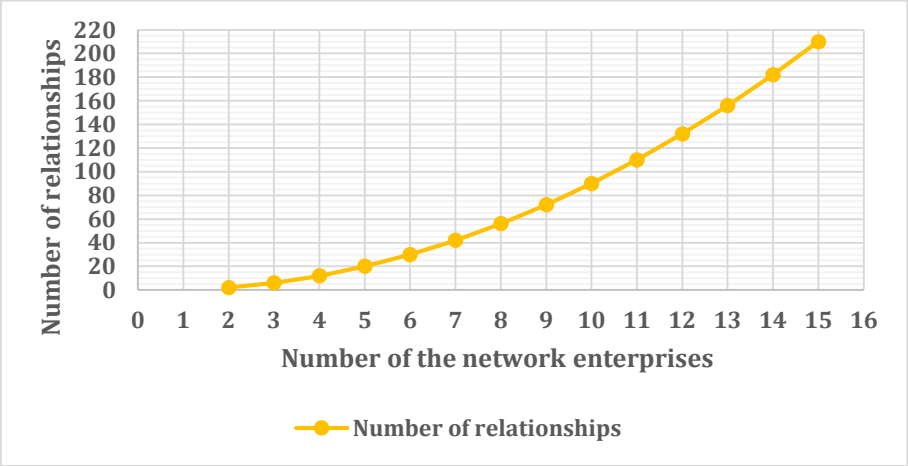
In addition, we will calculate the possible number of arrangements. Either $\boldsymbol{n}$ the number of actors in a logistics chain in the network, the number of possible relations that may exist in this supply chain $\boldsymbol{r}$ can be calculated by the following formula:

$$\boldsymbol{r = \frac{n!}{(n-2)!}}$$

Equation 1 : Calculation of possible relations number (r) in a logistics chain in function of the intervener number (n) in this same chain



Graph 1 : Evolution of the relationships number in a string to the stakeholders number function

The graph represents the number of possible relations in logistics chain multi-actors. It does appear the exponential pace of the chain complexity. To each time a new assignee integrates that chain.

- **The strategic disintegration disadvantages hidden by the logistics integration**

We are also wondering about the factors that allow the firms to increase their supply chain size. This leads us mainly to the study of outsourcing strategies, which is the opposite of the integration strategy **(Porter, 1980)**. Indeed, a firm may delegate a part of its production to an external service provider or outsource its distribution function in order to focus on its core business.

Even if the outsourcing allows the firm a certain internal flexibility, the relief of the structure is the main cause of the increase in the number of actors in the logistics network.

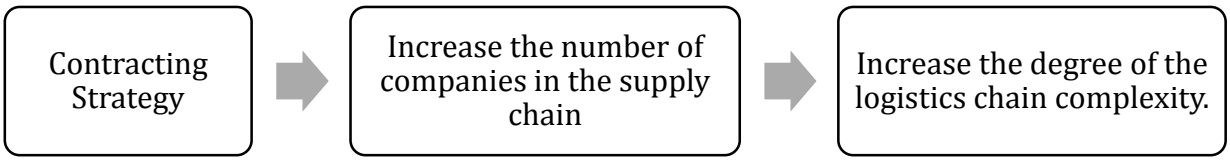


Figure 1 : Impact of the outsourcing strategies on the logistics chain complexity

- **The bullwhip effect in logistics activity:**

The logistics integration finds also its justification in the bullwhip effect theory. In effect, when the customers demand is seldom stable and regular, companies must anticipate the customer order to correctly generate stocks, optimize their production techniques and methods. The

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forecasts are based on statistics and demand history data, and they are rarely perfectly accurate: a forecast is false by nature! There will be an offset between the quantity needed (raw material, finished good), and the requested quantity or supplied. Through the supply chain links, we find that the stocks level increase due to the fact that the shift is widening as the number of intervening in a logistics chain increases.

Therefore, this theorem advance that the the information quality is more and more inaccurate and wrong farther away from the consumer and therefore worsens, more than proportionately with the lengthening of the supply chain (**Lee et al. , 1997**). This will lead to a new structure of costs with a non-negligible part of activities not values creativity. And therefore, in this sense, the volatility minimization of the bullwhip effect is a crucial issue for businesses.

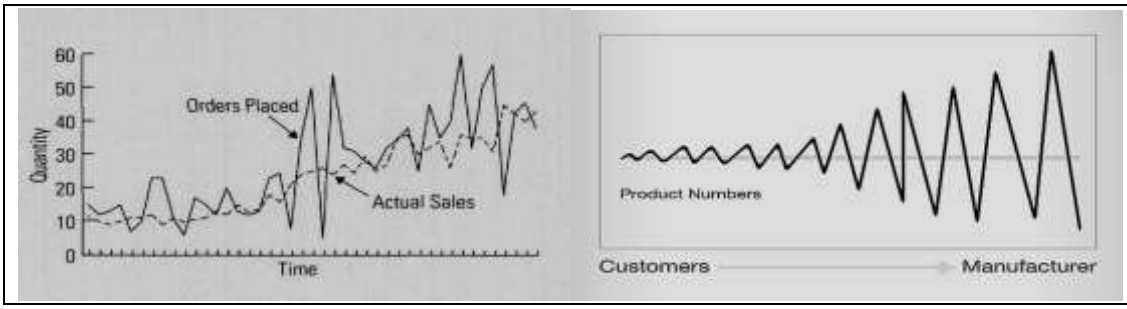

Figure 2 : Illustration of the logistics chain fundamental theorem: whiplash effect, Logistics (Lee et al. ; 1997)

Again the cure is in sharing information and collaborating in the Supply Chain. The objective of the supply chain approach is clear: it is to reduce the stock levels at all levels of the chain (to minimize costs of possession), improve the flexibility and responsiveness (and the performance in general) and optimal use of the available resources (**Jouenne; 2012**).

- **The logistics time reduction**

Principally, another main objective of the supply chain integration is the reducing of the time limits: Deadlines are then affected by the configuration of the network logistics structure. It is necessary to optimize both the intra-enterprise time (within the same company) also the inter-enterprises time limits.

The delivery times between supplier and producer impact also the quality of information. The greater the delay in delivery is, the greater the security stock becomes to deal with the hazards demand. In a framework of probabilistic modelling of the request, the safety stock is calculated by the product of the security factor and the standard deviation of the application during the period where the company is in a real risk with it stock quantities:

$$\boldsymbol{SS = u \times \sigma \times \sqrt{Dl}}$$

Equation 2 : Formula of the security stock in an uncertain context

With:

u: Represents the safety coefficient from the table of the Act, where models demand for the product in function of the maximum rate break that the company can bear.

σ: represents the gap-type of the request by unit of time.

Dl **:** represents the time of delivery supplier. The greater the delay in delivery is large, the more the company will need a high level of safety stock ***SS***.

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The time limit can be optimized through the deletion of the tasks that have not added-value, which can be done with some internal logistics methods such as lean management. With regard to time, logistics integration will allow a better transmission, flows fluidity and decryption, inter-organizational arrangements in real time.

✓ **The degrees of the logistics chain integration**

In order to measure the degree of the logistics chain integration, we have to give an answer to the following two questions: What integrate? And with which integrate?

According to the literature related to this topic, the answer to the first question leads us to present the different layers of the Supply Chain integration **(Fabbe-Costes; 2007):**

- **The flow**

The Flows integration means the control of joint manner between the flows partners of information and physical flows in the logistics network. It should be noted that even an integration of financial flows is desired too **(Alazard and Sépari ; 2010)** : the integration of accounting systems.

- **The business processes and activities**

It is to integrate the processes according to different level of decision: operational processes, process tactics and strategic process.

- **The technology and systems**

The integration of technologies and information systems allow the automation of the first layer (information flows and physical).

- **The Actors and Organizations**

It is to integrate individuals, teams or see even the companies by a collaboration and coordination.

Four layers of integration	**Characteristic of the integration for each layer**
Flow	Fluidity and continuity, relevance of physical flows, informational and financial, individually and in combination
Process and activity	Synchronization activities of operations for each Key Process; coherence between key business processes, piloting process and support process; integration of the processes at the operational level, organizational and strategic
Systems and Technology	Interoperability and inter-connectivity of systems and physical technologies and information, individually and in combination
Actors (organizations)	Interaction, coordination and collaboration of individuals, teams, functions, and enterprises; communication, collective work, structures interfaces or shared, strategic congruence, organizational and cultural life

Figure 3 : different layers of integration (Fabbe-Costes; 2007)

To clarify, the reader may note that these layers are not progressive. Only the flow integration is considered critical in an approach supply chain, the other layers are that of the necessary conditions for the integration of the stream.

As to the scope of the integration of the Supply Chain, the same author distinguishes 5 levels: from the integration intra-organizational (between functions and department) to the societal integration of the company with its environment of action.

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Field of investigation	The different levels of integration of the logistics chain				
	Intra-organizational	Inter-limited organizational	Inter-organizational	Multi chain	Societal
	Within each company	To direct partners (the first customers or suppliers of rank 1)	All the partners of a chain	The whole of chains which participates an organization	With a sustainable development perspective and who is interested in stakeholders external to the logistics chain

Figure 4 : Different levels of integration (Fabbe-Costes; 2007)

By crossing the different layers and levels of integration within logistics chains of reasoning by variables, it is possible to propose a measure of logistics integration degree.

✓ **The impact of innovation on the performance through the integration**

Above all, the firm strategy corresponds to the whole set of actions and decisions. It designates the mean necessary combinations to achieve them. This strategy is intended to change the company position and its competitive advantages in a decisive way and on the long term, in goal to cope with the frequent variations and the rapids of the environment.

Today, the business change has become a reality to which any business is essential to maintain a certain internal consistency, while adapting constantly to the constraints of the environment and to propose a number of actions aimed at fostering technical, social and societal innovation…etc. The action on the innovation that is the application, technical, organizational or commercial activities of an invention has to provide to the company a supplement of profit.

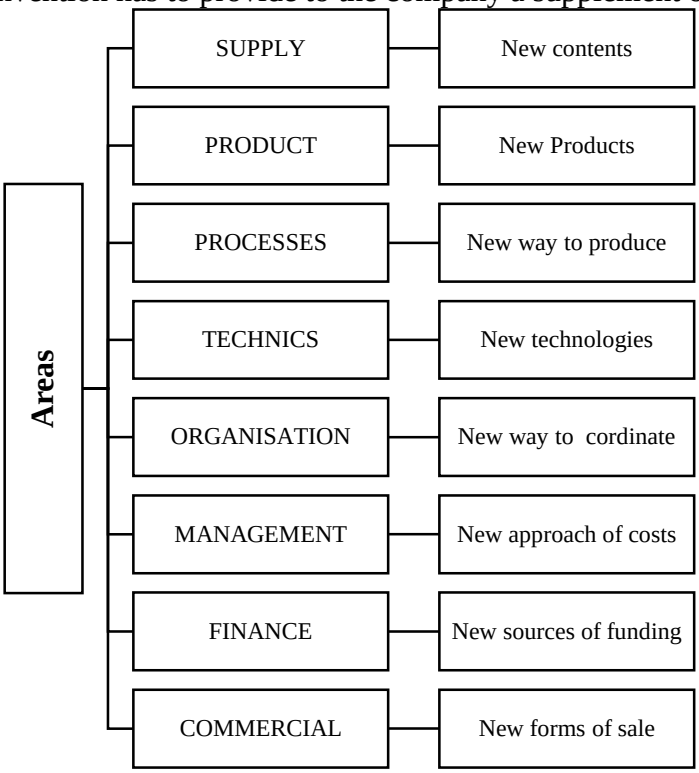

Figure 5: The different areas of innovation

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In the first place, there have been many waves of innovation in the history and each wave starts by a technological revolution and scientific one. The evolution of the economic context, the enlargement of the field of intervention and the differentiation of trades represent important issues for businesses. For this reason, these transformations are mainly initiated by the need to make over and modernize the information system under the influence of new technological, functional or strategic solutions.

The technology novelty is not decisive for the innovation. The new uses of the technology are more important than its novelty. Almost all of the innovations were receiving several innovation categories simultaneously and this opportunity allowed to innovative companies to position themselves well on their adequate markets. These allow the company to work in performance with its customers and suppliers.

In the perspective of the "technology-push", the innovation process follows a linear sequence of the "laboratory until the market" without feedback loops, nor return on the previous steps of the process.

In this perspective, the advances in science and technology are the principal stimulus of the innovation process, through the new opportunities to invent that they provide. As well, innovation is designed in a logical top-down and linear. The scientific discoveries are disseminated in a mechanical way and are supposed to change the whole of society.
In the approach "demand pull" of **Schmookler (1966)**, the innovation process is a result of the user's and customers' expectations. This approach puts forward the idea that the inventive step is before any searching to meet the demands and needs. This vision thus asserts a sort of power of the consumer/user/user without jeopardizing the linear character of the process.

We note that the organization performance is positively influenced by the innovation made by the organization itself. Then, it must be equipped with a portfolio of several technologies and, on the other hand, it must prepare the organization to adopt the innovation by putting in place the organizational practices supporting the information systems and innovation.
The synchronization between these two factors will maximize the achieved innovation impact, and therefore, a better organizational performance and best benefits.

CASE STUDY

In the first place, our case study is based on a sample of multinational firms, owing to corroborate the Supply Chain Integration impact and organizational performance hypothesis.
According to the following items, we could develop our interview guide by using some measurements;

- Innovation,
- Supply Chain integration,
- Supplier integration,
- Customer integration,
- Process integration,
- Organizational performance & competitiveness level.

This interview guide is conducted on multinational automotive companies implanted in Morocco. The appendix "A" represents the structure of our survey.

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This paper doesn't concern the Supply Chain analysis capability, neither for the supplier nor for the customer. We suppose that the triad Supplier-Company-Customer is able to respond to all actor's demands, not only for a similar product but also for products competitive diversity and variable volumes. We accept that SMC (Supply Management Capability), DMC (Demand Management Interface Capability), IMC (Information Management Capability) and we note that the coordination capability is satisfied.

The purpose of this research is to prove the positive correlation between technological innovation and the firm performance/competitiveness.

The basic hypothesis model is listed below:

H0: Innovation positively affects the firm performance & competitiveness.

Innovation is considered as a way to maintain the company competitiveness. As the famous British novelist **Lewis Caroll** (Alice in wonderland: *Through The Looking-Glass*) says in the Alice's adventures (when she constantly runs, but remain in the same point), and specifically in the red Queen's race: "**Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!**"

The second hypothesis concerns the innovation impact on the Supply Chain integration.

H1: Innovation positively affects the Supply Chain Integration.

This hypothesis is decomposed in three principal sub-hypothesis depending on the integration level:

Firstly, if the innovation helps the company to develop a collaborative relationship between it and their suppliers, then we are talking about the supplier integration. Secondly, if the innovation helps the company to enhance its internal activity, we are talking about the internal integration. Finally, if the innovation helps the company to develop a coordinated relationship between it and their customers, then we are talking about the customer integration.

To resume, our hypothesis is presented as following:

H1-1 – Supplier integration impacts the relationship between innovation and la SCI.

H1-2 - Internal integration impacts the relationship between innovation and la SCI.

H1-3 - Customer integration impacts the relationship between innovation and la SCI.

The third hypothesis of our model allows us to talk about the SCI impact on the firm performance:

H2: SCI positively impacts the firm performance and competitiveness.

Although, some studies[1] have proved that there is a strong relationship between Supply Chain external partners, internal functions, process and the external & internal links and it is organized by an information system called « integrator ».

We propose some adjacent sub-hypothesis to explain the main previous impact:

H2-1– Supplier integration affects the relationship between SCI and firm performance.

H2-2– Internal integration affects the relationship between SCI and firm performance.

H2-3– Customer integration affects the relationship between SCI and firm performance.

The firm efforts, concerning the customers-supplier's relationship and the internal activities organization, help to maximize the integration value to achieve organizational and operational performance.

[1]Flynn, B.B., Huo, B., Zhao, X., 2010. The impact of supplychain integration on performance: a contingency and configuration approach. Journal of Operations Management 28 (1), 58–71.

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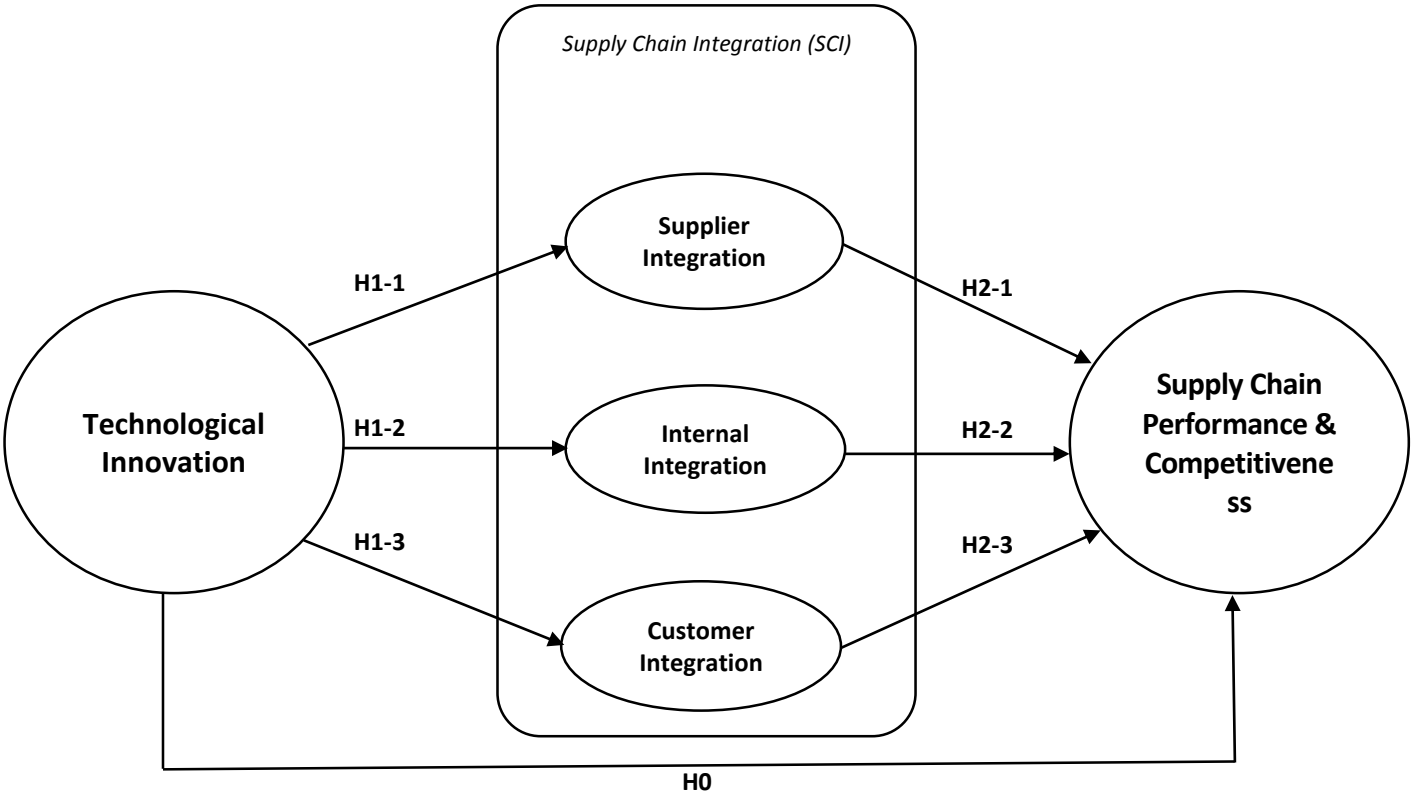

Figure 6: Theatrical study model

METHODOLOGY:

✓ **Methods:**

Our investigation method will be based on an interview guide conducted from logistics managers and schedulers of multinational automotive companies in Morocco. Some have an integrated information system, others still working under conventional EDI solutions (electronic message with a classic Email account).

The interview guide is composed by various scales questions (according to Likert attitude scale) assessing the various aspects surveyed. A highest value corresponds to a high level of integration or better performance. The idea is to help the interviewee to best meet the different issues dealt with.

Our sample is composed of 115 companies specialized on automotive industry. In terms of internal integration, we opted only for national and multinational companies operating in Morocco. Data is collected by a questionnaire (appendix A), completed by semi-structured interviews.

The survey deals on the set of measurements used to explain the pattern of the article and aims to study the relationship (hypothesis) between different proposed extra-variables. Some companies were contacted by E-mail other by phone, while others by direct contact. Among all the companies contacted, a number of 96 companies have correctly answered the survey (response rate of 83.48%).

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✓ **Methodological approach:**

The methodology is based on the hypothetical-deductive method: initially we developed our model abduction before assumptions are tested there and refer corroborated following our investigation. Therefore, we can say that we fit in a quantitative approach based on a positivist epistemological approach that aims to demonstrate the performance of the Supply Chain phenomenon causation with technical innovation and through the integration of Supply Chain.

RESULTS

✓ **Regression and Principal Component Analysis:**

The survey is divided in 5 main sections that represent a range of issues specific to a particular component of our model. The first section in our survey consists on thirteen questions on various aspects of the upstream integration (suppliers) of the company. The answers are presented by an incremented attitude LIKERT scale ranging from degree "One" to "seven" (1, 2, 3, ..., 7).

The implementation of the PCA (Principal Component Analysis) on 13 variables related to supplier integration has helped us to extract a single variable explaining at 81.436% of the total variance and an eigenvalue greater than 10. As shown in the table below cons:

Total Variance Explained

	Initial Eigenvalues			*Extraction Sums of Squared Loadings*		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	10,587	81,436	81,436	10,587	81,436	81,436
2	,640	4,925	86,361			
3	,505	3,884	90,245			
4	,317	2,441	92,686			
5	,243	1,866	94,552			
6	,212	1,634	96,186			
7	,155	1,191	97,377			
8	,116	,892	98,270			
9	,095	,731	99,000			
10	,061	,466	99,466			
11	,032	,250	99,716			
12	,024	,181	99,897			
13	,013	,103	100,000			

Table 1: Total Variance Explained for Supplier Integration

En procédant par la même méthode pour les autres questions relatives à l'intégration interne et à l'intégration client, on arrive à extraire une variable pour chaque type d'intégration. A noter que la composante de l'intégration interne permet d'expliquer 83,450 % de la variance totale et que celle relative à l'intégration client permet d'expliquer 83,253 % de la variance totale des réponses.

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Component Score Coefficient Matrix : Supplier Integration

	Component
	1
IF11	,091
IF12	,092
IF13	,090
IF14	,084
IF15	,073
IF16	,092
IF17	,073
IF18	,085
IF19	,085
IF110	,090
IF111	,088
IF112	,086
IF113	,075

Component Score Coefficient Matrix : Internal Integration

	Component
	1
II21	,123
II22	,122
II23	,116
II24	,108
II25	,128
II26	,119
II27	,126
II28	,123
II29	,128

Component Score Coefficient Matrix Customer Integration

	Component
	1
IC31	,119
IC32	,126
IC33	,129
IC34	,109
IC35	,128
IC36	,124
IC37	,111
IC38	,119
IC39	,129

Table 2: Component Score Coefficient Matrix for each integration

Using the matrix of coefficients generated, we can calculate a score for the level of integration of supplier companies surveyed by performing a linear regression. The coefficients are calculated using a rotation "Varimax" with Kaiser Normalization.For example, the IF113 variable means that the score for the “question 13” of “section 1” of the survey on Supplier Integration (IF). A final PCA was performed to express the score of the integration of the supply chain by being an independent variable explained by the three levels of integration mentioned above: integration provider, internal integration and customer integration.The extraction allows us to generate a "SCI" variable (Supply Chain Integration) linearly expressed in terms of three other variables. The observed eigenvalue is close to 3 and allows the explanation of a sizeable cumulative variance (98.5%).

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,955	98,506	98,506	2,955	98,506	98,506
2	,034	1,124	99,631			
3	,011	,369	100,000			

Table 3: Total Variance Explained for SCI

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The coefficients matrix allows us to extract the corresponding linear regression coefficients. We see that 3 variables have a substantially similar weight. The score of the integration of the SC (SCI) can, thus, be expressed using the following equation:

$$\boldsymbol{SCI} = 0{,}337 \times \boldsymbol{IF} + 0{,}335 \times \boldsymbol{II} + 0{,}336 \times \boldsymbol{IC}$$

Equation 3: Linear regression model of SCI

Once the variable "SCI" specified, we turn to the variable "IT" on technological innovation. The analysis of reduced dimensions enabled us to extract components from two different questions regarding the fourth section of the survey. These two variables explain a nearly the two-thirds of the total variance of the questions in this section.

	Initial Eigenvalues			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	4,169	41,693	41,693	4,169	41,693	41,693	3,843	38,431	38,431
2	2,464	24,642	66,335	2,464	24,642	66,335	2,790	27,904	66,335
3	,890	8,901	75,235						
4	,761	7,606	82,842						
5	,552	5,522	88,363						
6	,425	4,253	92,617						
7	,354	3,538	96,155						
8	,193	1,932	98,086						
9	,126	1,258	99,344						
10	,066	,656	100,000						

Table 4: Total variance explained of technological integration

Looking more closely the correlations between each component and related issues, we can distinguish between two types of innovation: technical innovation (X1) and managerial motivation for technical innovation (X2).

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Rotated Component Matrix[a]

	Component	
	X1	**X2**
IT4	**,883**	,117
IT5	**,878**	,183
IT3	**,805**	-,273
IT6	**,754**	,351
IT2	**,737**	-,148
IT1	**,665**	,455
IT8	-,106	**,852**
IT7	,179	**,851**
IT9	,207	**,675**
IT10	-,053	**,641**

Table 5: Component Matrix IT after rotation

The component matrix after rotation shows that the first 6 issues are quite correlated with "component 1" (what we qualified as a managerial motivation for technical innovation) while the rest of the questions is highly correlated "with component 2" (Technical Innovation). A final PCA allow us to build the equation of technological innovation "IT":

$$\boldsymbol{IT} = 0{,}709\boldsymbol{X1} + 0{,}709\boldsymbol{X2}$$

Equation 4: Linear regression of technological integration

The last variable, on the fifth and final section of the survey is related to the Supply Chain Performance and competitiveness. The PCA shows that we can express the SC performance and competitiveness based on the questions in the survey. The observed eigenvalue is 6.538 with a total explained variance of 65.375%.

	Initial Eigenvalues			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	6,538	65,375	65,375	6,538	65,375	65,375	5,466	54,664	54,664
2	1,023	10,233	75,608	1,023	10,233	75,608	2,094	20,944	75,608
3	,956	9,556	85,164						
4	,529	5,289	90,453						
5	,407	4,073	94,526						
6	,207	2,069	96,594						
7	,146	1,460	98,055						
8	,105	1,047	99,102						
9	,060	,601	99,703						
10	,030	,297	100,000						

Table 6: Total Variance Explained of SC performance and competitiveness

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Now we can express the scores of SCI variables, IT and PSC of each company in order to analyze the possible regressions, and be able to refute or corroborate our assumptions previously made.

✓ **Hypothesis corroboration:**

By studying the existing correlations between variables "IT" and "PSC" with the sub-variables "IF", "II" and "IC" we can ensure the mediation proposed in our model. The analysis of regressions between supplier integration and technological innovation shows the existence of a moderate correlation around 0,54 that corroborate the H1-1 hypothesis.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-,191	1,049		-,182	,857
	IT	,557	,159	,540	3,514	,001

Table 7: Regression study of IF and IT

The results of the linear regression allow us to express supplier integration based on the level of technological innovation:

$$\boldsymbol{IF} = 0{,}557 \times \boldsymbol{IT} - 0{,}191$$

Equation 5: Linear regression of supplier integration

Following the same approach to the rest of our model, we get the following results:

Hypothesis	Linear regression	Correlation
H1-2	$\boldsymbol{II} = 0{,}472 \times \boldsymbol{IT} - 0{,}03$	0,478
H1-3	$\boldsymbol{IC} = 0{,}603 \times \boldsymbol{IT} - 0{,}891$	0,573
H2-1	$\boldsymbol{PSC} = 1{,}056 \times \boldsymbol{IF} + 0{,}706$	0,740
H2-2	$\boldsymbol{PSC} = 1{,}086 \times \boldsymbol{II} + 1{,}006$	0,728
H2-3	$\boldsymbol{PSC} = 1{,}073 \times \boldsymbol{IC} - 1{,}077$	0,767

Table 8: Linear regression and correlation between the variables

We note that the correlation coefficients are significant enough for all of their assumptions allowing corroboration. About **H0**, it is a partial mediation that explains the effect of technological innovation (IT) on the performance of the Supply Chain (PSC) through logistics integration (SCI).

Statistically, this mediation is expressed by a linear regression formula:

$$\boldsymbol{PSC} = a \times SCI + b = \boldsymbol{a} \times (\boldsymbol{m} \times \boldsymbol{IT} + \boldsymbol{n}) + \boldsymbol{b} = \boldsymbol{am} \times \boldsymbol{IT} + (\boldsymbol{an} + \boldsymbol{b})$$

Equation 6: Linear regression of SC performance and competitiveness

With: Constants: a, b, m & n

ISSN 2054-0930 (Print), ISSN 2054-0949 (Online)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1,249	1,447		-,863	,395
	IT	,856	,219	,581	3,914	,000

Table 9: Regression study of PSC and IT

The observed correlation level is 0.581. We can, finally, say that the model with a triple partial mediation is therefore "**justified**".

DISCUSSION

There are several studies on this level that sought to justify the correlation between supply chain integration, performance and innovation. Our work is to find the correlation between technical innovation and performance through the integration. Therefore, it is still questionable that the degree of achievement of performance is not fully justifiable by innovation and supply chain integration. Hence the coefficient of almost 0.5 implying the existence of other variables to explain the performance of the supply chain.

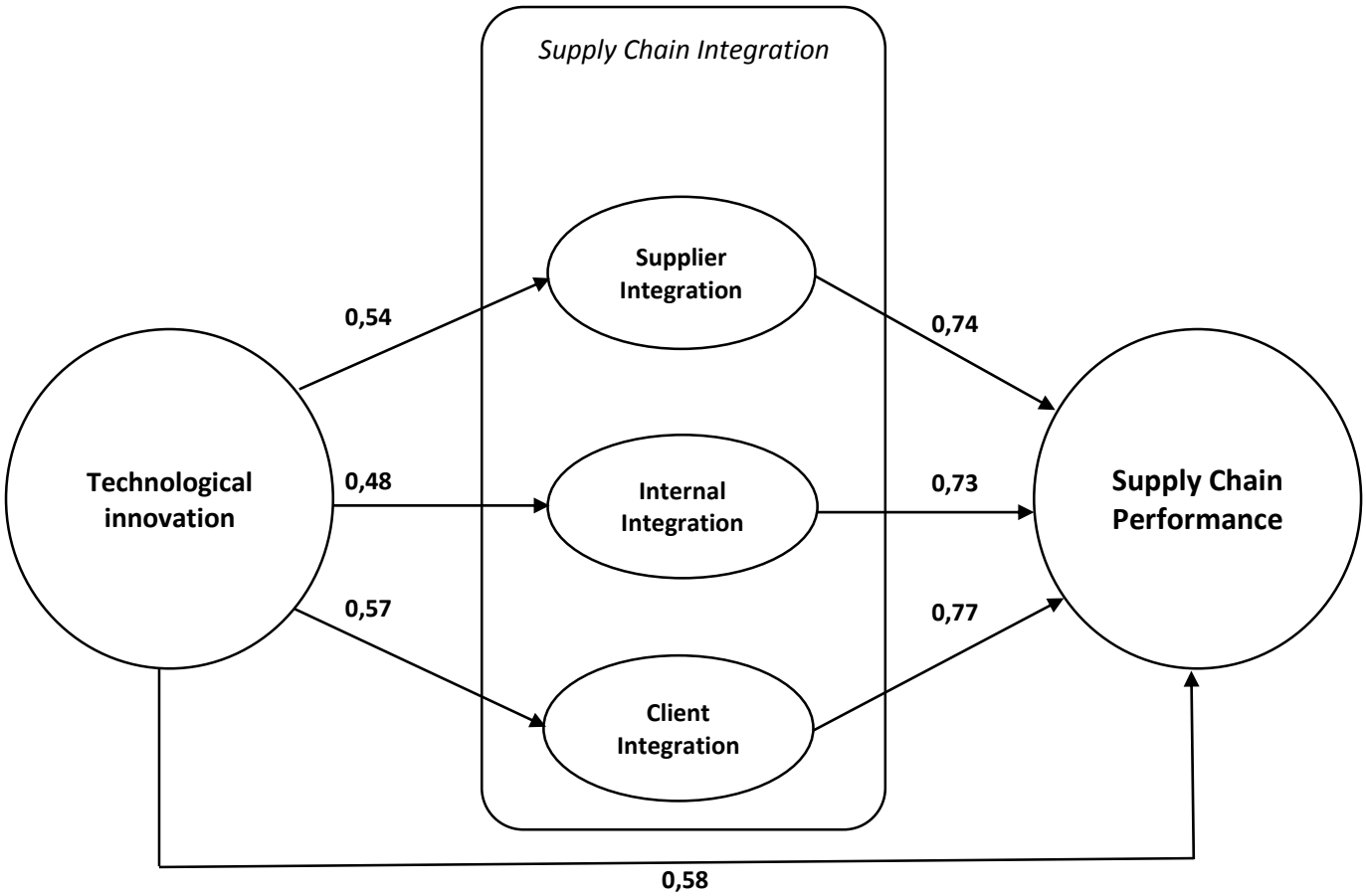

Figure 7: Hypothesis corroboration of the final model

ISSN 2054-0930 (Print), ISSN 2054-0949 (Online)

Thus, we can say that our model, as shown in figure 7, is corroborated, with the condition that the SCI is a partial mediating variable. In other words, the model is explained partly, but correctly, justify additional mediation or rather additional mediations increasing the accuracy of the representation of correlations.

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ISSN 2054-0930 (Print), ISSN 2054-0949 (Online)

1. APPENDIX: (FRENCH VERSION)

I. GUIDE D'ENTRETIEN SUR LE VOLET « INTEGRATION DE LA SUPPLY CHAIN »

1. Intégration Fournisseur :

Questions:	1	2	3	4	5	6	7
1.1. Quel est le niveau d'échange d'informations avec vos FI par les réseaux informatiques ?							
1.2. Quel est le niveau d'informatisation des approvisionnements de vos FI ?							
1.3. Quel est le niveau de partage de l'information sur le marché de vos FI ?							
1.4. Quel est le degré de participation et coopération avec vos FI ?							
1.5. Quel est le niveau de participation de vos FI dans les processus d'approvisionnement ?							
1.6. Quel est le niveau de participation de vos FI dans les processus de production ?							
1.7. Quel est le niveau de partage des plannings de production de vos FI ?							
1.8. Quel est le niveau de partage des capacités de production de vos FI ?							
1.9. Quel est le niveau de partage de votre plan de production avec vos FI ?							
1.10. Quel est le niveau de partage du stock de vos FI avec vous ?							
1.11. Quel est le niveau de partage des prévisions de la demande de vos FI ?							
1.12. Quel est le niveau de partage des niveaux de stock avec vos FI ?							
1.13. Quel est votre niveau d'assistance à vos FI pour améliorer leurs process pour répondre au mieux à vos besoins ?							

2. Intégration Interne :

Questions:	1	2	3	4	5	6	7
2.1. Quel est le niveau d'intégration des données entre les fonctions internes de l'entreprise ?							
2.2. Quel est le niveau d'intégration d'ERP entre les fonctions internes de l'entreprise ?							
2.3. Quel est le niveau de mise en application d'une démarche de gestion des stocks intégrée ?							
2.4. Quel est le niveau de visibilité du stock en temps réel ?							
2.5. Quel est le niveau de visibilité des données d'exploitation logistique ?							

ISSN 2054-0930 (Print), ISSN 2054-0949 (Online)

2.6. Quel est le niveau d'utilisation des réunions interministérielles périodiques entre les fonctions internes ?							
2.7. Quel est le niveau de mise en application d'équipe fonctionnelle transversale pour l'amélioration des procédés ?							
2.8. Quel est le niveau de mise en application d'équipe fonctionnelle transversale pour le développement de nouveaux produits ?							
2.9. Quel est le niveau d'intégration et de connexion en temps réel entre les fonctions internes depuis les matières premières à travers la production, l'expédition, et les ventes.							

3. *Intégration Client :*

Questions:	1	2	3	4	5	6	7
3.1. Quel est le niveau de raccordement avec vos CI par les réseaux informatiques ?							
3.2. Quel est le niveau d'informatisation des demandes d'approvisionnement de vos CI ?							
3.3. Quel est le niveau de partage de l'information sur le marché de vos CI ?							
3.4. Quel est le niveau de communication avec vos CI ?							
3.5. Quelle est la fréquence des contacts avec vos CI ?							
3.6. Quel est le niveau de partage des prévisions de la demande de vos CI ?							
3.7. Quel est le niveau de partage de votre stock avec vos CI ?							
3.8. Quel est le niveau de partage de votre plan de production avec vos CI ?							
3.9. Quel est le niveau d'intéressement de vos CI pour l'amélioration de vos process ?							

II. GUIDE D'ENTRETIEN SUR LE VOLET « INNOVATION TECHNIQUE »

Questions:	1	2	3	4	5	6	7
. Quel est l'apport du département R&D sur l'innovation (nouveau produits, nouveau design, nouveaux processus, …etc.) ?							
. Comment évaluer le souci de l'entreprise vis-à-vis de l'innovation de ses procédés ?							
. Comment évaluer la conscience de l'entreprise au sujet de l'innovation pour son développement ?							

ISSN 2054-0930 (Print), ISSN 2054-0949 (Online)

4. Quel est le niveau de l'utilisation de nouvelles méthodes et ressources ?							
5. Comment évaluer la motivation de la haute direction à chercher activement des idées novatrices ?							
6. Comment évaluer l'impact de l'innovation dans la conception des nouveaux produits dans les 3 dernières années ?							
7. Comment évaluer l'apport des nouveautés ou des améliorations significatives concernant ?							
8.1. Les procédés de fabrication (design, production, assemblage, …)	…..	…..	…..	…..	…..	…..	…..
8.2. Les méthodes logistiques (stockage, distribution, approvisionnement, …)	…..	…..	…..	…..	…..	…..	…..
8.3. Les activités de soutien ou de support (maintenance, achat, informatique)	…..	…..	…..	…..	…..	…..	…..
9. Comment évaluer le degré des partenariats avec les collaborateurs pour le but de développer les aspects novateurs de la TIC afin d'améliorer leur partage ?							

ISSN 2054-0930 (Print), ISSN 2054-0949 (Online)

III. GUIDE D'ENTRETIEN SUR LE VOLET « PERFORMANCE DE SUPPLY CHAIN »

Questions:	1	2	3	4	5	6	7
. Quel est le degré de réactivité de l'entreprise en matière de changement de process de production face aux besoins changeants de ses CI ?							
. Quel est le niveau de réactivité de l'entreprise face aux lancements de nouveaux produits par la concurrence ?							
. Quel est le degré d'adaptation de l'entreprise face aux mutations des marchés ?							
. A combien estimeriez-vous le niveau de service client de vos CI ?							
. Quel est le degré d'atteinte des objectifs de délai de traitement des commandes (entre la réception de la commande jusqu'à la livraison des marchandises) ?							
. Quel est le degré d'atteinte des objectifs de livraison à temps à vos CI ?							
. Quel est le niveau de performance de votre système SRM ?							
. Quel est le niveau de performance de votre système CRM ?							
. Après l'intégration d'un nouveau client, quel est le niveau de performance du marché relatif par rapport à d'autres clients non-intégrés ?							
. Quel est le niveau de performance en gestion de stocks de MP ou composantes des FI ?							

ISSN 2054-0930 (Print), ISSN 2054-0949 (Online)