SUPPLY CHAIN FLEXIBILITY AND BALANCED SCORECARD: CONCEPTUAL MODEL AND EMPIRICAL STUDY IN TUNISIAN COMPANIES LAUNCHED UPGRADING PROGRAM

Mohamed Mahjoub Dhiaf, Abdellatif Benabdelhafid, Fakher Jaoua*

Abstract: In this article, we clarify the concept of supply chain flexibility (SCF) in an attempt to unveil the difficulty in understanding and dealing with the scope this concept. The imprecise notion of SCF makes it difficult to develop valid and reliable measures which are needed to construct and test a theory involving supply chain flexibility.
This paper sheds light on literature relating to the impact of SCF on business performance. A conceptual framework is presented to uncover the effects of different dimensions of SCF (human resources, product, process, information technology and logistics) on the global performance. Valid and reliable measures are developed for each dimension of SCF and global performance and hypotheses are tested using structural equation modeling. From a large sample survey (n= 105) of manufacturing firms launched upgrading program, results indicate a partial impact of supply chain flexibility on the global performance. Three dimensions (human resources flexibility, Logistics flexibility and Information Technology flexibility) have positive and strong relationships on global performance. But, Product flexibility and Process flexibility were not present in Tunisian firms.

Keywords: Supply chain flexibility, Balanced Scorecard, Tunisian Upgrading Program, Structural Equation Modeling.

JEL Codes: L16, L90, C80

Introduction

As environmental diversity and uncertainty increases, companies are responding by adding flexibility as a dimension to their operation strategies. Flexibility may be defined as the ability to change or react with little penalty in time, effort, cost or performance (Upton, 1994). Flexibility can improve the company's competitiveness, particularly for the decision-making process of implementing technologies (Jaikumar, 1986; Alvarez Gil, 1994). But managers do not have a comprehensive view of flexibility because they focus more on machine flexibility than on total system flexibility (Slack, 1987; Upton, 1994). However, focusing flexibility on the implementation of technology does not lead necessarily to competitiveness (Gupta and Somers, 1996). In this regard, some

* **Dr. Mohamed Mahjoub Dhiaf**, Institut Superieur de Geston Industriellede Sfax, France,
✉ corresponding author: mohamedmahjoub.dhiaf@fsegs.rnu.tn
Prof. Abdellatif Benabdelhafid, University Le Havre, France,
Fakher Jaoua Msc, Institut Superieur de Geston Industriellede Sfax, France,

scholars (Brill and Mandelbaum, 1989; Gerwin, 1993) think that a supply chain logistics and its flexibility can be an important source of competitive advantage, and positively affect the business performance. However, supply chain flexibility is introduced to encompass those flexibility dimensions that directly impact a firm's customers, which is the shared responsibility of two or more functions along the supply chain, be it internal (marketing, manufacturing) or external (suppliers, channel members) to the firm. It may well represent a potential source to improve the company's efficiency and may be a significant measure of supply chain performance (Vickery et al., 1999). But, there are very few studies on supply chain flexibility (Dangayach and Deshmukh, 2001) and there are even fewer studies about the relationship between supply chain flexibility and global performance, especially in the Tunisian context, which offers a research opportunity.

It seemed that it is useful and interesting to perform a research around this thematic of SCF measure and performance in a Tunisian context in order to answer the main question that makes the object of our research study:

What is the impact of supply chain flexibility on the global performance in the Tunisian context?

The aims of this research can be summarized as follows:

1. Identifying the determinants of supply chain flexibility in Tunisian context,

2. Examining the influence of each dimension of SCF on the global performance of launched upgrading program in Tunisian companies.

Once our problem is defined, it remains to conceive the research methodology in order to come up with an answer to our question. Indeed, our paper is subdivided into four sections. The first section presents a reflection on the concept of SCF and global performance and their multiple measurements. In the second section, we develop a research framework that relates the different dimensions of SCF and to global performance. In the third section, we present the methodology adopted in the empirical study so as to valid and test hypotheses using structural equation modeling. The fourth section provides results and discussion. Finally, the paper concludes with the limitations of the study and recommendations for further research.

Conceptual Framework

In this section, we clarify the two main concepts of our study, specifically SCF and global performance. Also, we analyze the relationship between the different SCF dimensions and firm performance dimensions.

Supply Chain Flexibility: Concept and Definition

Supply chain flexibility is a complex, multidimensional and hard-to-capture concept (Sethi and Sethi, 1990). SCF, being the focus of this study, is defined as the ability of a firm to respond quickly and efficiently to changing customer needs in inbound and outbound delivery, support, and services (Day, 1994; Davis, 1993; Perry, 1991). It includes many activities such as organizing inbound and outbound shipments, providing manufacturing support, and supplying information to coordinate these efforts. With supply chain flexibility, a firm can delay commitment, embrace change, and fine tune delivery to meet specific customer needs. It is supported by a market-oriented strategy where all parties work together to create a fast, efficient, and reliable supply chain (Bowersox et al., 1999; Van Hoek, 2001). Flexibility in the supply chain adds the requirement of flexibility within and between all partners in the chain, including departments within an organization, and the external partners, including suppliers, carriers, third-party companies, and information systems providers. It includes the flexibility to gather information on market demands and exchange information between organizations. Five dimensions of SCF (Human resources, Product Development, Process, Information technology and logistics) have been identified from the literature on manufacturing flexibility, strategic flexibility and the limited writings on supply chain flexibility. Furthermore, after the reconfiguration of SCF, a new set of items focusing on measuring the different dimensions must be developed (See table 1, 2, 3, 4 and 5).

Human Resources Flexibility

Human Resources Flexibility (HRF) refers to the capability "to facilitate the organization's ability to adapt effectively and in a timely manner to changing or diverse demands from either their environment or from within the firm itself" (Dilliman et al. 1978). Flexibility of human capital can be achieved through skill, behavior and human resources practice flexibility (Bhattacharya et al., 2005). It can be measured through the following items (See Table 1):

Items	***Definitions***	***Literature***
Skill/ Functional flexibility	The number of potential alternative uses which employee skills can be applied and how individuals with different skills can be redeployed quickly.	Wright & Snell, 1998 ; Bhattacharya et *al.,* 2005

Behavior flexibility	The extent to which employees possess a broad repertoire of behavioral scripts that can be adapted to situation-specific demands.	Wright & Snell, 1998 ; Bhattacharya et *al.,* 2005
HR practices	The extent to which the firm's HR practices can be adapted and applied across a variety of situations, or across various sites or units of the firm, and the speed with which these adaptations and applications can be made.	Wright & Snell, 1998 ; Bhattacharya et *al.,* 2005

Table 1: Items of Human Resources Flexibility

Product Flexibility

Product flexibility (PRODF) is the ability to rapidly and effectively introduce and launch new (innovative) products and modify existing products in response to customer needs for design changes. Some authors (see table 2) measured this concept against new product flexibility and modification flexibility items.

Items	***Definitions***	***Literature***
New product flexibility	The ability to rapidly and effectively introduce and launch new products.	Sethi and Sethi 1990; Zhang et al. 2002b; Zhang et al. 2002a.
Modification flexibility	The ability to rapidly and effectively modify existing products in response to customer needs for design changes.	Sethi and Sethi 1990; Zhang et al. 2002a; Zhang et al. 2002b.

Table 2: Items of Product Flexibility

Process Flexibility

Process flexibility (PROCF) is the ability of manufacturing system to adapt to changes in production process includes the sequence change of steps through which product must progress (Gerwin (1987), Sethi and Sethi (1990), Sarker et al. (1994)). In the manufacturing literature, the types of Process flexibility can be reviewed through different items (see Table 3).

Items	***Definitions***	***Literature***
Volume flexibility	The ability of the manufacturing system to change the volume or	Gerwin 1987 ; Sethi and Sethi,

	output of a manufacturing process.	1990
Variety flexibility	The ability of the manufacturing system to produce many different products simultaneously and to incorporate new designs.	Browne et al. (1984) ; Gerwin (1987) ; Sethi and Sethi (1990) ; Upton (1994)
Machine flexibility	The ability of a piece of equipment to efficiently and effectively perform different operations.	Sethi and Sethi 1990; Chen et al. 1992; Zhang et al. 2002b; Zhang et al. 2003
Material handling flexibility	The ability of the material handling system to transport different materials between various processing centers over multiple paths.	(Sethi and Sethi, 1990)
Routing flexibility	Routing flexibility is the ability to efficiently and effectively process a given set of part types using multiple ways.	Sethi and Sethi 1990; Gerwin 1993; Upton 1995

Table 3: Items of Process Flexibility

Logistics Flexibility

Logistics flexibility (LOGF) is defined as the ability of a firm to respond quickly and efficiently to changing customer needs in inbound and outbound delivery, support, and services (Day (1994), Davis (1993), Perry (1991), Zhang et *al.* (2002), Bowersox and Closs (1996), Narasimhan and Carter (1998), Croom et *al.* (2000); Zhang et *al.* (2005)). Logistics flexibility is related to the different logistics strategies which can be adopted either to release a product to a market or to procure a component from a supplier. It is supported by a market-oriented strategy where all parties work together to create a fast, efficient and reliable supply chain (Bowersox et al., 1999; Van Hoek, 2001). The logistics flexibility can be identified by the following items (see Table 4):

Items	***Definitions***	***Literature***
Physical supply flexibility	The ability of a firm to provide a variety of inbound materials and supplies for production, quickly and effectively.	Day (1994) ; Langley and Holcomb (1992) ; Bowersox and Closs (1996) ; Carter and Narasimhan (1994)

		; Zhang et *al.* (2005)
Purchasing flexibility	The ability of a firm to make agreements to buy a variety of materials and supplies, quickly and effectively.	Van Hoek (2001) ; Ernst and Whinney (1987) ; Porter (1985), Narasimhan and Carter (1998) ; Zhang et *al.* (2005)
Physical distribution Flexibility	The ability of a firm to adjust the inventory, packaging, warehousing, and transportation of physical products to meet customer needs, quickly and effectively.	Day (1994) ; Van Hoek (1998) ; Langley and Holcomb (1992) ; Lambert et al. (1998) ; Lambert and Stock (1993) ; Cooper et al. (1997) ; Zhang et al. (2005)
Demand management Flexibility	The ability of a firm to respond to the variety of customer needs for service, deliver time, and price, quickly and effectively.	Day (1994) ; Langley and Holcomb (1992) ; Lee (2001) ; Lengnick-Hall (1996) ; Zhang et al. (2005)

Table 4: Items of Logistics Flexibility

Information Technology Flexibility

Information Technology flexibility (INFTF) is the ability to synchronize information systems with supply chain partners, to share information across internal business processes and to pass information along the supply chain (Lummes et *al*. 2003).

Items	***Definitions***	***Literature***
Synchronization flexibilty	The ability to synchronize information systems with supply chain partners.	Lummes et *al.* (2003)
Share flexibility	The ability to share information across internal business processes.	Lummes et *al.* (2003)
Pass flexibility	The ability to pass information along the supply chain.	Lummes et *al.* (2003)

Table 5: Items of Information Technology Flexibility

At this point, different dimensions of supply chain flexibility have been mentioned. These dimensions influence the firm performance. In the coming section, the impact of these dimensions on firm's performance is underlined through an exhaustive review of literature.

Supply Chain Flexibility and Performance: Model Development and Hypotheses

There are very few empirical papers available on the specific subject of SCF (Vickery et al., 1999; Barad and Sapir, 2003; Das and Malek, 2003; Garavelli, 2003). Because Supply chain flexibility can be studies from different perspectives, different aspects of this concept must be incorporated into the SCF model. This limit offers us an opportunity to investigate the influence of supply chain flexibility dimensions (Human resources flexibility, Product flexibility, Process flexibility, Information Technology flexibility and Logistics flexibility) on the global performance of Tunisian companies launched upgrading programs.

Upgrading programs are considered in a broader sense as a process by which the performances of the firms are boosted in order to survive in an open and competitive context. These policies need both to improve the competitive capacity of the firm and to improve the environment and the infrastructure of the industry. The main objective of this program is to modernize the manufacturing industry. Over 4000 firms have benefited from this program and have been supported by the European Union.

We must note that there is a little work addressing the issue of supply chain flexibility and, in particular, fewer studies on the relationship between SCF and global performance. However, contrary to flexibility in manufacturing systems which has been widely researched, it seems that research on SCF has been conspicuous by its absence (Barad and Sapir, 2003). Developing a model that describes the dimensions of SCF and illustrates the relationships with global performance depends on understanding the attributes and components of SCF and global performance. According to this idea, some authors have developed conceptual models of flexibility and business performance, but their previous research and their empirical results are contradictory.

Global performance in this study is schematized by the balanced scorecard (Kaplan et Norton 1992). As a model of strategic performance management, the characteristic of the balanced scorecard and its derivatives are a mixture of financial and non-financial measures. In its simplest form, the balanced scorecard breaks performance monitoring into four interconnected perspectives: Financial, Customer Satisfaction, Internal Process, and Learning & Growth.

- Financial perspective: covers the financial objectives of an organization and allows managers to track financial success and shareholder value.

- Customer perspective: covers the customer objectives such as customer satisfaction market.

- Internal process perspective: covers internal operational goals and outlines the key processes necessary to deliver the customer objectives.

- Learning and Growth perspective: covers the intangible drivers of future success such as human capital, organizational capital and information, capital including skills, training, leadership, organizational culture, system and databases.

Some scholars (Brill & Mandelbaum, 1989; Gerwin, 1993) think that a flexible operations system requires the management and control of different flexibility dimensions, by analyzing the total system flexibility. Flexibility is viewed as a reaction to environmental uncertainty (Riley & Lockwood, 1997) and can be an important source of competitive advantage, since material flows strongly affect business performance. According to Vickery et *al.* (1999), flexibility in supply chains may well represent a potential source of competitiveness to improve the company's efficiency and may be a significant measure of supply chain performance. In this respect, Swafford and *al.* (2008) identify a positive relationship between the supply chain flexibility and performance via the manufacturing flexibility.

Within the same scope, Vickery et al. (1999) presented analysis of SCF in furniture industry and its relationship to firm performance in the form of product, volume, launch, access, and responsiveness. These dimensions are applied to evaluate the impact of SCF components on firm's performance. As a result, volume, target market and launch flexibility have the highest correlation with market share growth. Similarly, Sanchez and Perez (2005) explored the relationship between the dimensions of supply chain flexibility and firm performance in automotive supplier industry. They found a positive relationship between the superior's performance in flexibility capabilities and the firm's performance. It is significantly clear that launched flexibility and target market flexibility are important for growth-related performance in automotive supplier industry. However, volume flexibility stands as the key factor in market share growth in furniture industry as it has the lowest impact on market share for automotive industry. On the other hand, Access flexibility is of paramount importance for automotive supplier industry, but unimportant for furniture industry. These indicators are vital not only in market share side but also in financial aspect. In addition, volume flexibility and launched flexibility incorporate time-based performance. This clearly shows that time-based

competitive approaches are crucial to meet the customers' requirements rapidly. These supply chain flexibility dimensions, which have enormous effects on market and customers, are due to effective coordination and capabilities consideration.

Sabri and Beamon (2000) define two types of flexibility measures in supply chain management: volume flexibility and delivery flexibility. Their results show that using volume flexibility reduces the costs of operating the supply chain by more than what is required to install the additional capacity.

The need for flexibility in the supply chain has been emphasized by Cohen and Lee (1988) and Cohen et al. (1988); it is one of the most strategic parts of enterprises which might attempt to increase the system performance. With the increase in competitiveness to satisfy the customer demand with less cost and in shorter time, it is not surprising that supply chain managers are beginning to recognize the importance of flexibility. Despite its importance, there is a lack of rigorous analytical models elucidating the relationships between the degree of flexibility in a system and the level of system performance (Mohamed et al., 2001). However, the performance of the entire supply chain can be improved if it is constructed with flexible components.

Swafford et al., (2006) highlight that supply chain flexibility enables an organization to react quickly and more effectively to marketplace volatility and other uncertainties, thereby allowing the firm to establish a superior competitive position. Previous studies have been conducted to unveil the relationship between supply chain flexibility, firm performance and competitive advantage (Loppacher, Cagliano & Spina, 2010; Betts & Tadisina, 2009; Lin & Tsai, 2009; Olugu & Wong, 2009; Landua, 2008). The increase in competitive advantage and firm performance can improve the level of implementation of supply chain flexibility practices (Lin, Chiu & Chu, 2006). With regards to supply chain flexibility, it can provide a positive influence on the company with regard to the environment of competitive and information technology; and consequently it affects the supply chain performance and the competitive advantage.

Table 6 reviews many empirical works and shows the major finding resulted from previous empirical studies related to supply chain flexibility. In addition, this literature revue can help us developing our framework model.

Author(s)	**Results**
Gupta and Somers (1996)	• Business strategy has direct effects on the adoption of manufacturing flexibility dimensions. • Manufacturing flexibility dimensions have direct effects on an organization's growth (financial) performance.

	• Business strategy indirectly affects on an organization's growth (financial) performance through its effect on manufacturing flexibility dimension. • Manufacturing flexibility would play a mediating role between business strategy and the organizational performance of firms.
Braglia and Petroni (2000)	• Firms look at manufacturing flexibility as an important competitive tool. • Empirical findings suggest that product flexibility is widely acknowledged as an important performance factor in all industries.
Das (2001)	• The results showed that new product flexibility had a positive influence on new product introduction time and customization responsiveness performance. • The data suggests that companies competing on innovation and customization should focus on developing new product flexibility, whereas mix flexibility would be important to companies competing on delivery and cost. • Mix flexibility can facilitate the development of modification flexibility. Similarly, modification flexibility can facilitate the development of new product flexibility.
Zhang et al. (2002)	• The results suggest that volume flexibility and mix flexibility have significant, positive, and direct impacts on customer satisfaction. • Mix flexibility seems to have a greater impact on customer satisfaction than volume flexibility.
Awwad (2004)	• Flexibility has a positive impact on adoption of excessive *demand* strategies (required to deal with changes in the product life cycle • Flexibility has a positive impact on adoption of excessive *capacity* strategies required to deal with changes in the product life cycle.
Salvador et al. (2007)	• The studied case suggests that a number of approaches typically used to increase volume flexibility, actually negatively affect mix flexibility and vice versa. Empirical evidence also suggests that, to some extent, volume flexibility and mix flexibility may be

	achieved synergistically, as initiatives such as component standardization or component-process interface standardization would improve both volume flexibility and mix flexibility
Zhang et al. (2008)	• Product concept flexibility enables firms to fully explore various product definitions and ideas. Product prototype flexibility allows firms to gather customers' feedback and investigate design feasibility. The results indicate that firms with high product concept flexibility are more likely to benefit from prototype flexibility than firms with low product concept flexibility, and that product concept flexibility and product prototype flexibility act independently and additively.

Figure 1 displays the basic research model of supply chain flexibility and global performance. Since no studies have tested the global performance of manufacturing flexibility in the Tunisian industry.

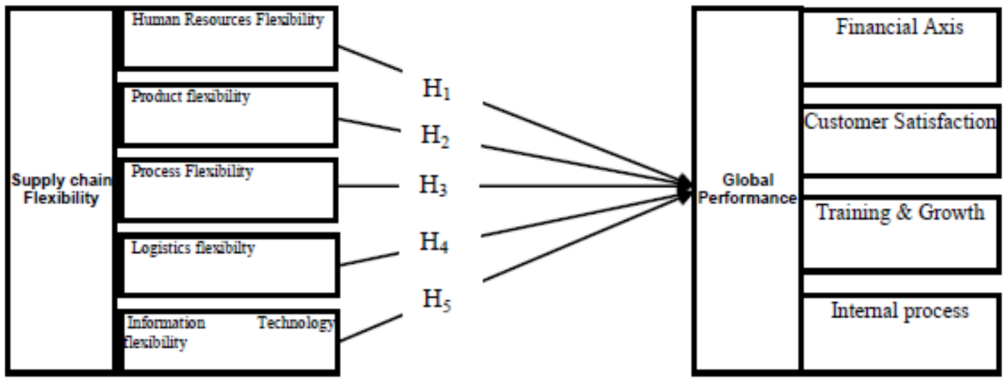

Figure 1. Conceptual Model

This study attempts to investigate the main research hypothesis regarding association between supply chain flexibility and global performance.

***Main hypothesis**: Supply chain flexibility has a positive effect on global performance.*

This main hypothesis is divided into five sub-hypotheses:

H1: Human resources flexibility has a positive structural effect on the global performance.

H2: Product flexibility has a positive structural effect on the global performance.

H3: Process flexibility has a positive structural effect on the global performance.

H4: Logistics flexibility has a positive structural effect on the global performance.

H5: Information technology flexibility has a positive effect on the global performance.

Quantitative Methodological Approach

We propose in this section the development and the validation of an instrument measure of SCF dimensions as well as the different measurements of the global performance through the statistical tests. First of all, we are anxious to test the reliability and the internal validity of items of each dimensions of SCF as well as the different measurements of the global performance. Then, an analysis of the main components will lead to assure a better initial data purification, to construct the final version of our model and to develop the relations that can exist between the different dimensions of the model using Structural Equation Modeling.

Sampling and Data Collection

This study targets a sampling firms listed in the agency of industry promotion and Innovation. These firms have launched an industrial upgrading program in order to increase the competitiveness of its enterprises and prepare them for international Market. A total of 214 questionnaires are distributed by mail to managers. Out of the 214 questionnaires distributed, only 105 are found useful. These useful and received questionnaires represent a response rate of 49.06 percent where the responding firms cover a wide range of manufacturing activities including Textile and clothing (51 firms with 48.57%), food (29 firms with 27.61%), chemical (14 firms with 13.33%) and glass & ceramic (11 firms with 10.47%).

The questionnaire format was highly structured where all of its questions were fixed-response alternative questions that required the respondents to select responses using five point Likert scales. All of the measurement scales used in this research was based on existing research. Assuring the validity and reliability measures requires supported literature to validate the measurement scales which are in favor of the research constructs.

Exploratory Factor Analysis

Exploratory factor analysis (EFA) is utilized to operationally redefine the various dimensions of Supply chain flexibility and global performance included in the research model. However, these dimensions are identified and measured depending on supported literature related to each variable included in the research model. EFA is the technique that defines the possible relationships in the most general form, and then allows for multivariate techniques to estimate the relationships (Hair et al, 1998, Field, 2000). Two main objectives of EFA are determined: data summarization and data reduction (Hair et al., 1998). The following subsections show that the factor analysis for the two mains concepts: Supply chain Flexibility and Global Performance.

Reliability Test of Supply Chain flexibility

A reliability analysis for every dimensions of the supply chain flexibility has been conducted in order to study the internal consistence between items for each variable. Coefficients are presented in the following table:

Code	**Dimensions of SCF**	**Number of items**	**Alpha of Cronbach (α)**
HRF	Human Resources Flexibility	3	0.861
PRODF	Product Flexibility	2	0.67
PROCF	Process Flexibility	5 ; (3)	0.682 ; 0.862
LOGF	Logistics Flexibility	3	0.907
INFTF	Information Technology Flexibility	3	0.89

According to this first step of analysis, results show that:

- Dimensions "Human resources flexibility", "Logistics Flexibility" and "Information Technology Flexibility" arrange a coefficient α > to 0.7 (they are in the order of 0.861; 0.907 and 0.89) without making any modification to their content.

- However, for the dimension "Process Flexibility", it is necessary to make the elimination of two items in order to have a coefficient α > to 0.7 (in the order of 0.862).

- Finally, The dimension of "Product Flexibility" has a coefficient of reliability alpha too weak to reach the level of acceptability. Therefore, this dimension leaves our basis of calculation since they do not have any effect.

3.2.2 Reliability Test of Performance Measurements

The same gait has been led to see the hardiness of variables reliability formulating the global performance. Results are presented in the following Table 8:

Code	**Dimensions of Performance**	**Number of items**	**Alpha of Cronbach (α)**
FINAN	Financial	4	0.902
CUSTSAT	Costumer Satisfaction	4	0.827
LEARGR	Learning & Growth	4	0.883
INTPR	Internal Process	4	0.825
Global Performance		**0.812**	

Table 8. Reliability Test of Performance Measurements

According to this table, we must signal that the four measurements of the global performance have a coefficient of α > 0, 7 (they are in the order of 0.902; 0.827; 0.883 and 0.825) without making any modification to their contents.

Measurement Model Results

The overall model fit can be tested using the comparative fit index (CFI), non-normed fit index (NFI), root mean square error of approximation (RMSEA), and

normed chi-square (i.e. **2/ddl**). Values of CFI and NFI between 0.80 and 0.89 represent a reasonable fit (Segars and Grover, 1993) and scores of 0.90 or higher are evidence of good fit. Values of RMSEA less than 0.08 are acceptable (Hair et al., 1995; Joreskog and Sorbom, 1986).

	Confirmatory Factor Analysis							**Validity Test**	
	χ2/ddl	**GFI**	**AGFI**	**RMR**	**RMSEA**	**NFI**	**CFI**	ρ	**vc**
HRF	2.73	0.98	0.96	0.012	0.077	0.97	0.97	0.850	0.606
PROCF	2.86	0.94	.99	0.038	0.061	0.97	0.96	0.891	0.740
LOGISF	2.51	0.97	0.94	0.052	0.072	0.95	0.97	0.937	0.760
INFTECF	2.16	0.98	0.97	0.047	0.022	0.98	0.98	0.901	0.621
FINPERF	2.51	0.97	0.94	0.048	0.072	0.95	0.97	0.902	0.715
CUSTSAT	2.50	0.94	0.89	0.050	0.064	0.89	0.92	0.830	0.568
LEARGR	2.25	0.97	0.96	0.043	0.032	0.97	0.98	0.846	0.589
INTERP	2.55	0.96	0.91	0.054	0.078	0.95	0.96	0.858	0.616
Seuil									
	<2 see <5	**>0.9**	**>0.8**	**→ 0**	**<0.08**	**>0.9**	**>0.9**	**>0.5**	**>0.5**

Rhô de Jöreskog, Rhô de validité convergente

Table 9: Confirmatory Factor Analysis Test

The confirmatory factor analysis (CFA) or a measurement model using AMOS 4.0 software was employed for examining construct validity of each scale by assessing how well the individual item measured the scale (Ahire, Golhar & Waller (1996); Agus, (2010)). According to Table 9, results showed all the dimensions were loaded highly on their corresponding constructs, which supported the independence of the constructs and provided strong empirical evidence of their validity.

Structural model results and testing hypothesis

Structural Model Results

After having validity models of measure, we propose to test some hypotheses (tests of causalities between the Supply chain flexibility dimensions and the global performance), which are the fruits of a specialized literature review. Hence, we tend to test the meaningful cause of effect relations between the different variables via the structural equation modeling. Structural model results were obtained to the sample of 105 firms, and the results are displayed in Table 10. These indices indicate that the model adequately fits the data.

□2/ddl	GFI	AGFI	RMR	RMSEA	NFI	CFI
2.55	0.97	0.82	0.068	0.059	0.91	0.93
Seuil						
<2 see <5	**>0.9**	**>0.8**	**→ 0**	**<0.08**	**>0.9**	**>0.9**

Table 10. Structural Model Results

Findings of the Structural Equation Modeling indicated that the resulting □2/ddl was 2.55 supported the null hypothesis that the Structural Equation Modeling model had a good fit. Furthermore, other statistical structural indices such as Goodness of fit index (GFI = 0.97), Comparative fit index (CFI = 0.93), Non Incremental Fit Index (IFI = 0.91) and Adjusted Goodness of Fit Index (AGFI = 0.82) further suggested that the model had a satisfactory fit. Since the probability value and structural modeling indices were well above the recommended level, the model was considered to be a reasonable representation of the data.

Testing Hypothesis and Discussion

The hypotheses of this research are formulated to investigate and examine the effect of SCF dimensions on global performance. To ensure that the hypothesized models are fit, the three types of goodness-of-fit measures recommended by Hair et al. (1998) are used in this study. These measures include: Structural loadings, Standard Errors, Critical ratio and its probability. Table 11 lists various measures of the statistical tests of the relationships between SCF dimensions and Global performance in order to confirm or disprove our hypotheses model fit used in this research and their recommended values as suggested in the literature.

	Std Loadings	Std Errors	Critical Ratio	Probability	Significant
PROCF→ Global Performance	0.058	0.078	0.875	0.254	Not Significant
HRF → Global Performance	0.786	0.038	5.231	0.002	Significant
LOGF → Global Performance	0.824	0.061	8.986	0.001	Significant
INFTF → Global Performance	0.869	0.235	7.208	0.001	Significant

Table 11: Relationship between SCF Dimensions and Global Performance

As shown Table 11, the direct structural effect of Human Resources flexibility (**HRF**) on Global Performance (GP) is high with structural effect value of 0.786. The standardized structural coefficient of HRF on Global

Performance is associated with low standard error (0.038) and non-zero critical ratio (5.231), which indicates that the structural effect between these two constructs is positive and the relationship is significant. The direct structural effect of Logistics flexibility (**LOGF**) on Global performance is also quite high and significant (structural effect value of 0.824) with low standard error (0.061)

and non-zero critical ratio (8.986). In addition, Information Technology Flexibility (**INFTF**) exhibits a positive structural effect on business performance (structural direct effect = 0.896), with low standard error (0.235) and significant critical ratio (7.208).

In contrast, the relationship between Process flexibility (**PROCF**) and Global Performance is not significant. The results indicate that the structural effect equal 0,058, with standard error (0,078) and critical ratio (0,875). Therefore, there is enough evidence to accept and reject the hypotheses. Table 12 shows us three hypotheses are accepted (**H1**, **H4** and **H5**) and two hypotheses are rejected (**H2** and **H3**).

Thus, we can conclude that SCF has a ***partial effect*** on global performance. Overall, it is essential to confirm that SCF can ultimately improve business performance of manufacturing companies that launched upgrading programs in Tunisia.

Code	**Hypotheses**	**Results**
Main Hyp.	Supply chain flexibility has a positive effect on global performance	**Partially confirmed**
H1	Human resources flexibility have a positive structural effect on the global performance	**Confirmed**
H2	Product flexibility has a positive structural effect on the global performance.	**Rejected**
H3	Process flexibility has a positive structural effect on the global performance.	**Rejected**
H4	Logistics flexibility has a positive structural effect on the global performance	**Confirmed**
H5	Information technology flexibility has a positive structural effect on the global	**Confirmed**

	performance	

Table 12. Hypothesis Results

In summary, the results of the tested hypotheses, as presented in Table 12, imply that SCF has a ***partial impact*** on the global performance. These results are consistent to the Tunisian companies launched upgrading programs to identify their lack of flexibility in all along the supply chain activities. Our study proves that the deficiency in the Tunisian firms resides at the level of two-dimensions: Product flexibility and Process flexibility. Therefore, Tunisian upgrading companies need more investment in terms of Product flexibility and Process flexibility in order to develop their competitive advantage and global performance. But, we have to explain the mains reasons of this lack.

Firstly, we have to signal that there is a strong correlation between Product flexibility and Process flexibility (Jack and Raturi, 2002). Product flexibility needs a flexible process which can be achieved by implementing varying strategies for creating volume flexible responses, improving forecasting and planning systems with information technology as well as leveraging the firm's ability to negotiate on volume with suppliers and customers.

Secondly, the operation systems of the major companies interviewed have a rigid structure, machinery and equipment. Rigidity of structure and equipment may inhibit several aspects of the supply chain such as: product differentiation, process improvements, replacement products, new uses for product, process efficiencies; product innovation, product replacement, market segmentation, new channels of distribution, and selection of the target markets. All these strategies are basically related to various operations and marketing strategies and they contribute to the development of competitive advantage of a firm. However, Tunisian companies that launched upgrading programs should emphasize greater attention to the technology and innovation, and lean production aspects (Supply Chain Management process and a greater degree of management support).

Thirdly, we have to mentioned that this lack can be explained by the fact that Tunisian managers does not have the courage to invest in this area because of their financial fragility and the smallest size of the Tunisian market.

Fourthly, the last explanation is linked to the profile of Tunisian managers. Several studies (Bellon et al. 2006 and 2007) show that the performance of the firms in the Mediterranean area is still hugely dependent on the entrepreneurship style. They seem to apply a "wait and see" attitude upgrading policies. Their approach is not proactive and is more reactive which does not fit the principle of Flexibility.

But, no one can ignore the contribution or value-added of the upgrade program in the Tunisian context. Already, the presence of three dimensions of the supply chain flexibility (**HRF**, **LOGF** and **INFTF**) could be explained by the applicability of this program. In all cases, upgrading policies were considered as industrial and commercial policies seeking to improve the performance of Less Developed Countries's (LCD's) firms in order to become able to compete in a more open context. In fact, upgrading policies are industrial policies affecting the structure, the behavior and the performance of the firms by increasing the skills of local production, moving into market niches that are relatively insulated from competition on global markets, and expanding the range of activities in a given value chain carried out of a firm or a cluster of firms (Humphery and Schmitz, 2002). However, in the case of Tunisian context, few studies have tried to understand the impact of upgrading program on firm's performance. Achy et al. (2007) signaled a positive effect through three complementary channels:

- Upgrading policies aim at improving the technological capabilities of the firm and encouraging the use of more efficient technology. The cost of these technologies, the intellectual propriety rights and the lack of trained and well-educated workers are among the most known arguments. Starting from these considerations, upgrading policies seek to improve the technological capabilities of the local firms and to help them in order to acquire more advanced machinery and to promote innovative activities within the firms.

- Upgrading program prepare firms to more competitive contexts (open economy). Firms move from protected positions and soft competition to a dynamic process of competition. This process influences their attitudes and their efficiency. Imitation of best practices in terms of marketing, pricing, distribution and innovation is expected.

- Upgrading program help firms to reach the critical size in order to benefit from scale economies. In fact, most of Tunisian companies are small and medium sized; so, they are not able to compete in terms of pricing since their costs are high.

Conclusion

It is important to stress that organizations need to evaluate their performance affected by supply chain flexibility aspects. In the same way, an empirical investigation has been launched in the Tunisian context to survey the nature of relations that can exist between the Supply chain flexibility dimensions and the global performance. Hence, an exploratory investigation close to 105 firms launched upgrading program operating into four industrial sectors participated in this study. A procedure of data collection via the technique of

questionnaires is used. In order to purify data, an analysis in two stages has been achieved using the SPSS 18.0 and AMOS 4.0 software. A first iteration is dedicated to the survey of reliability and validity according to the coefficient alpha of Cronbach. Then, a second equation factory analysis (EFA) stage has been launched in order to determine the importance of the initial variables in the formation of new factors. Besides, results of this analysis permitted to eliminate many items and one variable bound to the SCF (Product flexibility).

The last stage of the analysis gave us the possibility to test the effect of the SCF dimensions on the global performance. So, a modeling has been launched via the structural equations modeling with latent variables. Indeed, thanks to an analysis of progress, four direct relations have been tested. Generally speaking, results show the existence of a positive relationship between the following supply chain flexibility dimensions: Human Resources flexibility, Logistics flexibility and Information Technology flexibility and the global Performance. But, there are no statistically positive relationships between dimensions "Product flexibility" and "Process flexibility" and global performance.

As summary, we can signal that there is a partial influence of supply chain flexibility on global performance. Certainly, the upgrade program has contributed to such level of performance. But, other actors such as state, Business associations, Institutions, and managers must support Tunisian firms in terms of Product flexibility and Process flexibility. Furthermore, state policies can create training centers, foster linkages between research and development institutions, firms, business associations and marketing channels, and identify priority sectors for development. Also, Tunisian managers must have more desire and have to be initiative especially in terms of investment in research & development, innovation, training in the field of flexible manufacturing systems, and increasing the rate of coaching through the recruitment of qualified people that can bring added value throughout the supply chain logistics.

The conclusion emerging from this study validates some of the key linkages and supports beliefs and evidence by researchers regarding the relationships between supply chain flexibility and performance. It is also important to note that this study attempts to enrich the literature review and make a contribution in supply chain management-related studies.

Some limitations in this study may be noted. The study has not taken into consideration the effect of the moderating and intervening variables (*such as company size, business unit, organizational structure, industry type, etc.*) on the relationships between supply chain flexibility and business performance. In addition, the results of this study concerned only the Tunisian manufacturing companies launched upgrading program. Thus, these results may not be applied

to all Tunisian firms. A new research can be conducted for the firms that has not launched upgrading program yet. Also, in this study, both the dependent and independent variables were measured through a single respondent, which may introduce common-method bias. Finally, the current study was limited to 105 firms, which might not be a representative sample.

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ELASTYCZNOŚĆ ŁAŃCUCHA DOSTAW I ZRÓWNOWAŻONA KARTA WYNIKÓW: MODEL KONCEPCYJNY I STUDIUM EMPIRYCZNE W PRZEDSIĘBIORSTWACH RUNEZYJSKICH. URUCHOMIENIE PROGRAMU AKTUALIZACJI

Abstrakt: W artykule tym wyjaśniamy koncepcję elastycznego łańcucha dostaw (FCM), starając się odsłonić trudności związane z pojmowaniem tej koncepcji. Nieprecyzyjne pojęcie elastycznego łańcucha dostaw utrudnia rozwój aktualnych i wiarygodnych środków, które są potrzebne do budowy i testowania teorii z uwzględnieniem elastycznego łańcucha dostaw. Artykuł ten rzuca światło na literaturę dotyczącą wpływu elastycznego łańcucha dostaw na wydajność biznesową. Prezentowana rama koncepcyjna ma za zadanie odkrycia skutków jaki niosą za sobą różne wymiary elastycznego łańcucha dostaw (zasoby ludzkie, produkty, procesy, technologie informacyjne i logistyka) w wymiarze globalnym. Dla każdego wymiaru elastycznego łańcucha dostaw i jego wymiaru globalnego, opracowane zostały prawidłowe i niezawodne środki, a hipotezy zostały przetestowane przy użyciu strukturalnego modelowania równań. Z dużego badania reprezentacyjnego (n=105) zakładów produkcyjnych, uruchomiono program aktualizujący, a wyniki wskazują na częściowy wpływ elastyczności łańcucha dostaw na wydajność w skali globalnej. Trzy wymiary (elastyczność zasobów ludzkich, elastyczność logistyki i elastyczność technologii informacyjnej) mają pozytywne i silne relacje związane z wydajnością w skali globalnej. Jednakże elastyczność produkcyjna i elastyczność procesowa nie były obecne w firmach tunezyjskich.

供應鏈的靈活性和平衡計分卡的概念模型和實證研究在突尼斯公司推出升級方案

摘要：在這篇文章中，我們澄清在供應鏈的靈活性（SCF）的概念，試圖揭開這個概念理解和處理範圍的困難。

SCF不精確的概念，因此很難制定有效和可靠的措施，這需要涉及供應鏈的靈活性來構建和測試理論。

本文揭示光與文學的SCF對企業經營績效的影響。一個概念框架，提出發現的SCF（人力資源，產品，工藝，信息技術和物流）的不同層面上的整體性能的影響。有效和可靠的措施，SCF和全球業績的每個維度開發和使用結構方程模型假設檢驗。從一個大型製造企業的抽樣調查（N=105）推出升級方案，結果表明，在全球的表現部分影響供應鏈的靈活性。三個層面（人力資源的靈活性，物流的靈活性和信息技術的靈活性）在全球的表現有

正面和牢固的關係。但是，產品的靈活性和過程的靈活性在突尼斯公司不存在。