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Integration of Supply Chain Determinants on The Operational Performance of The Tunisian Agro-Industrial Sector

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Abstract: This contribution aimed to shed light on the impact of the determinants of supply chain management on the success of the Tunisian agro-industrial sector and the benefits it provides, it is an essential entry point to achieve competitiveness.

A quantitative study was conducted to verify the impact of supply chain integration dimensions on operational performance. Direct relations were tested in this case. After discriminant analysis and regression analysis by quantitative measurement, we can affirm that our objective contributes to support the agro-food companies whose integration dimensions of the supply chain positively affect the operational performance.

Thus, we applied the characteristic analysis to be able to classify the various alternatives studied, then to choose the best solution. The results obtained through the application of the analysis of characteristics show that the variable "information and information technologies" is the best dimension and occupies a fundamental place in the integration of the supply chain.

Keywords: Supply chains, Tunisian agro-industrial company, SPSS 26, Quantiles regression.

Literature review:

Globalization and the rapid development of information technologies are changing the relationships between businesses today. Tunisian agribusinesses increasingly depend on a complex web of global partners to deliver the right quantity of produce, to the right place, at the right time[1]. However, long and complex supply chains are generally slow to react to changes and as a result they are vulnerable to supply chain disruptions. One way to address this issue is to successfully manage supply chain

[1]Sessu, A., Sjahruddin, H., and Santoso, A. (2020), "The Moderating Effect of Supply Chain Dynamic Capabilities on the Relationship of Sustainable Supply Chain Management Practices, Supply Chain Integration and Business Performance". Journal of Talent Development &Excellence, 12(1), 1339-1353.

integration, which requires cross-enterprise business processes with appropriate levels of information sharing, operational coordination, and partnerships[2].

Onboarding has become an integral and very important part of any organization. Indeed, the integration of technology, people, business and process has become crucial for the survival of any organization and especially if the organization needs to find an edge competitive in today's global economy[3].

The importance of supply chain integration between a company, its suppliers and its customers is also growing in importance. As with any business relationship, the association should be long term and the strength of the relationship depends on the behavior of the members of the supply chain.

For integration to be successful, there must be a clear understanding of the materials being purchased, the core competencies, the supplier expertise, the customer being served, and the organization itself. The quality of the integration always depends on the relationship between the organization and the supplier[4].The development of integration between the agribusiness and its suppliers or the agribusiness and its customers aims to improve specific areas of business performance, resulting in savings in quality control costs. and better integration of design efforts to meet customer needs[5].

Introduction

In this article, we have presented the framework for analyzing two concepts: supply chain integration and operational performance. Hence, following their conceptualization, the relationship between the dimensions of supply chain integration and the operational performance of agribusinesses.

This article will thus aim to expose the methodology used in the context of our work. From a methodological point of view, we based ourselves on a sample composed of 110 Tunisian industrial agro-food companies. The data collection method was a structured questionnaire in the form of a Likert scale. The validation of variable measurement scales, these methods make it possible to ensure the relevance and precision of the data collected to explain the phenomenon studied. It then becomes necessary to provide justifications for the choice of methods and tools they use. Regressions and discriminant analysis are performed using SPSS 26 software.

This article is divided into two sections. In the first section, we will present the research methodology. Specifically, we describe the geographical area of our study, the method of data collection and the processing and analysis of the data. In addition, we look at measures of the variable to be explained (operational performance) and (supply chain integration). In the second section, we will first adopt the exploratory factor analysis which aims to study the unidimensionality of the variables through the PCA method (Principal Component Analysis). Second, we will adopt discriminant analysis (DA) and

[2]Leuschner, R., Rogers, D.S. and Charvet, F.F. (2013), "A meta-analysis of supply chain integration and firm performance". Journal of Supply Chain Management, 49(2), 34-57.

[3]Arend, R. J., and Wisner, J. D. (2005), "Small business and supply chain management : is there a fit " ? Journal of Business Venturing, 20(3), 403–436.

[4]Wood, G., and Brewster, C. (2005), "Trust, Intrafirm, and Supplier Relations". Business and Society Review, 110(4), 459-484.

[5]**M**udambi,R.,andC.P.Schründer(2006),"ProgresstowardBuyer-SupplierIntegration".EuropeanJournalof Purchasing& Supply Management 2(2/ 3), 119-127.

quantile regression analysis which aims to analyze the causal relationships between the variables of the conceptual model.

Section/1: Description of the study area

1- Tunisia: geographical context

Tunisia is a country in North Africa, bathed by the Mediterranean Sea, having a western border with Algeria (965 km) and a south-eastern border with Libya (459 km) where the width of the land narrows towards the southwest into the Sahara. Tunisia occupies an area of 163,610 square kilometers, of which 8,250 is water. The main and reliable rivers rise in the north of the country with a few notable exceptions in northeastern Algeria and flow through the northern plain where sufficient rainfall supports diverse vegetation cover and irrigated agriculture[6].

2- People

The population frame for surveyed data collection was the Tunisian industrial agro-food enterprises[7].

Table n°1 : The population of the Tunisian industrial agro-food company

Sectors	TE*	OTE*	Total	%
Agrifoods industries	203	809	1 012	20,8%

Source : Agency for the Promotion of Industry and Innovation - November 2022

TE*: Totally Exporters

OTE*: Other than Totally Exporting.

Section 2/: Method of data collection and operationalization of variables

We will use in our study the quantitative method, the recommended tool for data collection is the questionnaire. The questionnaire is one of the most efficient methods of data collection. It is intended to be the best tool for carrying out quantitative studies since it makes it possible to collect a large amount of information on large samples and to establish statistical relationships or numerical comparisons[8].

• The first section: aims to obtain general information on the agro-food company, such as the size of the agro-industrial company, the sector of activity, the number of employees, etc. So on the respondents such as age, sex, function, year of experience etc.

• The second section: focused on supply chain integration. The concept was measured using 6 dimensions.

- ✓ The first dimension concerns the integration of suppliers[9].
- ✓ The second dimension concerns the integration of Producers[10].

[6]Nyvo, 03/11/2007, about_tunisia_fr.pdf, Microsoft Word - présentation tunisie-français.doc,page-1, http://www.mdptunisie.tn/ar/conference/images/pdf/about_tunisia_fr.pdf.

[7]Agence de Promotion de l'Industrie et de l'Innovation ,iaa.pdf, 02/03/2021,les industries agro-alimentaire en Tunisie,page-6, http://www.tunisieindustrie.nat.tn/fr/tunisienne.asp.

[8]Baumard, P., C. Donada, J. Ibert et J.M. Xuereb (2008), "La collecte des données et la gestion de leurs sources, in méthodes de recherche en management". Thiétart R.A. Méthodes de recherche en management, Dunod - 3ème édition, 228-262.

[9]Flynn, B.B., Huo, B. and Zhao, X. (2010), "The impact of supply chain integration on performance : acontingency and configuration approach". Journal of Operations Management, 28 (1), 58-71.

- ✓ The third dimension concerns internal integration[11].
- ✓ The fourth dimension concerns retailer integration[12].
- ✓ The fifth dimension concerns the integration of customers[13].
- ✓ The sixth dimension concerns the integration of information and information technologies[14].

• The third section: focused on the evaluation of operational performance. The concept was measured by flexibility, product quality, production cost, responsiveness and product innovation.

- ✓ Flexibility[15].
- ✓ Product quality[16].
- ✓ The cost of production[17].
- ✓ Responsiveness[18].
- ✓ Product innovation[19].

To measure the dimensions of the variables, we used the five-point Likert ordinal scales ranging from 1 (totally disagree) to 5 (totally agree) because it presents ease of administration for our research. bigger.

The scale is as follows:

Not agree at all	Disagree	Neutral	Agree	Totally agree

After the operationalization phase of the "integration of the supply chain" variable and the "operational performance" variable, we administered the questionnaire to managers of agro-industrial companies, belonging to Tunisian industrial agro-industrial companies. It was disseminated via the Internet, by sending an electronic message (e-mail) to the target population, by telephone and by face-to-face interview.

1- Data processing and analysis

[10]Sempore Aristide, Andrieu Nadine,2015, Quelles stratégies pour améliorer l'intégration agriculture-élevage dans des exploitations de savane ouest-africaine ? Approches par simulation avec les producteurs, ANDRIEU p.349-360.pdf, https://agritrop.cirad.fr/578120/1/ANDRIEU%20p.349.pdf.

[11]Flynn, B.B., Huo, B. and Zhao, X. (2010), "The impact of supply chain integration on performance : contingency and configuration approach". Journal of Operations Management, 28 (1), 58-71.

[12]Abdelfattah TRIKI, 2010, Le comportement du détaillant : Développement d'un modèle pivotant autour d'un nouveau construit libellé « opportunité de la commercialisation de la marque », Direction et Gestion | « La Revue des Sciences de Gestion » 2010/3 n°243-244 | pages 161 à 170, file:///C:/Users/DELL/Downloads/RSG_243_0161.pdf.

[13]Droge, C., Vickery, S. K., and Jacobs, M. A. (2012), "Does supply chain integration mediate the relationships between product/process strategy and service performance ? An empirical study". International Journal of Production Economics, 137(2), 250-262.

[14]Sundram, V.P.K, Chandran, V. and Awais Bhatti, M. (2016), "Supply chain practices and performance : the indirect effects of supply chain integration", Benchmarking : An International Journal,23 (6), 1445-1471.

[15]Narasimhan, R., Swink, M., and Viswanathan, S. (2010), "On Decisions for Integration Implementation : An Examination of Complementarities Between Product-Process Technology Integration and Supply Chain Integration". Decision Sciences, 41(2), 355–372.

[16]Swink, M., Narasimhan, R. and Wang, C. (2007), "Managing beyond the factory walls : effects of four types of strategic integration on manufacturing plant performance". Journal of Operations Management, 25(1), 148-164.

[17]Ward, P. T., and Duray, R.(2000), "Manufacturing Strategy in Context : environment, Competitive Strategy and Manufacturing Strategy". Journal of Operations Management,18 (2),123–138.

[18]Gunasekaran, A., Lai, K.h., and Cheng, T.C.E. (2008), "Responsive Supply Chain : A Competitive Strategy in a Network Economy". International Journal of Management Science, 36, 549-564.

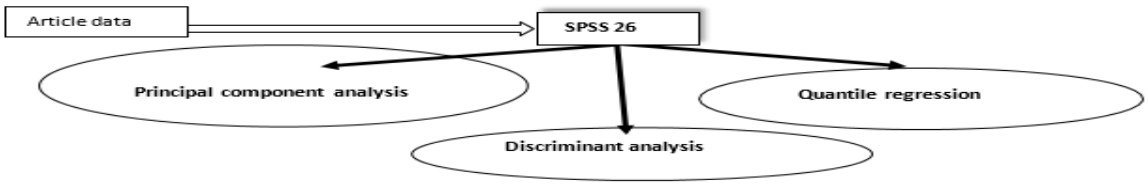
[19]Camisón, C., and Villar-López, A. (2014), "Organizational Innovation as an Enabler of Technological Innovation Capabilities and Firm Performance". Journal of Business Research, 67 (1), 2891-2902.

The data obtained was processed using IBM SPSS Statistics version 26 software. This version was released in April 2019 and offers advanced statistical and textual analysis, integrates with bigdata, open source extensibility[20]. This software is flexible, scalable, accessible, easy to use and supports hypothesis testing.

The basic information of the respondents was analyzed and summarized using descriptive statistics in the form of frequency and percentage. The study applied discriminant and quantile regression analysis to investigate the relationship and impact between supply chain integration construct and operational performance.

Our approach to the empirical validation of research is summarized in the following figure:

Figure 1 : Data analysis methods used to study the relationship between supply chain integration and operational performance



Source : Own survey result, 2022

Section 3/: Discussion of the main results of the principal component analysis and the discriminant analysis

1- Profile of respondents and distribution of agro-industrial enterprises

We distributed 200 questionnaires and we had a return of 110 questionnaires, a return rate of 55%. For reasons related to the lack of information, 90 questionnaires that we consider usable.

Table n°2: The rate of returns and use of the questionnaires

Industries	Number of questionnaires distribute	Number of questionnaires returned	Questionnaire return rate	Number of usable questionnaires	Rate of usable questionnaires
Oils and fats industry	35	21	60%	18	20%
Cereals and derivatives industry	30	12	40%	10	11.11%
Fruit and vegetable industry	25	11	44%	6	6.66%
Milk industry and derivatives	35	20	57.1%	20	40%
Sugar industry and	18	12	66.66%	9	10%

[20]Routledge (2020), Pallant J. SPSS survival manual : A step bystep guide to data analysis using IBM SPSS.

derivatives					
beverage industry	30	13	43.33%	12	13.33%
Cold storage	12	11	91.66%	5	5.55%
fish industry	10	05	50%	7	7.77%
meat industry	05	05	100%	3	3.33%
Total	**200**	**110**	**55%**	**90**	**45.33%**

Source: Own article result, 2022

Table n°3: Profile of respondents

Characteristic	Number of companies	Percentage
Sex		
Man	60	66.66%
Women	30	33.33%
Age		
Between 25 and 35 years old	40	44.44%
Between 35 and 45 years old	30	33.33%
Between 45 and 55 years old	15	16.66%
Over 55	5	05.55%
Qualification		
Certificate	10	11.11%
Diploma	30	33.33%
Baccalaureate	10	11.11%
master	40	44.44%
PhD	0	0
Experience		
Less than or equal to 5 years	20	22.22%
Between 5 and 10 years	30	33.33%
Between 10 and 15 years old	25	27.77%
More than 15 years	15	16.66%
Position		
Manager/Production Manager	25	27.77%
Senior Executive/Purchasing Manager	30	33.33%
Logistics/distribution manager	18	20.00%
Procurement and planning manager	10	11.11%
Financial framework	7	7.77%

Source : SPSS 26 software

As shown in Table 3, of the total respondents included in the analysis, 60 were men, representing 66.66%, and the remaining 30 (33.33%) were women. Statistics show that more than half of the respondents are men.

In terms of age distribution, 40 (44.44%) of respondents were aged 25-35, followed by 30 (33.33%) aged 35-45, 15 (16.66%) aged 45-55 and 5 (05.55%) aged over 55.

Regarding their level of education, 20 (22.22%) of the respondents held a diploma, followed by 30 (33.33%) who held a certificate, 25 (27.77) held a master's degree and 15 (16.66%) had a bachelor's degree. Most respondents have experience between 10 and 15 years with a rate of 27.77%.

Regarding the professional status of the respondents, 25 (27.77%) were production managers, while 30 (33.33%) were purchasing managers, 18 (20.00%) were logistics managers, 10 (11.11%) were supply and planning managers and 07 (7.77%) were financial executives.

2- Results of the principal component analysis

An exploratory principal component factor analysis was conducted with the SPSS 26 software for processing the data collected and especially the verification of the psychometric quality of the variables and the reliability of the scales for the validation of the hypotheses.

This analysis is based on two main phases:

1- Analysis of the dimensionality of the scale
2- Internal consistency analysis

To ensure the factorizable nature of the data, two tests were carried out. The KMO test (>0.5), it is used to test the suitability of the data to the factorial analysis and the Bartllett test (p=0.000), makes it possible to check to what extent the correlation matrix is very different from the matrix identity, in which case the variables do not represent links between them. These two criteria are met and show that the data can be factored.

To examine the reliability of the scale and analyze the internal consistency of the items with reference to Cronbach's alpha. The Cronbach's alpha reliability coefficient normally lies between 0 and 1. According to these authors, there is greater internal consistency of the items if the Cronbach's alpha coefficient approaches 1, thus based on their rule of thumb, if Cronbach's alpha > 0.7 it is "Acceptable".

The results of this analysis reveal the one-dimensional nature of the scales used. They are presented in the following table:

Table 4 : Dimensionality and reliability of measurement scales

Variables	Factors	Number of items	KMO	Variance explained	Cronbach's Alpha
Supply chain integration	Supplier integration	10	0,876	70,79%	0,895
	Integration of producers	7	0,889	65,602%	0,910
	Internal integration	8	0,917	64,335%	0,918
	Retailer integration	4	0,615	66,905%	0,945
	Customer onboarding	5	0,880	69,870%	0,891
	information integration and information technology	6	0,833	60,706%	0,836
	Total	**40**			
Operational performance	Flexibility	7	0,886	60,221%	0,882
	Quality	6	0,874	77,671%	0,940
	Cost	5	0,840	68,320%	0,882
	Reactivity	4	0,740	78,854%	0,907
	Product innovation	5	0,852	71,258%	0,897
	Total	**27**			

Source: Own survey result, 2022

The results show that all reliability values are greater than 0.7.

The highest Cronbach's alpha for the independent variable was observed for information sharing at (0.945) and the lowest for joint decision making (0.836).
The highest Cronbach's alpha for the dependent variable was observed for quality (0.940) and the lowest for flexibility (0.882).
The high value of Cronbach's alpha for all variables in the study indicates that the answers are reliable and consistent. This first phase of validation of the measurement scales allows moving on to the phase of testing the hypotheses.

3- Result of the discriminant analysis

Discriminant analysis (DA) is a statistical technique that aims to explain, describe and predict the membership of predefined groups (classes, modalities of the variable to be predicted, etc.) of a set of observations (individuals, examples, etc.) from a series of predictive variables (descriptors, exogenous variables).
The 3 main steps for a discriminant analysis are:

- ✓ Verification of existence between groups
- ✓ Estimation of the coefficients of the discriminant function
- ✓ Verification of the discriminating power of the axes

To establish the discriminant equation and determine a score, the coefficients of the discriminant function were estimated from the table "coefficients of the canonical discriminant function".
The discriminant analysis equation was:

$$Y= \beta 0+\beta 1X1+\beta 2X2+\beta 3X3+\beta 4X4+\beta 5X5 + \beta 6X6$$

Where: Y: is the dependent variable (operational performance)
β0, β1, β2, β3, β4, β5 and β6: are the parameters of the model
X1: Integration of suppliers; X2: Integration of producers; X3: Internal integration; X4: Integration of retailers; X5: Customer integration; X6: information integration and information technology.
One of the measures of discriminating power is the correct classification rate. The latter is equal to the ratio of the number of agro-industrial enterprises well ranked in the two groups to the total number of agro-industrial enterprises. Agro-industrial enterprises are classified into two groups: group of non-performing agro-industrial enterprises (class 0) and group of performing agro-industrial enterprises (class 1).

4- Impact of supply chain integration on flexibility

a- Verification of the existence of relations between the groups

Table n°5 : Test of equality of the means of the groups

	Lambda deWilks	F	ddl1	ddl2	significant	Rank
Supplier integration	,924	11,027	1	134	,001	**4**
Integration of producers	,960	5,651	1	134	,019	**6**
Internal integration	,936	9,139	1	134	,003	**5**
Retailer integration	,887	17,074	1	134	,000	**3**
Customer onboarding	,874	19,339	1	134	,000	**2**
information integration and information technology	,874	19,339	1	134	,000	**1**

Source : SPSS 26 software

From the table, it can be concluded that supplier integration, producer integration, internal integration, retailer integration, customer integration and information integration and Joint information technologies significantly affect the operational performance of the agro-industrial enterprise in terms of flexibility.

Examination of Fisher's F confirms that it is indeed the variables "integration of information and information technologies" and "Customer integration" that are the most discriminating.

The table shows that the best dimension representing the integration of the supply chain and allowing a better improvement of the operational performance in terms of flexibility is the integration of the information which integrates the information technologies and the integration client.

b- Estimation of the coefficients of the discriminant function

Table n°6 : Coefficients of the canonical discriminant function

	Fonction
	1
Supplier integration	,895
Integration of producers	-,263
Internal integration	-,486
Retailer integration	-1,639
Customer onboarding	2,457
information integration and information technology	,809
(Constant)	0

Source : SPSS 26 software

This allows us to establish the following discriminant function:

(Flexibility)= 0 + 0.895*(Supplier integration) – 0.263*(Producer integration) – 0.486*(Internal integration) – 1.639*(Retailer integration) + 2.457*(Customer integration) + 0.809*(the integration of information and information technologies).

c- Verification of the discriminating power of the axes

Table n°7 : Results of the classification of the basic[a] sample

			Intended group membership		
Y		**Flexibility**	**0**	**1**	**Total**
Original	**Effective**	**0**	46	15	61
		1	19	56	75
	%	**0**	77,3	22,7	100,0
		1	27,6	72,4	100,0
Has 74.85% of the original observations are classified correctly.					

Source : SPSS 26 software

As this table shows, the good ranking rate of non-performing companies in terms of flexibility is equal to 77.3% and the good ranking rate of high-performing companies is equal to 72.4%.

Thus, the number of companies well classified by the model is equal to 74.85%.

This study focuses on 6 dimensions of supply chain integration. These six variables explain that 74.85% of the number of well-ranked companies. Other non-integrated factors such as resource sharing, strategic integration, process integration, collaborative communication can increase this rate.

5- Impact of supply chain integration on product quality

a- Verification of the existence of relations between the groups

Table n°8 : Test of equality of the means of the groups

	Lambda deWilks	F	ddl1	ddl2	significant	Rank
Supplier integration	,915	12,455	1	134	,001	4
Integration of producers	,945	7,811	1	134	,006	6
Internal integration	,933	9,550	1	134	,002	5
Retailer integration	,887	17,145	1	134	,000	2
Customer onboarding	,880	18,316	1	134	,000	1
information integration and information technology	,901	14,677	1	134	,000	3

Source : SPSS 26 software

In the Test for equality of the means of the groups sub-table, we have the F value of all the independent variables which is significant with $p < 0.05$. This informs us that the six independent variables are significantly related to the dependent variable product quality.

Examination of Fisher's F confirms that it is indeed the "Customer integration" and "Retailer integration" variables that are the most discriminating.

b- Estimation of the coefficients of the discriminant function

Table n°9 : Coefficients of the canonical discriminant function

	Fonction
	1
Supplier integration	,445
Integration of producers	,206
Internal integration	-,428
Retailer integration	-,427
Customer onboarding	1,457
information integration and information technology	,822

(Constant)	0

Source : SPSS 26 software

This allows us to establish the following discriminant function:

(Product Quality) = 0 + 0.445*(Supplier Integration) + 0.206*(Producer Integration) – 0.428*(Internal Integration) – 0.427*(Retailer Integration) + 1.457*(Customer Integration) + 0.822*(information integration and information technology).

b- Verification of the discriminating power of the axes

Table n°10 : Results of the classification of the basic[a] sample

			Intended group membership		
Y		**Quality**	**0**	**1**	**Total**
Original	**Effective**	**0**	52	18	70
		1	21	45	66
	%	**0**	74,3	25,7	100,0
		1	20,7	79,3	100,0
Has. 76.8% of the original observations are classified correctly.					

Source : SPSS 26 software

As this table shows, the good ranking rate of non-performing companies in terms of quality is equal to 74.3% and the good ranking rate of high-performing companies is equal to 79.3%. Thus, the number of companies well classified by the model is equal to 76.8%.

6- Impact of supply chain integration on production cost

a- Verification of the existence of relations between the groups

Table 11 : Test of equality of group means

	Lambda deWilks	**F**	**ddl 1**	**ddl2**	**significant**	**Rank**
Supplier integration	,918	12,021	1	134	,001	**4**
Integration of producers	,938	8,868	1	134	,003	**6**
Internal integration	,934	9,521	1	134	,002	**5**
Retailer integration	,905	14,113	1	134	,000	**2**
Customer onboarding	,875	19,193	1	134	,000	**1**
information integration and information technology	,911	13,100	1	134	,000	**3**

Source : Own survey result, 2022

In the sub-table we have the F value of all the independent variables which is significant with $p < 0.05$. This informs us that the six independent variables are significantly related to the dependent variable cost of production.

c- Estimation of the coefficients of the discriminant function

Table 12 : Coefficients of the canonical discriminant function

	Fonction
	1
Supplier integration	-,560
Integration of producers	,379
Internal integration	,067
Retailer integration	,227
Customer onboarding	,583
information integration and information technology	,545
(Constant)	,420

Source : SPSS 26 software

This allows us to establish the following discriminant function:

(Cost of production) = 0.420 - 0.560*(Supplier integration) + 0.379*(Producer integration) + 0.067*(Internal integration) + 0.227*(Retailer integration) + 0.583*(Customer integration) + 0.545*(information integration and information technology).

c- Verification of the discriminating power of the axes

Table 13 : Base[a] sample ranking results

			Intended group membership		
Y		Production cost	0	1	Total
Original	Effective	0	40	14	54
		1	12	70	82
	%	0	75,1	24,9	100,0
		1	16,6	83,4	100,0
Has. 79.25% of the original observations are classified correctly.					

Source : SPSS 26 software

As this table shows, the good ranking rate of non-performing companies in terms of production cost is equal to 75.1% and the good ranking rate of high-performing companies is equal to 83.4%. Thus, the number of companies well classified by the model is equal to 79.25%.

7- Impact of supply chain integration on responsiveness

a- Verification of the existence of relations between the groups

Table 14 : Test of equality of group means

	Lambda deWilks	F	ddl1	ddl2	significant	Rank
Supplier integration	,925	10,936	1	134	,001	**4**
Integration of producers	,970	4,172	1	134	,043	**6**
Internal integration	,937	9,071	1	134	,003	**5**
Retailer integration	,904	14,243	1	134	,000	**3**
Customer onboarding	,898	15,139	1	134	,000	**2**
information integration and information technology	,879	18,370	1	134	,000	**1**

Source : Own survey result, 2022

From the table below, we find that all the independent variables are significantly related to the responsiveness dependent variable (Fisher's F is significant with $p < 0.05$). This table shows the relevance of the variable "integration of information and information technologies" which has the highest discriminating power (Fisher's F 18.370), which shows that this variable does indeed influence business performance food industry in terms of reactivity.

b- Estimation of the coefficients of the discriminant function

Table 15 : Coefficients of the canonical discriminant function

	Fonction
	1
Supplier integration	-,060
Integration of producers	-,075
Internal integration	,167
Retailer integration	-,627
Customer onboarding	1,583
information integration and information technology	,745
(Constant)	0

Source : SPSS 26 software

This allows us to establish the following discriminant function:

(Responsiveness)= 0 - 0.060*(Supplier Integration) - 0.75*(Producer Integration) + 0.167*(Internal Integration) - 0.627*(Retailer Integration) + 1.583*(Customer Integration) + 0.745*(information integration and information technology).

b- Verification of the discriminating power of the axes

Table 16 : Base[a] sample ranking results

			Intended group membership		
Y		**Reactivity**	**0**	**1**	Total
Original	**Effective**	**0**	51	19	70
		1	16	50	66
	%	**0**	72,9	27,1	100,0
		1	24,2	75,8	100,0
Has. 74.3% of the original observations are classified correctly.					

Source : Own survey result, 2022

As this table shows, the good ranking rate of non-performing companies is equal to 72.9% and the good ranking rate of high-performing companies is equal to 75.8%.

Thus, the number of companies well classified by the model is equal to 74.3%.

8- Impact of supply chain integration on product innovation

a- Verification of the existence of relations between the groups

Table 17: Test of equality of group means

	Lambda deWilks	**F**	**ddl1**	**ddl2**	**significant**	**Rank**
Supplier integration	,945	7,158	1	134	,008	**6**
Integration of producers	,913	21,174	1	134	,000	**1**
Internal integration	,915	19,815	1	134	,000	**2**
Retailer integration	,929	10,328	1	134	,002	**5**
Customer onboarding	,856	13,751	1	134	,000	**3**
information integration and information technology	,888	11,492	1	134	,000	**4**

Source : Own survey result, 2022

From the table, it may be possible to conclude X1: Integration of suppliers; X2: Integration of producers; X3: Internal integration; X4: Integration of retailers; X5: Customer integration; X6: Information integration and information technology significantly affect product innovation. Examination of Fisher's F confirms that it is indeed the variables "Integration of producers" and "Integration of processors" that are the most discriminating.

c- Estimation of the coefficients of the discriminant function

Table 18 : Coefficients of the canonical discriminant function

	Fonction

	1
Supplier integration	,090
Integration of producers	-,275
Internal integration	-,267
Retailer integration	,283
Customer onboarding	,140
information integration and information technology	,345
(Constant)	-,088

Source : SPSS 26 software

This allows us to establish the following discriminant function:

(Product Innovation) = -0.088 +0.90*(Supplier Integration) - 0.275*(Producer Integration) - 0.267*(Internal Integration) + 0.283*(Retailer Integration) + 0.140*(Customer Integration) + 0.345*(integration of information and information technologies).

c- Verification of the discriminating power of the axes

Table 19 : Base[a] sample ranking results

Y		Innovation of products	Intended group membership		Total
			0	1	
Original	**Effective**	**0**	71	18	89
		1	7	40	47
	%	**0**	79,8	20,2	100,0
		1	14,9	85,1	100,0
Has. 81.6% of the original observations are classified correctly.					

Source : Own survey results, 20212

As this table shows, the good ranking rate of non-performing agribusinesses in terms of product innovation is equal to 79.8% and the good ranking rate of high-performing agribusinesses is equal to 85.1 %. Thus, the number of companies well classified by the model is equal to 81.6%.

Section 4/: Discussion of the main results of the quantile regression

Quantile regressions are statistical tools whose purpose is to describe the impact of explanatory variables on a variable of interest. They allow a richer description than classical linear regressions, since they are interested in the entire conditional distribution of the variable of interest and not only in its average[21].

1- Quantile regression models

[21]Pauline Givord - Xavier D'Haultfœuill, M 2013/01, Document de travail, Méthodologie statistique, La régression quantile en pratique, page-4, file:///C:/Users/DELL/Downloads/doc_regression_quantile.pdf.

A summary of the regressions used to test our research hypotheses using quantile regression on SPSS 26 is presented in the following table:

Table 20 : Summary of regression models by quantiles

Model 1:
FLEXitq=α0i+α1VIitq+α2IPitq+α3IIitq+α4RIitq+α5CIitq+α6IIITitq
Model 2:
QUALitq=α0i+α1VIitq+α2IPitq+α3IIitq+α4RIitq+α5CIitq+α6IIITitq
Model 3:
COÛTitq=α0i+α1VIitq+α2IPitq+α3IIitq+α4RIitq+α5CIitq+α6IIITitq
Model 4:
RÉACitq = α0i+α1VIitq+α2IPitq+α3IIitq+α4RIitq+α5CIitq+α6IIITitq
Model 5:
INPDTitq=α0i+α1VIitq+α2IPitq+α3IIitq+α4RIitq+α5CIitq+α6IIITitq

Source : Own survey result, 2022

With :

q: indicates a quantile of the operational performance distribution, FLEX, QUAL, COST, REAC, FIAB, INPDT: Operational performance measures.

VI: Vendor Integration

IP: Integration of producers;

II: Internal integration;

RI: Retailer integration;

CI: Customer Integration;

IIIT: Information Integration and Information Technology;

2- Results of the regression by quantile:

Using the quantile regression method, we re-estimate the relationship between supply chain integration and operational performance. We choose four quantiles: 25, 50.75 and 90%.

The tables below show our results:

Table 21 : Impact of supply chain integration on flexibility using the quantile regression method.

VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**
	0.25	**0.50**	**0.75**	**0.9**
VI	0.079**	0.077***	0.098***	0.083***
	(2.595)	(3.297)	(4.606)	(5.313)

IP	0.037*	0.061***	0.066***	0.065***
	(1.714)	(2.824)	(3.867)	(5.148)
II	0.026*	0.030**	0.044***	0.043***
	(1.764)	(2.185)	(3.884)	(5.166)
RI	0.434***	0.263***	0.249***	0.241***
	(6.033)	(7.127)	(8.582)	(11.200)
CI	0.216***	0.236***	0.242***	0.201***
	(3.861)	(5.534)	(6.618)	(7.494)
IIIT	0.069**	0.160***	0.144***	0.144***
	(2.135)	(4.889)	(5.608)	(7.490)
Constant	-0.231***	0.094	0.446***	0.655***
	(-3.471)	(1.435)	(8.636)	(16.984)
Comments	110	110	110	110

Robust standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1

Notes: (*), (**) and (***) denote significance at the thresholds of 10% (t>1.64), 5% (t>1.96) and 1% (t>2.57), respectively.

Source : SPSS 26 software

Table 22 : Impact of supply chain integration on product quality using quantile regression method.

VARIABLES	(1)	(2)	(3)	(4)
	0.25	**0.50**	**0.75**	**0.9**
VI	0.165**	0.030**	0.068***	0.090***
	(2.137)	(2.332)	(3.357)	(4.731)
IP	0.045*	0.026**	0.036**	0.077***
	(1.713)	(2.255)	(2.182)	(4.545)
II	0.030*	0.026**	0.041**	0.050***
	(1.925)	(2.150)	(2.330)	(4.127)
RI	0.313***	0.186***	0.232***	0.251***
	(3.838)	(8.100)	(9.097)	(9.213)
CI	0.369***	0.596***	0.283***	0.257***
	(5.470)	(14.571)	(19.543)	(21.249)
IIIT	0.189**	0.112***	0.192***	0.135***
	(2.318)	(5.366)	(6.271)	(7.417)
Constant	-0.190***	0.061*	0.308***	0.545***
	(-4.919)	(1.951)	(7.288)	(12.026)
Comments	110	110	110	110

Robust standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1

Notes: (*), (**) and (***) denote significance at the 10%, 5% and 1% levels, respectively.

Source : SPSS 26 software

Table 23: Impact of supply chain integration on cost of production using quantile regression method.

VARIABLES	(1)	(2)	(3)	(4)
	0.25	**0.50**	**0.75**	**0.9**

VI	0.116***	0.096***	0.140***	0.096***
	(4.829)	(3.888)	(4.285)	(5.968)
IP	0.048***	0.039**	0.085***	0.042***
	(2.975)	(1.972)	(4.284)	(4.338)
II	0.024**	0.057***	0.034***	0.034***
	(2.043)	(2.967)	(2.555)	(4.717)
RI	0.227***	0.207***	0.150***	0.160***
	(6.192)	(4.227)	(5.351)	(10.319)
CI	0.405***	0.379***	0.442***	0.360***
	(7.559)	(5.071)	(6.817)	(11.551)
IIIT	0.067***	0.134***	0.146***	0.102***
	(5.317)	(3.417)	(4.910)	(7.958)
Constant	-0.312***	0.074	0.364***	0.604***
	(-6.922)	(1.326)	(6.258)	(20.745)
Comments	110	110	110	110

Robust standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1

Notes: (*), (**) and (***) denote significance at the 10%, 5% and 1% levels, respectively.

Source : SPSS 26 software

Table 24 : Impact of supply chain integration on responsivenessusing the quantile regression method

VARIABLES	(1)	(2)	(3)	(4)
	0.25	**0.50**	**0.75**	**0.9**
VI	0.044*	0.114***	0.083***	0.045***
	(1.680)	(4.666)	(3.001)	(3.004)
IP	0.042***	0.035*	0.064***	0.036***
	(1.691)	(1.737)	(3.572)	(3.609)
II	0.049**	0.046**	0.028**	0.044***
	(2.169)	(2.490)	(2.586)	(5.641)
RI	0.043**	0.180***	0.254***	0.210***
	(2.465)	(5.948)	(5.826)	(8.969)
CI	0.117***	0.091***	0.356***	0.314***
	(4.611)	(6.176)	(5.914)	(9.318)
IIIT	0.327***	0.376***	0.120***	0.131***
	(9.986)	(11.443)	(6.811)	(13.354)
Constant	-0.320***	-0.016	0.354***	0.632***
	(-4.851)	(-0.296)	(6.597)	(22.046)
Comments	110	110	110	110

Robust standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1

Notes: (*), (**) and (***) denote significance at the 10%, 5% and 1% levels, respectively.

Source : SPSS 26 software

Table 24: Impact of supply chain integration on product innovation using the quantile regression method

VARIABLES	(1)	(2)	(3)	(4)
	0.25	0.50	0.75	0.9
VI	0.120***	0.125***	0.131***	0.105***
	(4.995)	(5.882)	(6.125)	(6.464)
IP	0.048***	0.023***	0.022***	0.035***
	(2.950)	(3.779)	(3.543)	(3.078)
II	0.022**	0.011**	0.012***	0.014***
	(1.772)	(2.581)	(2.867)	(3.320)
RI	0.239***	0.137***	0.125***	0.222***
	(6.393)	(8.781)	(7.963)	(10.226)
CI	0.462***	0.489***	0.475***	0.270***
	(8.355)	(11.504)	(11.120)	(15.284)
IIIT	0.071***	0.082***	0.102***	0.109***
	(5.618)	(5.931)	(7.401)	(6.575)
Constant	-0.243***	0.032	0.227***	0.613***
	(-5.288)	(0.835)	(5.836)	(18.648)
Comments	110	110	110	110

Robust standard errors in parentheses ***p<0.01, **p<0.05, *p<0.1

Notes: (*), (**) and (***) denote significance at the 10%, 5% and 1% levels, respectively.

Source : SPSS 26 software

From the tables presented above, we notice that the results are different according to the quantiles. In the following, we present the main results that emerge from our study. In the Tunisian context, agro-industrial companies need greater supply chain integration to improve their operational performance due to the complexity of the supply chain.

Quantile models are used to analyze the operational performance of Tunisian agro-food industrial companies. The results show that the six variables used in our study as dimensions of supply chain integration have a positive and statistically significant effect on operational performance (flexibility, product quality, cost of production, responsiveness and innovation of the product).

The charts above show that effective supply chain integration leads directly to higher operational performance.

Furthermore, the results also show the importance of applying supply chain integration in a food industry, as supply chain integration can be a source of competitive advantage leading to superior performance by improving the operational performance of food companies.

Therefore, managers of Tunisian agribusiness industrial companies expected to consider supply chain integration as a unique agribusiness objective in order to excel their operational performance by providing quality customer service. , quality products, cost reduction and flexible response to market demand. They insist on strengthening their supply chain integration internally with all functional departments and externally with their supply chain partners.

CONCLUSION

In this article, a quantitative study was conducted to validate the impact of supply chain integration dimensions on operational performance. Direct relationships were tested in this case. Following the discriminant analysis and the regression analysis by quantile, we can affirm that our objective contributes to support the works according to which the dimensions of the integration of the supply chain positively impact the operational performances. We also find, through the results of our case, that supply chain integration positively and significantly influences operational performance. Therefore, food companies should improve the integration of their supply chain in order to achieve better operational performance. Thus, we applied the discriminant analysis to be able to classify the different alternatives studied, and then choose the best solution. The results obtained by the application of the discriminant analysis show that the variable "information and information technologies" is the best dimension and occupies a primordial place in the integration of the supply chain.

In order to have a modern and collaborative supply chain management, it is necessary to implement supply chain management practices such as CRM practice, SRM practice, buyer-supplier collaboration practice… whose purpose is to facilitate the inter-company integration of data.

Bibliographic reference

- Sessu, A., Sjahruddin, H., and Santoso, A. (2020), "The Moderating Effect of Supply Chain Dynamic Capabilities on the Relationship of Sustainable Supply Chain Management Practices, Supply Chain Integration and Business Performance". Journal of Talent Development &Excellence, 12(1), 1339-1353.
- Leuschner, R., Rogers, D.S. and Charvet, F.F. (2013), "A meta-analysis of supply chain integration and firm performance". Journal of Supply Chain Management, 49(2), 34-57.
- Arend, R. J., and Wisner, J. D. (2005), "Small business and supply chain management : is there a fit " ? Journal of Business Venturing, 20(3), 403–436.
-Wood, G., and Brewster, C. (2005), "Trust, Intrafirm, and Supplier Relations". Business and Society Review, 110(4), 459-484.
-**M**udambi,R.,andC.P.Schründer(2006),"ProgresstowardBuyer-SupplierIntegration". EuropeanJournalof Purchasing& Supply Management 2(2/ 3), 119-127.
-Nyvo, 03/11/2007, about_tunisia_fr.pdf, Microsoft Word - présentation tunisie-français.doc,page-1, http://www.mdptunisie.tn/ar/conference/images/pdf/about_tunisia_fr.pdf.
-Agence de Promotion de l'Industrie et de l'Innovation ,iaa.pdf, 02/03/2021,les industries agro-alimentaire en Tunisie,page-6, http://www.tunisieindustrie.nat.tn/fr/tunisienne.asp.
- Baumard, P., C. Donada, J. Ibert et J.M. Xuereb (2008), "La collecte des données et la gestion de leurs sources, in méthodes de recherche en management". Thiétart R.A. Méthodes de recherche en management, Dunod - 3ème édition, 228-262.
- Flynn, B.B., Huo, B. and Zhao, X. (2010), "The impact of supply chain integration on performance : acontingency and configuration approach". Journal of Operations Management, 28 (1), 58-71.
-Sempore Aristide, Andrieu Nadine,2015, Quelles stratégies pour améliorer l'intégration agriculture-élevage dans des exploitations de savane ouest-africaine ? Approches par simulation avec les producteurs, ANDRIEU p.349-360.pdf, https://agritrop.cirad.fr/578120/1/ANDRIEU%20p.349.pdf.
- Flynn, B.B., Huo, B. and Zhao, X. (2010), "The impact of supply chain integration on performance : contingency and configuration approach". Journal of Operations Management, 28 (1), 58-71.
-Abdelfattah TRIKI, 2010, Le comportement du détaillant : Développement d'un modèle pivotant autour d'un nouveau construit libellé « opportunité de la commercialisation de la marque », Direction

et Gestion | « La Revue des Sciences de Gestion » 2010/3 n°243-244 | pages 161 à 170, file:///C:/Users/DELL/Downloads/RSG_243_0161.pdf.

- Droge, C., Vickery, S. K., and Jacobs, M. A. (2012), "Does supply chain integration mediate the relationships between product/process strategy and service performance ? An empirical study". International Journal of Production Economics, 137(2), 250-262.

- Sundram, V.P.K, Chandran, V. and Awais Bhatti, M. (2016), "Supply chain practices and performance : the indirect effects of supply chain integration", Benchmarking : An International Journal,23 (6), 1445-1471.

- Narasimhan, R., Swink, M., and Viswanathan, S. (2010), "On Decisions for Integration Implementation : An Examination of Complementarities Between Product-Process Technology Integration and Supply Chain Integration". Decision Sciences, 41(2), 355–372.

- Swink, M., Narasimhan, R. and Wang, C. (2007), "Managing beyond the factory walls : effects of four types of strategic integration on manufacturing plant performance". Journal of Operations Management, 25(1), 148-164.

- Ward, P. T., and Duray, R.(2000), "Manufacturing Strategy in Context : environment, Competitive Strategy and Manufacturing Strategy". Journal of Operations Management,18 (2),123–138.

- Gunasekaran, A., Lai, K.h., and Cheng, T.C.E. (2008), "Responsive Supply Chain : A Competitive Strategy in a Network Economy". International Journal of Management Science, 36, 549-564.

- Camisón, C, and Villar-López, A. (2014), "Organizational Innovation as an Enabler of Technological Innovation Capabilities and Firm Performance". Journal of Business Research, 67 (1), 2891-2902.

- Routledge (2020), Pallant J. SPSS survival manual : A step bystep guide to data analysis using IBM SPSS.

- Pauline Givord - Xavier D'Haultfœuill, M 2013/01, Document de travail, Méthodologie statistique ,La régression quantile en pratique, page-4, file:///C:/Users/DELL/Downloads/doc_regression_quantile.pdf