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Information System Integration in Citrus Packing Stations: A Key Driver for Product Quality and Customer Satisfaction

Intégration des Systèmes d'Information au sein des Stations de Conditionnement d'Agrumes : Un Levier Essentiel pour la Qualité des Produits et la Satisfaction des Clients

BENTALEB Fatima Zahra
PhD Researcher
Faculty of Legal, Economic and Social Sciences
Mohammed V University, Agdal
Laboratory for the Study and Research in Management Sciences
Morocco
fatimazahra-bentaleb@um5r.ac.ma

TAKI Mounaim
PhD
Faculty of Legal, Economic and Social Sciences
Mohammed V University, Agdal
Laboratory for the Study and Research in Management Sciences
Morocco
mounaim.t.2010@gmail.com

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Abstract
In the context of Morocco's growing citrus exports and its involvement in the dynamic global market, Citrus Packing Stations play a crucial role as intermediaries in the distribution of processed agricultural commodities. The main aim of this study is to investigate the impact of integrating information systems on the improvement of product quality and customer satisfaction within the framework of CPS. Employing a mixed sequential exploratory approach, this research first draws on qualitative insights from five citrus packing case studies to generate survey items assessing the influence of information systems on product quality and customer satisfaction. In the subsequent quantitative phase, data from 40 CPS are analyzed using exploratory factor analysis and simple linear regression. Empirical findings demonstrate that the effective integration of information systems has a significant impact on enhancing product quality, improving customer satisfaction, and establishing a strong relationship between these two variables. The results underscore the broader importance of integrating information technologies into the context of supply chain management, hence providing prospects for further academic research in this field. The population size also suggests larger-scale investigations in order to expand the analytical framework.

Keywords : Information System Integration; Product Quality; Customer Satisfaction; Citrus Packing Stations; Agricultural Supply Chains.

Résumé
Au vu de l'émergence progressive du Maroc en tant qu'acteur prééminent dans le domaine des exportations d'agrumes au niveau mondial, les stations de conditionnement d'agrumes se révèlent être des maillons essentiels dans la valorisation et la distribution de produits agricoles La présente étude vise à examiner l'impact de l'intégration des systèmes d'information sur la qualité des produits ainsi que sur la satisfaction client. Dans le cadre d'une approche mixte séquentielle exploratoire, la présente étude se base sur des analyses qualitatives de cinq études de cas des SCA pour élaborer des items évaluant l'impact des systèmes d'information sur la qualité des produits et la satisfaction client. Lors de la phase quantitative subséquente, les informations recueillies auprès de 40 SCA font l'objet d'une analyse factorielle exploratoire suivie d'une régression linéaire simple. Les résultats obtenus établissent une corrélation significative entre l'intégration réussie des systèmes d'information, l'amélioration de la qualité des produits et la satisfaction accrue des clients et l'établissement d'une forte relation entre ces deux variables. La taille de la population suggère l'impératif de mener des études transnationales complémentaires pour élargir le cadre d'analyse.

Mots clés : Intégration du Système d'Information ; Qualité des Produits ; Satisfaction Client ; Stations de Conditionnement d'Agrumes ; Chaînes Logistiques Agricoles.

Introduction

Agriculture serves as a catalyst for societal progress, employing around 40% of the labor force at a national level, with its importance being particularly significant in rural areas. This statement clearly communicates the economic value of the agricultural sector, as well as its crucial role in fostering socio-economic development. In the 2021-2022 crop year, the agri-sector witnessed a 40% surge in citrus exports, resulting in a significant total of 766,500 tonnes. This expansion is not solely apparent in the statistics related to production and exports. Rather, it is particularly noteworthy in terms of Morocco's capacity to adjust and broaden its scope in response to the dynamics of the global market. The Citrus Packing Stations (CPS) are of utmost importance in enhancing the value and processing of agricultural commodities for international trade. These stations function as pivotal centers where agricultural products undergo processes of transformation, adaptation, and refinement to fulfill the stringent requirements of a highly competitive global market. In an environment where the highest priority is placed on speed, accuracy, and traceability, the integration of digital technology into supply chain management signifies an obvious advancement. Drawing upon the progress achieved through the Green Morocco Plan (2008-2020) and aligning with the goals of the Generation Green 2020-2030 vision, the emphasis on enhancing production highlights the importance of effective supply chain management within the context of circular production systems. The significance of integrated information systems is highlighted by the convergence of technology and supply chain management in these hubs amidst Morocco's globalization and sustainability concerns, which require innovation. The incorporation of information systems plays a significant role in improving logistic capacities, maintaining accurate traceability, and facilitating rapid market adaption. These factors are of the greatest significance in an economy that strongly depends on exports. The integration of new information and communication technologies has become an essential component of the techniques employed by CPS, enabling adaptability and response. The present study highlights the importance of exploring the relationship between information systems and supply chain in the context of the Moroccan agricultural industry. This relevance is emphasized by the perishable nature of agricultural products. Moreover, the strategic geographical positioning of Morocco, along with its extensive array of trade agreements, establishes it as a significant contender in the context of global agricultural commerce. This observation highlights the imperative of a proficient supply chain that is driven by effective technologies. Given the previously mentioned factors, this study aims to investigate the

potential of technology advancements in addressing the particular challenges faced by the Moroccan CPS. Particularly, our research aims to examine the prospective effect of successful information system adoption on product quality and customer satisfaction . This statement provides the foundation for addressing our primary research question : to what extent does successful information system integration enhance the product quality and customer satisfaction in Moroccan Citrus Packing Stations? Employing a mixed sequential exploratory approach, the research paper begins with a comprehensive assessment of the existing literature related to agricultural supply chains. Subsequently, the article proceeds to outline the development of the research model and hypotheses. The next section entails the presentation of the research methodology, followed by an extensive analysis of the obtained results. Lastly, the conclusion and the limitations of the research are outlined.

1. Agricultural Supply Chains

In the ever-changing and interconnected global market, it has become crucial for enterprises to develop a cohesive supply chain in order to maintain a competitive edge and effectively advertise their products (Oghazi, 2009; Oghazi et al., 2018). The extent of this integration extends beyond the internal confines of a company to encompass interactions with both upstream and downstream collaborators. It facilitates a seamless and continuous movement of goods, data, and monetary resources, which plays a vital role in efficiently addressing client requirements (Wook Kim, 2006; Flynn et al., 2010; Wiengarten et al., 2016). The agricultural supply chains consist of a wide array of actors, such as suppliers and consumers, who support the flow of raw materials through several phases of processing, storage, transportation, and retailing until they are ultimately consumed by the end user (Oghazi, 2009; Oghazi et al., 2018). The effective management of dynamic supply chain environments and the reconciliation of diverse stakeholder interests necessitate the implementation of efficient flow and complete integration solutions (Oghazi et al., 2016). The incorporation of radio frequency identification and information systems significantly improves the degree of integration in supply chains (Oghazi et al., 2018). The application of information technology facilitates the improvement of traceability and real-time monitoring capabilities. Furthermore, the integration of information systems enhances the efficiency of data management and enhances the quality of decision-making processes. As a result, these developments provide enhanced integration and coordination across the many organizations involved in the supply chain. By integrating strategies with the overarching objectives of the supply chain,

organizations may enhance the efficiency and effectiveness of their operational activities (Oghazi, 2009; Oghazi et al., 2018). In the realm of agriculture, this integration pertains to the guarantee of food quality, safety, and sustainability in light of many uncertainties and hazards, hence exerting a significant impact on societal, economic, and environmental aspects (Lezoche et al., 2020; Melesse et al., 2023). The pandemic has shed light on the susceptibility of global supply networks and the consequent challenges, including unforeseen delays, cost management, barriers to collaboration, and inaccuracies in demand prediction (Burgos & Ivanov, Melesse et al., 2023; 2021; Violi et al., 2023). The narrative transitions its attention to the pressing necessity for a transformation in agri-food supply chain systems that favor the centralization of data, adaptability, and independent connection. The incorporation of cutting-edge technology, such as the Internet of Things (IoT), blockchain, big data analytics, and artificial intelligence, has garnered much acknowledgement as a substantial progression in the modernization of agri-food supply chains. The significance of resilience has been underscored, and the use of digital twinning has emerged as a robust approach for evaluating and enhancing agri-food supply chains in light of worldwide issues (Burgos & Ivanov, 2021; Melesse et al., 2023). Moreover, the examination of sustainable logistics planning in the agri-food supply chain remains a popular area of academic enquiry. The extant literature explores the unique attributes and challenges that are inherent within agricultural supply networks. The aforementioned sources (Balon et al., 2016; Bhosale & Kant, 2016) emphasize the significant significance of collaborative efforts and compatibility across different stakeholders to enhance the operational effectiveness of the supply chain. The agricultural supply chains possess intrinsic characteristics such as perishability, seasonal output, and changes in product quality, which need the implementation of strategic management and a significant degree of coordination across the whole supply chain (Patidar & Agrawal, 2020). The agricultural sector faces numerous challenges, such as coordination difficulties, regulatory constraints, supply volatility due to weather conditions, and apprehensions regarding food quality and safety (Xiao, 2015; Gazdecki, 2018; Doukidis et al., 2007; Govindan, 2018; Ramos et al., 2021). The ever-changing nature of the global agri-food business, which is marked by the rise of new retail chains and changes in the worldwide market, underscores the need of adopting integrated performance management systems and coherent strategies. The use of these methods is crucial in order to effectively tackle the intricate issues and enhance the efficiency of the agricultural supply chain (Guardian & Sedano, 2019; Kumar & Routroy, 2018; Ramos et al., 2021; Sillanpaa, 2015; Trujillo Velasquez, 2019).

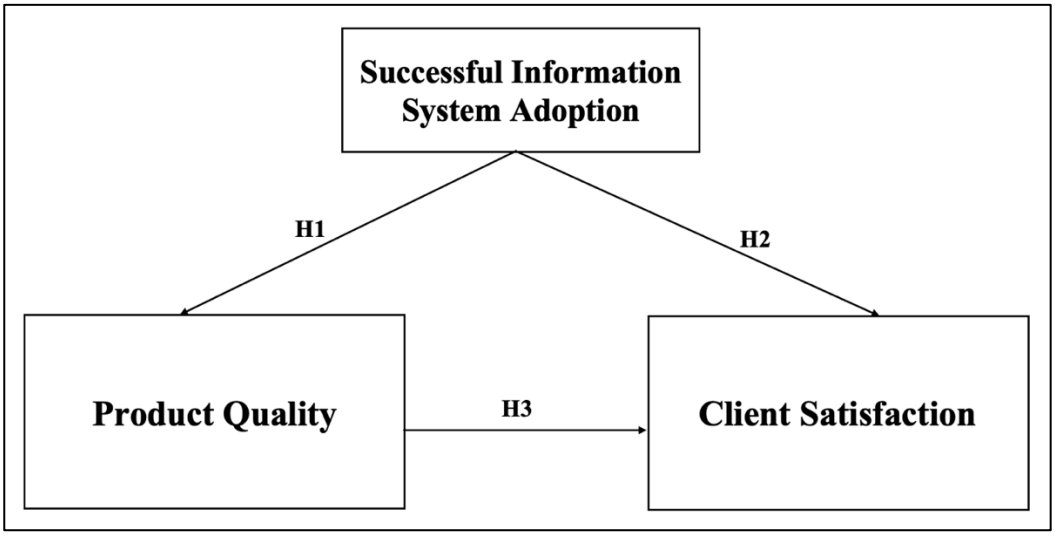
2. Research Model and Hypothesis

Within the citrus packing industry, proficient handling and adept manipulation of data have become crucial requirements. The need for promptly sharing precise and transparent information is heightened by the perishable nature of citrus goods and the need to meet stringent quality standards in order to satisfy the demands of a worldwide clientele. Given the complex nature of international trade dynamics, there is an increasing need to employ modern technologies and processes. The integration of information systems is crucial for facilitating corporations in meeting these demands by establishing a seamless linkage between the organizations, their suppliers, and their customers (Banker et al., 2006; Sundram et al., 2020). The use of integrated information systems has resulted in notable transformations to the operational structure, replacing vertical silos with a transversal dissemination of information. IS implementation has led to enhanced communication across departments that were previously separated, hence improving the capacity to make well-informed choices (Fiaz et al., 2018; Suprapto et al., 2017). The adoption of integrated systems within manufacturing processes has shown beneficial results within the industrial sector. These solutions enhance the level of transparency throughout the whole lifespan of a product (Boyer & Pagell, 2000; Sundram et al., 2020). Their ability to deliver updates in real-time has a substantial impact on waste reduction and overall efficiency enhancement. The ability to surmount obstacles such as geographical distance and temporal constraints has significant significance in several studies (Li et al., 2009; Paulraj & Chen, 2007; Sundram et al., 2020). The previously indicated level of expertise greatly enhances the effectiveness of the feedback loop, allowing companies to rapidly adapt and make necessary adjustments in light of unexpected problems or shifts in market needs. The enhancement of information transmission, particularly in sectors where urgency is critical, increases organizations' ability to swiftly respond to various demands and circumstances. The incorporation of supply chain management in conjunction with the field of information Systems, is widely acknowledged as a pivotal element in streamlining data flows, augmenting product quality, and expanding client services. Prior research underlines the need for maintaining up-to-date information and guaranteeing preparedness for all players involved in the supply chain, such as procurement and distribution (Lambert et al., 1998; Zailani & Rajagopal, 2005; Sundram et al., 2020). This competence enables them to effectively and immediately satisfy customer demands. Furthermore, given the growing complexity of customer preferences, businesses are faced with the challenge of not only meeting the need for quantity but also ensuring a continuously

high standard of quality. Supply Chain Integration provides a comprehensive view of operations, from production to consumer, reducing risks from quality flaws or service outages. It enables early detection of issues, enabling timely deployment of solutions. This enhances product quality and reliability, contributing to operational efficiency and global competitiveness. Integrated systems are particularly beneficial in industries like citrus packing, where risk and error tolerance are high. By leveraging integrated information systems, organizations may enhance their competitive edge, enhance their ability to adapt, and effectively address the changing demands of a global client base. Consequently, this strategic approach successfully fosters sustained growth and financial viability. Building upon the above and considering the particularity of the packing process, we formulated our study hypothesis and constructed our theoretical framework **(Figure N°1)**:

- **H_1**: Successful information system implementation enhances product quality within Citrus Packing Stations.
- **H_2**: Successful information system implementation enhances customer satisfaction within Citrus Packing Stations.
- **H_3**: Enhanced product quality positively affects customer satisfaction within Citrus Packing Stations.

Figure N°1 : The proposed research model



Source : Bentaleb & Taki (2023)

3. Research Methodology

The application of a mixed methods approach in academic research involves the combination of quantitative and qualitative procedures, leading to a more thorough and nuanced

comprehension of an issue in question (Leavy, 2022). This approach has garnered considerable interest in recent times, particularly within the field of social sciences, due to its efficacy in mitigating the constraints associated with exclusively relying on either quantitative or qualitative research methods (Vivek & Nanthagopan, 2021; Sakata, 2022). The combination of methods not only entails an in-depth understanding of the subject matter and its contextual factors, but also enables larger applicability, thereby assuming a pivotal role in various fields (Anguera et al., 2018; Vebrianto et al., 2020). The application of these approaches allows researchers to get a full grasp of complex sociocultural processes while also discovering overarching patterns in the collected data (Vivek, 2022; Vivek et al., 2023).The mixed technique is widely acknowledged and valued for its ability to use the strengths of qualitative and quantitative research methodologies. The five primary designs identified in the literature are sequential explanatory, sequential exploratory, convergent parallel, embedding, and transformational (Creswell & Plano Clark, 2018). Each design possesses unique advantages as well as specific challenges during the stages of data collection, analysis, and integration. Data triangulation is a method utilized to augment the reliability and dependability of research findings (Creswell & Plano Clark, 2018; O'Cathain et al., 2018). Despite the inherent challenges related to intricate design and resource intensity (Riggio et al., 2020; Teddlie & Tashakkori, 2021; Vivek et al., 2023), the present study employed the sequential exploratory design. Within the framework of our research, we conducted five one and a half hours semi-structured interviews with key personnel from each station—including the Chief Executive, Information System Director, and the Supply Chain Manager— after which theoretical saturation was achieved. Our primary aim was to get a full comprehension of the inherent complexities and procedures associated with the logistical chains of citrus packing stations. Additionally, the study sought to thoroughly evaluate the importance of integrating information systems in order to ensure product quality and enhance customer satisfaction. The initial phase of our study was crucial in generating the items necessary for our survey, as to evaluate the impact of the information system on both product quality and customer satisfaction in the domain of citrus packing. In the subsequent phase of our research, aimed at quantitatively validating our findings, we used Google Forms to conduct a census by disseminating our questionnaire to all 50 operational citrus packing stations in Morocco. This procedure was executed under the thorough oversight of Mrs. Ghita El Ghorfi, the director of MOROCCO FOODEX, thereby ensuring the effective gathering of data. An extensive database of replies was obtained from a total of 40 participants, resulting

in a noteworthy response rate of 80%. The study hypotheses were examined through the use of simple regression analysis to directly test the relationship between each explanatory variable and the dependent variable, providing clear, unambiguous relationships, minimizing the risk of overfitting and ensuring interpretability. Statistical analysis was conducted using SPSS (29th version).

4. Results and Discussion

4.1. Exploratory Qualitative Phase

Station "A" established in October 2021, produces up to 25,000 tonnes of citrus fruits annually, focusing on Afourer Nadorcott and clementine varieties. It exports to Europe, North America, and Russia, adhering to various certifications. Stations "B" through "E" are affiliated with a Moroccan citrus export group, which exports over 100,000 metric tons annually. Established in 1975, the company has production capabilities ranging from 15,000 to 80,000 tonnes. The stations adhere to strict international quality standards, ensuring every fruit meets safety norms. The stations have implemented the OMNIPACK system for packing operations and the SAGE system for purchasing and accounting tasks. Stations "B" through "E" have an enhanced IT infrastructure, combining a centralized information system with specific software applications like LOGISTA, DYNAMICS AX, and AGIRH. Within our study framework, the IS integration is seen as an independent variable, suggesting that it has an impact on our dependent variables : product quality and customer satisfaction. The following section will provide the findings obtained from the semi-structured interviews.

Successful Information System Adoption

During the initial phase of exploration, we uncovered a number of critical components that are considered essential for evaluating the integration of information systems among the stations. These elements include internal and external communication, product traceability, as well as the monitoring and analysis of key performance metrics. The findings obtained from the qualitative investigation, as presented in **Table N°*1***, enabled the evaluation of system integration within citrus packing stations for each of the identified components.

Table N°1 : Items "Successful IS Adoption"

Description	Item Code	Item	Scale Type
Role of Information System in Internal Communication	**ISIC1**	Automated Report Sharing	**Likert scale 1 = Strongly Disagree to 5 = Strongly Agree**
	ISIC2	Direct Information Access	
	ISIC3	Real-time Notifications	
	ISIC4	Integrated Communication Optimization	
	ISIC5	Communication History	
	ISIC6	Multi-device Accessibility	
	ISIC7	Task Accountability & Traceability	
Role of Information System in External Communication	**ISEC1**	Reporting Automation & Transparency	
	ISEC2	Real-time Stock Visualization	
	ISEC3	Automated Ordering	
	ISEC4	Supplier Notifications	
	ISEC5	Demand Forecast Access	
	ISEC6	Quality & Feedback Module	
	ISEC7	Process Transparency	
Role of Information System in Traceability	**IST1**	Detailed Product Tracking	
	IST2	Transport Logistics Transparency	
	IST3	Centralized Logistics Data	
Role of Information System in Monitoring & Analyzing KPI	**ISKPI1**	Real-time KPI Dashboards	
	ISKPI2	Data Analysis & Improvement	
	ISKPI3	Automated KPI Reports	
	ISKPI4	Deviation Alerts	
	ISKPI5	Customized KPI	

Source : Bentaleb & Taki (2023)

Product Quality

The quality assessment of fruit at packing stations is categorized into three levels: size, exterior appearance, and interior characteristics. Fruit sizes 1, 2, and 3 exhibit notable quality characteristics, leading to increased market demand for these sizes. Fruits in size groups 4 and 5 may indicate lower quality from plantations. The second tier focuses on external attributes, including flaws like mottling, mites, California skins, and bruising. The third level evaluates intrinsic characteristics, such as juice volume, acidity, and Brix value, which indicate sugar concentration. The information system plays a significant role in affecting the quality of goods, primarily through efficient cold chain management and strict adherence to food safety and quality criteria. A temperature monitoring system is crucial for cold chain management, enabling precise cooling capacity control and effective inventory management. It ensures compliance with laws, identifies production failures, and records product pallet details. A specialized module manages commercial programming, ensuring only specific requirements are associated. Implementing IS in citrus packing helps mitigate inaccurate associations and provides guidance to personnel. This holistic approach ensures fruit undergoes thorough examination in accordance with predetermined criteria, resulting in both freshness and

excellent quality. The quality of products holds significant importance in sustaining customer and regulatory expectations, hence maintaining high standards. **Table N°2** provides a comprehensive overview of all of the factors related to the influence of information systems on product quality within citrus packing stations:

Table N°2 : Items "IS-Product Quality"

Description	Item Code	Item	Scale Type
Role of Information System in Product Quality	ISPQ1	Detailed stock tracking	Likert scale 1 = Strongly Disagree to 5 = Strongly Agree
	ISPQ2	FIFO principle adherence	
	ISPQ3	Precise program specifications	
	ISPQ4	Blocks uncertified producers	
	ISPQ5	Records producer data	
	ISPQ6	Enhanced pallet traceability	
	ISPQ7	Dedicated commercial module	
	ISPQ8	Standards for commercial programs	
	ISPQ9	Non-compliance alerts	
	ISPQ10	Ensured product freshness.	

Source : Bentaleb & Taki (2023)

Client Satisfaction

Clients often use a pre-established protocol to formalize feedback, often using a rating framework to assess the perceived excellence of a product. Station "A" has developed a customized process to understand customer satisfaction through extensive questionnaires. This helps the station understand its services and gain a detailed understanding of its customers' viewpoints. Customer satisfaction is closely linked to punctuality of deliveries and product quality. The information system plays a crucial role in influencing customer perception by preserving product quality and adhering to strict delivery schedules. Consistent product quality fostering trust and assurance among customers leads to increased brand or service loyalty. Information system adoption has a noticeable impact on customer experience, as clients place a high value on consistency and dependability. The benefits provided by the IS in maintaining consistent quality and timely delivery positively influence customer satisfaction. We intend to investigate the impact of information systems on customer satisfaction, which serves as our secondary dependent variable. **Table N°3** presents an extensive analysis of the fundamental elements related to the role of information systems in guaranteeing customer satisfaction within citrus packing stations:

Table N°3 : Items "IS-Customer Satisfaction"

Description	Item Code	Item	Scale Type
Role of Information System in Client Satisfaction	**ISCS1**	Efficient package management	**Likert scale 1 = Strongly Disagree to 5 = Strongly Agree**
	ISCS2	Real-time stock information	
	ISCS3	Improved order handling	
	ISCS4	Comprehensive stock view	
	ISCS5	Proactive stock alerts	
	ISCS6	Swift restocking	
	ISCS7	Reliable deliveries	
	ISCS8	Consistent product quality	

Source : Bentaleb & Taki (2023)

4.2. Confirmatory Quantitative Phase

The main objective of the explanatory analysis is to evaluate the validity of the assumptions that underpin our research model via a series of various tests. The investigation starts with an initial exploratory factor analysis, which is subsequently reinforced by psychometric assessments to ensure the reliability and validity of our measurement scales. Following this, a regression analysis is performed in order to assess the validity of the three hypotheses established in our study. The statistical analyses were conducted with SPSS (29th version).

Exploratory Factor Analysis and Reliability Measurement

The main purpose of doing exploratory factor analysis tests is to improve and refine the variables under research in preparation for further hypothesis testing. This entails the procedure of verifying the suitability of the current items with respect to the underlying dimensions, with the aim of ensuring that the data is appropriate for factor analysis. The present approach uncovers common factors, structuring the items for each variable while maintaining internal measurement consistency. The scope of our investigation will encompass the utilization of a factor analysis technique that is especially tailored to examine the variables integrated within our research framework.

- ***Exploratory Factor Analysis "Successful IS Adoption"***

The study deployed an exploratory factor analysis to examine the latent components of internal and external communication, traceability, and key performance indicator monitoring and analysis. The findings that have been acquired will serve in the calculation of the composite score for the selected components. The assessment of system integration will be

carried out by calculating the average composite scores obtained from the individual sub-domains. The Kaiser-Meyer-Olkin (KMO) index, as presented in

Table N°4, assesses the adequacy of sampling and provides an understanding of the degree of correlation among the variables employed in the research. A correlation coefficient over .50 indicates a level of representativeness that is deemed sufficient (Delacroix et al., 2021). This suggests that the items under investigation make a significant contribution to the understanding of their respective elements

Table N°4 : KMO index and Bartlett's test for the variable "Successful IS Adoption"

KMO and Bartlett's Test		**ISIC**	**ISEC**	**IST**	**ISKPI**
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.918**	**.796**	**.706**	**.836**
Bartlett's Test of Sphericity	Approx. Chi-Square	294.991	239.102	113.402	175.239
	df	21	15	3	10
	Sig.	**<.001**	**<.001**	**<.001**	**<.001**

Source : Bentaleb & Taki (2023)

The KMO index exhibited a range of values from .706 to .918, suggesting that the sample size is essentially sufficient for conducting a factorial analysis. The Bartlett's test revealed a statistically significant result ($p < 0.001$), indicating that the variables under examination are indeed intercorrelated. This finding provides support for the validity of the factorial analysis.

Table N°5 displays the results of the main component analysis conducted on the items pertaining to the four variables, namely ISIC, ISEC, IST, and ISKPI. The study was performed utilizing eigenvalues. Solely the components with eigenvalues greater than 1 are showcased, in line with Kaiser's criterion.

Table N°5 : Principal Component Analysis Results of the variable "IS Adoption"

Total Variance Explained » ISIC »			
Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	**5.548**	**79.255**	**79.255**
Total Variance Explained » ISCE »			
Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	**4.721**	**78.683**	**78.683**
Total Variance Explained « IST »			
Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	**2.674**	**89.149**	**89.149**
Total Variance Explained » ISKPI »			
Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	**4.037**	**80.742**	**80.742**

Source : Bentaleb & Taki (2023)

The decision to retain only the first principal component is based on its eigenvalue above 1 for all four variables, indicating its significance. Furthermore, this component explains a substantial proportion of the variation (> 78%). The factorial loadings of each variable on the first extracted component are specified by the component matrix. The factorial loadings within the first component highlight significant values for the ISIC, ISEC, IST, and ISKPI variables, with values ranging from .809 to .971. It is important to point out that the ISCE1 item; the Automation & Transparency Ratio, demonstrates a rather low factorial loading of .541. Adjustments following principal component analysis necessitated a reduction in the number of items for the ISCE variable, culminating in a revised total of six items.

A Cronbach's alpha coefficient value that is near to 1 implies a high level of dependability for the scale. However, it is often acknowledged that exploratory inquiries typically required reliability coefficients more than .60, whilst confirmatory studies require coefficients beyond .80 to be considered satisfactory (Nunally, 1994).

Table N°6 : Reliability statistics for the variable "Successful IS Adoption"

Reliability Statistics			
ISIC	**ISEC**	**IST**	**ISKPI**
Cronbach's Alpha	Cronbach's Alpha	Cronbach's Alpha	Cronbach's Alpha
.954	**.945**	**.939**	**.940**

Source : Bentaleb & Taki (2023)

The findings shown in

Table N°6 indicate that the Cronbach's alpha coefficients for the four variables exceed .930, indicating a high level of internal consistency among the items. The results reported in this research provide empirical evidence that supports the dependability and consistency of the notion under investigation.

- ***Exploratory Factor Analysis "Product Quality"***

According to the findings presented in **Table N°7**, the KMO is 0.916, indicating a high level of adequacy. This suggests that the utilization of the EFA technique is not only suitable, but also reveals the presence of a substantial factor structure within the variables under investigation. The statistical test produces a significant result ($p < .001$), so providing evidence to reject the null hypothesis, which posits the absence of correlations between variables. The chi-square statistic has a significantly high value of 420,804, suggesting a robust intercorrelation among the variables

Table N°7 : KMO index and Bartlett's test for the variable "Product Quality"

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.916**
Bartlett's Test of Sphericity	Approx. Chi-Square	420.804
	df	45
	Sig.	**<.001**

Source : Bentaleb & Taki (2023)

Information representation adheres to Kaiser's criteria, which entails retaining only those components with eigenvalues larger than 1. Only the initial component possesses an eigenvalue that is notably bigger than 1, namely at 7.677 (as presented in **Table N°8**). This signifies that the first component effectively captures a substantial proportion of the

information included within the complete dataset. According to Kaiser's criteria practice, the retained component represents 76.767% of the overall variance.

Table N°8 : Principal Component Analysis Results of the variable "Product Quality"

Total Variance Explained			
Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	7.677	76.767	76.767

Source : Bentaleb & Taki (2023)

The ten communalities presented in **Table N°*9*** demonstrate a strong level of convergent validity, with values ranging from 0.790 to 0.918. This observation shows a significant correlation between each item and the major component, so providing a rationale for retaining all items for further in-depth study.

Table N°9: Communalities of the "Product Quality" variable scale

Component Matrix	
	Component 1
Enhanced pallet traceability	.918
Precise program specifications	.905
Non-compliance alerts	.899
Dedicated commercial module	.895
Ensured product freshness.	.885
Detailed stock tracking	.885
FIFO principle adherence	.872
Records producer data	.866
Blocks uncertified producers	.837
Standards for commercial programs	.790

Source : Bentaleb & Taki (2023)

The Cronbach's Alpha coefficient, as shown in **Table N°*10***, is 0.965. This value signifies a high level of internal consistency for the scale, indicating that the 10 elements included in the construct measuring the influence of Information system on product quality are highly reliable. This finding provides evidence for the uniformity and reliability of the construct.

Table N°10 : Reliability statistics for the variable "Product Quality"

Reliability Statistics	
Cronbach's Alpha	N of Items
.965	10

Source : Bentaleb & Taki (2023)

- ***Exploratory Factor Analysis "Client Satisfaction"***

The suitability of the sample for factorial analysis is inferred from the KMO index of 0.832, as presented in **Table N°*11***. The Bartlett test yielded a statistically significant result ($p < 0.001$), indicating that the correlation between the items is sufficiently enough to justify doing a factorial analysis.

Table N°11 : KMO index and Bartlett's test for the variable "Client Satisfaction"

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.832**
Bartlett's Test of Sphericity	Approx. Chi-Square	456.488
	df	28
	Sig.	**<.001**

Source : Bentaleb & Taki (2023)

The analysis of in **Table N°12** reveals that the first component is responsible for 82.064% of the overall variance, making it the sole component retained due to its eigenvalue above 1.

Table N°12 : Principal Component Analysis Results of the variable "Customer Satisfaction"

Total Variance Explained			
Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	6.565	82.064	82.064

Source : Bentaleb & Taki (2023)

The coefficients in component matrix reported in **Table N°*13*** provide an indication of the degree to which each variable is represented in the first main component. All coefficients have a considerable magnitude, ranging from 0.777 to 0.944, indicating that all variables are adequately captured by the principal component under consideration.

Table N°13 : Communalities of the "Customer Satisfaction" variable scale

Component Matrix	
	Component 1
Real-time stock information	.944
Efficient package management	.942
Improved order handling	.940
Consistent product quality	.922
Reliable deliveries	.905
Swift restocking	.904
Comprehensive stock view	.902
Proactive stock alerts	.777

Source : Bentaleb & Taki (2023)

The reliability of our scale in evaluating customer satisfaction is deemed outstanding, as evidenced by the Cronbach's alpha value of 0.968 (**Table N°*14***).

Table N°14 : Reliability statistics for the variable "Customer Satisfaction"

Reliability Statistics	
Cronbach's Alpha	N of Items
.968	8

Source : Bentaleb & Taki (2023)

Hypothesis Validation via Simple Linear Regression

Prior to conducting the simple linear regression analysis to test the validity of our research hypotheses H1 through H3, we undertook measures to ensure that the distribution of all our research variables was normal. The Shapiro-Wilk and Kolmogorov-Smirnov tests show that the variables in question satisfy the normality criterion, as evidenced by a significance value greater than 0.05, which is indicative of a normally distributed distribution. In order to systematically assess the associations between our main variables, we will be performing linear regression analyses. The assumptions that we aim to validate are presented in **Table N°*15***:

Table N°15 : Hypotheses for Linear Regression Analysis

Hypothesis	Independent Variable	Dependent Variables
1	SI Adoption	Product Quality
2	SI Adoption	Customer Satisfaction
3	Product Quality	Customer Satisfaction

Source : Bentaleb & Taki (2023)

Table N°*16* displays both the coefficient of determination R^2 and the corrected R^2. The coefficient R^2 signifies the fraction of the overall variance in the dependent variable that is accounted for by the model. Yet, the coefficient of determination has a tendency to significantly overstate the accuracy of the regression model's fit, particularly as the number of predictors in the model rises. In order to tackle this issue, the adjusted R^2 statistic is employed, which incorporates the number of predictors included in the model, so offering a more accurate assessment of the model's efficacy. Despite the little disparity between the two measures within the realm of simple regression, we have opted to employ the adjusted R^2 in order to get a more cautious assessment of the quality of fit.

Table N°16 : Regression results applied to research hypothesis variables

Model Summary : Hypothesis 1				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.873	.762	**.756**	5.13845
Model Summary : Hypothesis 2				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.822	.676	**.668**	.61159
Model Summary : Hypothesis 3				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.855	.731	**.724**	.55712

Source : Bentaleb & Taki (2023)

Regression results detailed in **Table N°*16*** indicate that:

- The adoption of information systems has a significant impact on product quality improvement, explaining 75.6% of the observed variability.
- The integration of information systems shows a moderate to strong correlation with customer satisfaction, accounting for 66.80% of the total variance, as indicated by the adjusted Pearson coefficient of 0.668.
- Enhancing customer satisfaction is largely influenced by product quality improvement, explaining 72.4% of the observed variability.

The analysis of variance findings presented in **Table N°*17*** indicate statistically significant Fisher indices. Specifically, the Fisher index for H1 is 121.974, for H2 is 79.399, and for H3 is 103.479. All of these indices are found to be statistically significant at a significance level of $p < 0.001$. This study provides evidence of a strong positive correlation between the integration of IS integration and both customer satisfaction and product quality improvement.

Additionally, it establishes a link between product quality enhancement and a rise in customer satisfaction.

Table N°17 : ANOVA applied to Hypotheses variables

ANOVA : Hypothesis 1						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3220.562	1	3220.562	**121.974**	**<.001**
	Residual	1003.338	38	26.404		
	Total	4223.900	39			
ANOVA : Hypothesis 2						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	29.699	1	29.699	**79.399**	**<.001**
	Residual	14.214	38	.374		
	Total	43.913	39			
ANOVA : Hypothesis 3						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	32.118	1	32.118	**103.479**	**<.001**
	Residual	11.794	38	.310		
	Total	43.913	39			

Source : Bentaleb & Taki (2023)

The statistical model provides evidence supporting a statistically significant positive association between the variables in each hypothesis. The regression coefficients pertaining to H1, H2, and H3 demonstrate that the effective integration of the information system has a positive impact on both the quality of products and the contentment of customers inside citrus packing stations. Furthermore, the enhancement of product quality resulting from this integration subsequently leads to an increase in customer satisfaction.

Conclusion

The aim of our research was to examine the impact of information system integration on both product quality and customer satisfaction within Moroccan Citrus Packing Stations. Based on our underlying assumptions, we have developed the premise that the efficient implementation of information systems is pivotal in improving product quality, enhancing customer satisfaction, and establishing a symbiotic relationship between enhanced product quality and strengthened customer satisfaction. Qualitative analysis stressed the significance of

information systems not alone as instruments, but as essential components for maintaining optimal quality. Moreover, the quantitative results provided clear and conclusive proof supporting the validity of all three hypotheses, demonstrating that the deployment of an information system contributes to high levels of customer satisfaction by ensuring excellent product quality and timely delivery. These findings align with previous research that highlights the importance of integrating supply chains to optimize the flow of goods and data (Kim, 2006; Flynn et al., 2010; Wiengarten et al., 2016). The significance of information systems in addressing difficulties specific to the agricultural sector, such as perishability, is of utmost importance. This aligns with existing literature that emphasizes the need for integrated performance systems within agricultural supply chains (Guardian & Sedano, 2019; Ramos et al., 2021; Patidar & Agrawal, 2020). However, similar to any academic research, we found some methodological constraints. The limited scope of the study, which included only 40 citrus packing stations, highlights the need for more extensive and cross-national examinations. This would enhance the scope and depth of the findings. The present study emphasizes the crucial role of information systems within the citrus packing sector in Morocco, while also elucidating its broader significance within the domain of supply chain management. The existing circumstances provide several prospects for future study attempts to investigate the complex dynamics at play, perhaps integrating emerging technological features and conducting comparative evaluations across various locations. This study makes a valuable contribution to the advancement of a framework for the future of information system integration within the agri-food sector, which is now experiencing ongoing changes. The objective is to guarantee that the attainment of product quality and client satisfaction is not only an aspiration, but an imminent outcome.

BIBLIOGRAPHY

Anguera, M. T., Blanco-Villaseñor, A., Losada, J. L., Sánchez-Algarra, P., & Onwuegbuzie, A. J. (2018). Revisiting the difference between mixed methods and multimethods: Is it all in the name? Quality & Quantity, 52(6), 2757–2770. https://doi.org/10.1007/s11135-018-0700-2

Balon, V., Sharma, A.K. & Barua, M.K. (2016). Assessment of barriers in green supply chain management using ISM: a case study of the automobile industry in India. Global Business Review, 17(1), 116-135.

Banker, R. D., Bardhan, I. R., Chang, H., & Lin, S. (2006). Plant information systems, manufacturing capabilities, and plant performance. MIS Quarterly, 30, 315-337.

Bhosale, V.A. & Kant, R. (2016). An integrated ISM fuzzy MICMAC approach for modelling the supply chain knowledge flow enablers. International Journal of Production Research, 54(24), 7374-7399.

Boyer, K. K., & Pagell, M. (2000). Measurement issues in empirical research: Improving measures of operations strategy and advanced manufacturing technology. Journal of Operations Management, 18, 361-374.

Creswell, J.W. & Plano Clark, V.L. (2018). Designing and conducting mixed methods research. Sage publications.

Delacroix, E., Jolibert, A., Monnot, É., & Jourdan, P. (Eds.). (2021). Méthodes de recherche et d'études en marketing. Dunod.

Doukidis, G.I., Matopoulos, A., Vlachopoulou, M., Manthou, V. & Manos, B. (2007). A conceptual framework for supply chain collaboration: empirical evidence from the agri-food industry. Supply Chain Management: An International Journal, 12(3), 177-186.

Fiaz, M., Ikram, A., & Ilyas, A. (2018). Enterprise Resource Planning Systems: Digitization of Healthcare Service Quality. Administrative Sciences, 8(3), 38. https://doi.org/10.3390/admsci8030038

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

Gazdecki, M. (2018). Factors of business relationships change in agribusiness input distribution channel: the case of Polish market. IMP Journal, 12(3), 567-582.

Govindan, K. (2018). Sustainable consumption and production in the food supply chain: a conceptual framework. International Journal of Production Economics, 195, 419-431.

Guardian Sedano, J.E. & Trujillo Velasquez, I.A. (2019). Cadena de suministros para la exportación de granos andinos a Estados Unidos. Ingeniería Industrial, 037, 15-31.

Kumar, S. & Routroy, S. (2018). Improving supply chain performance by Supplier Development program through enhanced visibility. Materials Today: Proceedings, 5(2), 3629-3638.

Lambert, D. M., Cooper, M. C., & Pagh, J. D. (1998). Supply chain management: Implementation issues and research opportunities. The International Journal of Logistics Management, 9, 1-20.

Leavy, P. (2022). Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches. Guilford Publications.

Lezoche, M., Panetto, H., Kacprzyk, J., Hernandez, J.E., & Alemany Díaz, M.M.E. (2020). Agri-Food 4.0: A survey of the supply chains and technologies for the future agriculture. Comput. Ind., 117, 103187.

Li, G., Yang, H., Sun, L., & Sohal, A. S. (2009). The impact of IT implementation on supply chain integration and performance. International Journal of Production Economics, 120, 125-138.

Melesse, T.Y., Franciosi, C., Di Pasquale, V., & Riemma, S. (2023). Analyzing the Implementation of Digital Twins in the Agri-Food Supply Chain. Logistics, 7, 33. https://doi.org/10.3390/ logistics7020033

Nunnally J., 1978, Psychometric theory, McGraw-Hill Book Company, 2e ed., New York.

O'Cathain, A., Murphy, E., & Nicholl, J. (2018). Why, and how, mixed methods research is undertaken in health services research in England: A mixed methods study. BMC Health Services Research, 18(1), 8.

Oghazi, P. (2009). Supply chain management: an empirical study on Swedish manufacturing firms' enterprise systems adoption, supply chain integration, competition capability and performance. doctoral dissertation, Luleå tekniska universitet.

Oghazi, P., Rad, F.F., Zaefarian, G., Beheshti, H.M. & Mortazavi, S. (2016). Unity is strength: a study of supplier relationship management integration. Journal of Business Research, 69(11), 4804-4810.

Oghazi, P., Rad, F., Karlsson, S., & Haftor, D. (2018). RFID and ERP systems in supply chain management. European Journal of Management and Business Economics, 27. 10.1108/EJMBE-02-2018-0031.

Patidar, R. & Agrawal, S. (2020). A mathematical model formulation to design a traditional Indian agri-fresh food supply chain: a case study problem. Benchmarking: An International Journal, 27(8), 2341-2363.

Paulraj, A., & Chen, I. J. (2007). Strategic buyer-supplier relationships, information technology and external logistics integration. Journal of Supply Chain Management, 43(2), 2-14. 10.1111/j.1745- 493X.2007.00027.x.

Riggio, H.R., Diefenbeck, C.A., & Ferrari, J.R. (2020). Use of mixed methods research in health care. Journal of Health and Human Services Administration, 43(2), 177-208.

Sakata, N. (2022). Embracing the Messiness in Mixed Methods Research: The Craft Attitude. Journal of Mixed Methods Research.

Sillanpaa, I. (2015). Empirical study of measuring supply chain performance. Benchmarking: An International Journal, 22(2), 290-308.

Sundram, V. P. K., Chhetri, P., & Bahrin, A. S. (2020). The Consequences of Information Technology, Information Sharing and Supply Chain Integration, towards Supply Chain Performance and Firm Performance. Journal of International Logistics and Trade, 18(1), 15–31. https://doi.org/10.24006/jilt.2020.18.1.015

Suprapto, W., Tarigan, Z. J., & Basana, S. R. (2017). The influence of ERP system to the company performance seen through innovation process, information quality, and information sharing as the intervening variables. Proceedings of the 2017 International Conference on Education and Multimedia Technology - ICEMT '17. https://doi.org/10.1145/3124116.3124131

Teddlie, C. & Tashakkori, A. (2021). Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences (3rd ed.). SAGE Publications.

Vebrianto, R., Thahir, M., Putriani, Z., Mahartika, I., Ilhami, A., & Diniya. (2020). Mixed methods research: Trends and issues in research methodology. Bedelau: Journal of Education and Learning, 1(2), 63–73. https://doi.org/10.55748/bjel.v1i2.35

Violi, A., De Maio, A., Fattoruso, G., & Olivieri, M.G. (2023). An Age-Based Dynamic Approach for Distribution of Perishable Commodities with Stochastic Demands. Soft Comput, 27, 7039–7050.

Vivek, R. (2022). Systematic review of modern techniques in qualitative research. Management and Entrepreneurship Trends of Development, 4(22), 34–49. https://doi.org/10.26661/2522-1566/2022-4/22-03

Vivek, R., & Nanthagopan, Y. (2021). Review and comparison of multi-method and mixed method application in research studies. European Journal of Management Issues, 29(4), 200–208. https://doi.org/10.15421/192119

Vivek, Ramakrishnan & Chandrakumar, Sathiyakumar. (2023). A critical review of the mixed method application and its criticism. Social A CRITICAL REVIEW OF THE MIXED METHOD APPLICATION AND ITS CRITICISM, 2023. 10.25128/2520-6230.23.2.8.

Wiengarten, F., Humphreys, P., Gimenez, C., & McIvor, R. (2016). Risk, risk management practices, and the success of supply chain integration. International Journal of Production Economics, 171(3), 361-370.

Wook Kim, S. (2006). The effect of supply chain integration on the alignment between corporate competitive capability and supply chain operational capability. International Journal of Operations & Production Management, 26(10), 1084-1107.

Xiao, Y. (2015). Flexibility measure analysis of supply chain. International Journal of Production Research, 53(10), 3161-3174.

Zailani, S., & Rajagopal, P. (2005). Supply chain integration and performance: US versus East Asian companies. Supply Chain Management : An International Journal, 10, 379-393.