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Antecedents and enablers of inter-organizational systems on Firm Performance: The Mediation Effect of Supply Chain Capabilities

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Abstract: Network-enabled enterprise systems called inter-organizational systems use (IOS) go beyond the walls of an organization, allowing partners in the supply chain to collaborate better by exchanging business information in real time. As a result, the study (Case Study: Sudan Food Industry) examined the Mediating Role of Supply Chain Management Capabilities on the Relationship between Inter-Organizational System Use on Firm Performance, with the purposeful participation of (450) participants, to whom the questionnaire was addressed. The information was then gathered from the supply chain and production management at the Sudanese food processing industry. The data was then coded using SPSS and AMOS 26. After ensuring normality, validity, and reliability, a descriptive analysis was conducted and variable correlation was examined. Path analysis was formerly used to test hypotheses. The findings of the study reveal IOS have a positive and significant impact on SCM capabilities. also, SCM capabilities mediating the relationship between IOS and Performance.

Key words: Inter-organizational systems, Supply chain responsiveness, Supply chain integration.

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1. Introduction

Network-enabled enterprise systems called inter-organizational systems (IOS) go beyond the confines of an organization, allowing partners in the supply chain to interact more successfully and share business information in real time (Bakos, 1991; Chatterjee &Ravichandran, 2004; Hartono, Li, Na, & Simpson, 2010).

Businesses have implemented a variety of IOS uses, such as vendor managed inventory, electronic data interchange, and collaborative planning, forecasting, and replenishment, to enable supply chain partners to communicate in real time and make informed decisions. To gain a competitive edge, interorganizational systems enable efficient management of activities in a coordinated and integrated manner.

According to the resource-based view (RBV) hypothesis, a corporation acquires a competitive edge when it manages and successfully combines resources that are uncommon, valued, heterogeneous, and unique (Barney, 1991; Peteraf& Barney, 2003). Consequently, research in logistics and resource-based theory both demonstrate for the mutual advantage of the supply chain network's participants, inter-organizational systems enable an organization to supplement its internal resources and capabilities with external resources made available to the partners.

The entire supply chain significantly benefits from the usage of IOS (Asamoah, Agyei-Owusu, Andoh-Baidoo, &Ayaburi, 2019; Hartono et al., 2010). However, there are calls for deeper research into the methods by which IOS use improves firm performance and for the supply chain Blackbox to be opened. (Agbenyo, Asamoah, &Agyei-Owusu, 2018; Aydiner, Tatoglu, Bayraktar, & Zaim, 2019; Yu, Chavez, Jacobs, & Feng, 2018). Therefore,

Through the following research gaps, the study attempts to cover the food industry in Sudan in order to get the benefit of IOS and SCC in Sudan Food Industry.

The current study thus concentrates on 1) external IOS usage in SCC and 2) the impact of inter-organizational system uses on firm performance. Management's comprehension of the operational dynamics of IOS in the organization is enriched by insights from the investigation of the interaction between IOS use and SCC in improving Firm performance. In this work, we investigate the complex interactions between SCC, Firm performance, and IOS usage.

The remaining sections of this essay are organized as follows. Introduction in Section 1, evaluation of pertinent literature in Section 2, and formulation of hypotheses in Section 3. Section 4 presents the research methodology, while Section 5 summarizes the findings. Finally, our analysis and conclusions in Section 6.

2. Literature review

2.1 Inter-organizational information systems (IOS)

Over the past few decades, IOS adoption and implementation have grown and have moved across industries broadly. According to studies, implementing and utilizing IOS may support the achievement of the following three objectives: enable communication, facilitate integration, and support business intelligence (Zhang and Cao 2018; Subramani 2004).

Adopting IOS for business intelligence is more central in the present big data era, where large amounts of corporate data are generated every day. Exploring and understanding corporate data can help organizations gain new insights into their processes, customers, and markets, which can pave the way for enhanced performance.

IOS-enabled business intelligence refers to how effectively IOS is used to support learning and business intelligence. IFIP (2021), International Federation for Information Processing A. Kumi et al., "Knowledge Sharing in a Supply Chain Network," Springer Nature Switzerland AG, 2021 (Zhang and Cao 2018). Cooperative knowledge acquisition, shared databases and decision support systems, and artificial intelligence are examples of applications for IOS-enabled business intelligence (Mandal and Dubey 2021).

Implementing IOS enhances a number of consequences, including firm performance, according to past studies (Hartono et al. 2010, Rajaguru and Matanda 2013, and Firm performance (Cho et al. 2017; Asamoah et al. 2021a). While focusing primarily on IOS use at the second order level, the present literature on IOS outcomes usually blends a variety of IOS use factors and neglects to examine how certain IOS use dimensions may enhance firm performance. Therefore, it is currently unknown whether and how IOS-enabled business information affects the performance of businesses. Researchers have often encouraged to look into how different IOS use aspects affect performance (Asamoah et al. 2021a; Agbenyo et al. 2018).

Additionally, nothing is known about how IOS-enabled business intelligence enhances company performance. This study closes these research gaps by analyzing the significance of information interchange, coordination, integration, and supply chain responsiveness abilities in explaining the outcomes of IOS-enabled business intelligence.

2.2 Dynamic Supply Chain Capabilities (SCC)

In order to adapt to the rapid changes in the business environment, firms must be capable to develop, integrate, and reorganize their internal and external resources and competencies. According to Zahra and George (2002), dynamic capabilities allow businesses to update and reorganize their resource base in response to shifting consumer demands and rival strategies. The importance of using dynamic capabilities in the supply chain is rising (Witcher et al., 2008 & Allred et al., 2018).

The formation of dynamic supply chain capabilities is a result of shifting long- and short-term supply and demand, market dynamics, and consumer demands (Ju et al., 2016). In order to deal with these changes, businesses need dynamic supply chain capabilities. Dynamic supply chain skills qualify businesses to foresee market demands precisely, forge collaborative relationships with consumers and suppliers, and improve the supply chain's response to those needs (Sanders, 2014). From a supply chain perspective, the dynamic capabilities have been studied by numerous academics.

According to Mathivathanan et al. (2017), the supply chain's ability to build dynamic capabilities is crucial for meeting future demands. Dynamic supply chain capabilities are defined by Oh et al. (2019) as a firm's capacity to recognize and utilize internal and external resources in order to improve supply chain processes effectively and efficiently. They add that information exchange, coordination, integration, and supply chain responsiveness are examples of dynamic supply chain capabilities. According to Ju et al. (2016), in order to meet customer expectations and keep competitiveness in a dynamic environment, dynamic supply chain capabilities are procedures of information sharing, supply chain alignment, and information technology. According to Aslam et al. (2018), dynamic supply chain capabilities include cohesive elements of supply chain agility and flexibility which should be integrated to support supply chain ambidexterity.

A company's capacity to adapt its internal and external resources to market changes depends on its supply chain agility. This skill aids an organization's efforts to seize opportunities or fend off dangers posed by unstable environments (Van Hoek et al., 2001), which may result in the acquisition or preservation of a competitive advantage (Eisenhardt and Martin 2000). According to numerous studies, enhancing supply chain agility capability—that is, becoming more responsive to changes at low costs—has a favorable effect on the performance and competitiveness of businesses (Blome et al., 2013; Chakravarty et al., 2013; Oh ., 2018).

2.2.1 Supply chain responsiveness is a company's capacity to react swiftly to fluctuations in consumer demands, production and delivery volumes, and product mix, volume, and delivery. Most likely, these modifications will result in improved performance results, such as lower manufacturing costs, higher customer satisfaction, and quicker delivery (Yu et al., 2016). Additionally, studies by Prago and Olhager (2016) and Mandal et al. (2016) demonstrate that supply chain responsiveness has a favorable effect on operational performance.

2.2.2 Collaboration capability refers to a company's capacity to establish a long-term relationship in terms of supply chain operations and the exchange of knowledge, resources, and risk in order to meet shared goals (Bowersox et al., 2002). According to Cao and Zhang (2011), an organization's capacity for information sharing determines its capacity for supply chain collaboration, knowledge and resource, goal consistency. Customer cooperation, supplier collaboration, and internal collaboration are crucial components that make up the collaborative supply chain, according to Yunus (2018). Integrability reflects a company's aptitude to forge strategic alliances and work in tandem with its supply chain partners (Flynn et al., 2010).

2.2.3 Supply chain integration emphasizes the availability of the appropriate items to the appropriate consumers at the appropriate time and at a reasonable cost (Angeles, 2009). According to Rajaguru and Matanda (2019), supply chain integration entails integrating financial, physical, and informational flows. The ability of a business to adapt quickly to market changes and turbulence in order to better serve its suppliers and consumers is referred to as agility capability (Aslam et al., 2018).

Additionally, supply chain agility is a dynamic process that modifies or reconfigures the current business process to deal with market hiccups and other uncertainties. According to Li et al. (2009), strategic readiness and reaction capability, operational readiness and response capability, and episodic readiness and response capability are key components of supply chain agility. The ability of supply chain partners to react to changes and alterations in the environment is referred to as responsiveness capability (Williams et al., 2013). According to Singh and Sharma (2015), supply chain responsiveness places an emphasis on cutting down on lead times, enhancing service quality, responding quickly to client needs, and optimizing transportation. Shekarian and others, (2020) contend that there are three essential components to supply chain responsiveness: agility to respond to customer requests, flexibility to facilitate the development of new products and entry into new markets, and a reduction in the likelihood of supply chain bottlenecks and interruptions.

2.3 Firm Performance

Operational performance in a changing environment, with businesses aiming for superior organizational performance and competitive advantages (Rajaguru and Matanda, 2019), pertaining to the effectiveness of the company's internal operations, which may allow the company to increase its profitability and competitiveness in the market (Hong et al., 2019). Operational performance is a multilayered concept that involves the successful transformation of operational capabilities into organizational competitive advantages. Productivity, quality, cost, delivery, flexibility, and customer satisfaction can all be used to evaluate it. Businesses aim to

gain competitive advantages and achieve good organizational performance in a dynamic environment (Rajaguru and Matanda, 2019). Operational performance is related to the effectiveness of the company's internal operations, which may allow the company to maximize its competitiveness and sustainability in the market (Hong, 2019).

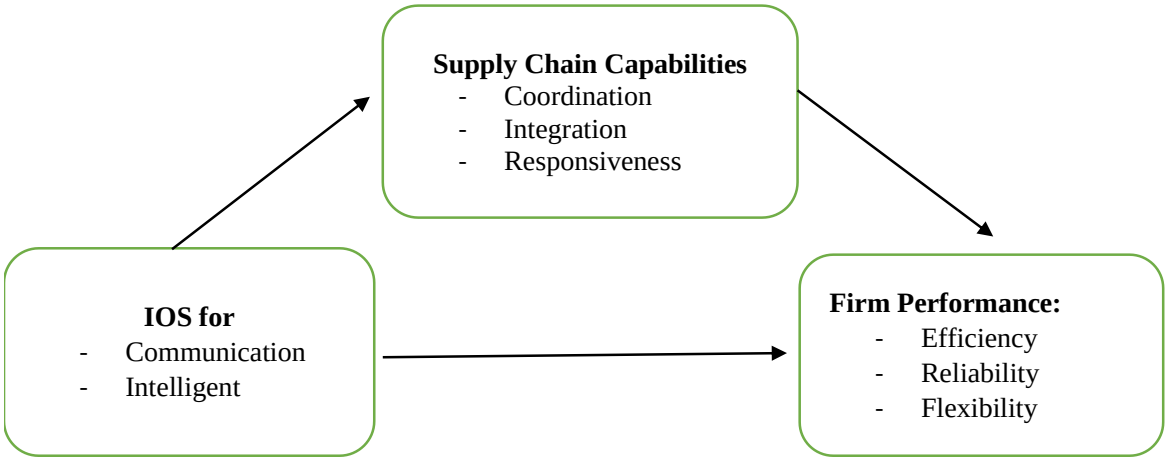


Fig. 1. Conceptual framework.

2.4 Theory underpinning the model

In order to explain how firms that adopt communication technology improve their performance and achieve better competitive advantage, this study has taken support from the resource-based view (RBV). According to M.; Ebrahimi, S.; Hassanein, K. as cited in (Lutfi, et al., 2022), giving to the RBV, a firm's performance is defined by its primary resources, Company resources as described by Wade, M.; Hulland, J, 2004 and cited in (Lutfi, et al, 2022) might include both actual and intangible assets, including information, knowledge, and business procedures and routines accordingly, precious, uncommon, unique, and non-substitutable resources can provide organizations with competitive advantages by creating value and enhancing firm performance. To maintain a better competitive advantage, firms need to adopt approach that cannot be easily replicated by their competitors (Vrontis, Chaudhuri, & Chatterjee, 2022). How firms can maximize the utility of their resources to produce and sustain competitive advantage through enhancing their performance has become the attention of researchers as well as practitioners. Moreover, firms perform differently from one another as they have distinct capabilities and resources which are valuable, rare, inimitable, as well as non-substitutable (VRIN). This concept corroborates with RBV theory (Vrontis, Chaudhuri, & Chatterjee, 2022).

Using the implications of communication technology (CT) as well as supply chain capabilities (SCC), is considered part of the resource portfolio of firms, that grant them competitive advantage to sustain in the local market and achieve profitability and growth.

2.5 Development of Hypotheses

Implementing IOS enhances a number of outcomes, including firm performance, according to past studies (Hartono et al. 2010, Rajaguru and Matanda 2013, and Firm performance (Cho et al. 2017; Asamoah et al. 2021a). While concentrating primarily on IOS use at the second order level, the present literature on IOS outcomes usually blends a variety of IOS use factors and neglects to examine how certain IOS use dimensions may enhance firm performance. Therefore, it is currently unknown whether and how IOS-enabled business information affects the performance of businesses. Researchers have often encouraged to look into how different IOS use aspects affect performance (Asamoah et al. 2021a; Agbenyo et al. 2018). Accordingly, main hypothesis of this study will be:

H_1 Inter-organizational system use IOS with sub-dimension (C-I) has positive impact on firm performance SCP with sub-dimension (R.E.F)

According to numerous studies, enhancing supply chain agility capability—that is, becoming more responsive to changes at low costs—has a favorable effect on the performance and competitiveness of businesses (Blome et al., 2013; Chakravarty et al., 2013; Oh , 2018). Accordingly, the second hypothesis of this study will be:

H_2 Supply chain management capabilities SCMC with sub-dimension (I.S.R) has positive impact on firm performance SCP with sub-dimension (R.E.F)

Network-enabled information systems known as inter-organizational information systems (IOS) enable enterprises to efficiently coordinate business operations and supply chain activities across many organizations (Asamoah et al. 2021). Accordingly, the third hypothesis of this study will be:

H_3 Inter-organizational system use IOS with sub-dimension (C-I) has positive impact on supply chain capabilities with sub-dimension (I.C.R)

Depending on the previous hypotheses which are proved theoretically and practically in the nexus of Inter-organizational system use IOS and SCP, this study contributes to the knowledge in this field by assuming the mediating role of supply chain management capabilities SCMC multi-dimension between inter-organizational system use IOS with multi-dimension and SCP. Accordingly, the fourth hypothesis of this study will be:

H_4 Supply chain management capabilities SCMC multi-dimension mediated the positive impact of inter-organizational system use IOS use with multi-dimension on SCP.

2.6 Measurement

Measurement instruments for the constructs were obtained from previous studies and adapted to suit the context of this study. IOS Use was adopted from Zhang and Cao (2018), Supply Chain Capabilities was adopted from Wu et al. (2006), and Firm performance was adopted from Kocoglu et al. (2011) and Lee et al. (2007).

3 Research Methods

3.1. Study Population

The present research population encompassed Sundanese food processing industry. The main reasons for selecting this type of industry were the flexibility and accessibility of this company (Sudan Food Industry) . It is worth mentioning that the user friendliness and flexible nature of this company allowed the researchers to select them as the primary population. In addition, Sudan Food Industry view such flexible attributes as their visibility to physical work environment and social responsibility. Furthermore, the accessibility of and collection of data through the proper approval process from other companies were complicated, which was the main reason for choosing this company as the target population in this research.

3.2. Sampling Size

The ever-growing demand for research has given rise to the necessity for an effective technique for defining the required sample size in a given population. The previous literature declared that no additional calculations are required to identify the sample size in quantitative research. A standard table has been developed for calculating the sizes of samples required for studies. The current study aimed to investigate a population of 440 managers and employees. Thus, a sample size of 440 participants was required to investigate the current phenomena. As such, a total of 440 questionnaires were distributed to manager an employee in Sudan Food Industry. This took into consideration that the larger the study sample, the more the results can be generalized to the target population. The selected sampling method enabled the gathering of accurate information from the population concerning.

3.3. Sampling Technique

Purposive sampling of the estimated population was more suitable for the present research. manager and employee who are experienced and familiar with institutional excellence and multiple intelligences. are expected to possess and reflect expert knowledge, and they provide relevant data for research inquires. Thus, the respondents for the present research were manager and employee who were involved in Sudan Food Industry, regardless of their rank or Position. Hence, we chose an individual-level analysis for the present study in order to evaluate the correlation between institutional excellence and multiple intelligences.

3.4. Data Collection Procedures

The current study is categorized as both a cause-and-effect and descriptive study. Its goal is to analyze how Supply Chain Management will affect the food processing industry (Sudan Food Industry). The approach begins with a review of the literature in order to compile a profile for assessing the influence of the interorganizational supply chain using the Sundanese food processing industry as an example. I.e., a survey.

3.5. Response Rate

To achieve the appropriate response rate, 450 questionnaires were distributed to Sudan Food Industry. Out of the 440 questionnaires that were returned to the researchers. This is a safe and easy method that is most commonly used in any statistical study to avoid bias due to incomplete questionnaires and cases of missing data. Thus, 440 responses were used for the analysis. The distribution of the questionnaires and the response rate are shown in Table 1

Table 1 Response rate of questionnaire

	The number	The ratio
Distributed questionnaires	450	100
questionnaires received	10	3%
Invalid questionnaires	0	0
Questionnaires received (valid for analysis)	440	97%

Source: prepared by researcher from data (2023)

4 Analysis and Results

There were two main stages to the data analysis. The first stage was conducted using SPSS.v26 to provide information about the data distribution, response rate, multicollinearity, and coding. This was followed by the screening of the data to ensure there were no missing data and outliers. The second stage of the data analysis in the current study was conducted in two phases using AMOS.v24. The first phase was a confirmatory factor analysis (CFA) to assess the overall measurement model, while the second phase involved structural equation modeling (SEM), which included testing the hypotheses of the study.

Table 2 Demographic Profile of Respondents

		Frequency	Percent
Gender	Male	260	59.1
	Female	170	38.6
	Total	440	100.0
Age	18 to 24	180	40.9
	25 to 30	210	47.7
	31 to 35	30	6.8
	More than 36	10	2.3
	Total	430	97.7
Academic qualification	B.sc	10	2.3
	M.sc	380	86.4
	PhD	40	9.1
	Total	430	97.7
Specialization	Business	150	34.1
	Management (MIS)	70	15.9
	Supply chain Management	180	40.9
	IT	20	4.5
	Others	10	2.3

	Total	430	97.7
Income	Less than 100,000	30	6.8
	In range 100,000 to 500,000	380	86.4
	Above 500,000	10	2.3
	Total	420	95.5
Missing	System	20	4.5
Total		440	100.0

4.1 non-response bias and common method bias countermeasures

Countermeasures for non-response bias and common method bias inclination We compared 25% of replies from the first fourteen days of the review period with 25% of responses from the most recent two weeks, as recommended by Armstrong and Overton (1977), and performed a t-test to determine whether our review was free of the NRB problem. Additionally, it was confirmed that there were no disparities in the respondents' responses in the two states using the ANOVA analysis, which revealed that there were no significant differences. We conducted many tests to mitigate the negative effects of normal technique predisposition (CMB). In addition to the programming stacking test by Muthen and Muthen (2007), Harman's single element test (Gomez-Conde et al., 2019), and Podsakoff et al's. (2003) NRB test. These tests showed that our review was liberated from CMB. Besides, we directed pre-testing for the questionnaire to guarantee the understandability of the assertions introduced in that.

4.2 Assessment of Measurement Model

A measurement model shows how latent variables have been measured through their observed variables and assesses their measurement properties. In addition, before proceeding to the structural equation modeling (SEM), the measurement model properties need to be satisfied. Furthermore, in the present study, twelve reflective variables were used. These variables were measured through forty-five items. CFA for all reflective variables was performed in AMOS.v24. The assessment of the measurement model is usually conducted for reliability and validity.

4.5 Factor analysis

4.3.1 Exploratory factor analysis

EFA used to be done in an organized order and was viewed as such. First, the significance of the issue evaluation, which was evaluated by looking at the correlation matrix of the accumulated statistics, was verified using the Bartlett sphericity test (Hair et al., 2005). Kaiser-Meyer-Olkin (KMO) statistics were employed to calculate sample adequacy at the same time. Sphericity and the KMO value are considered in the Bartlett's grading. Maximum Likelihood Approach to Habits (EFA). The twelve elements that were originally utilized to gauge the dimensions Impact of exchange and communications technology on firm performance: the mediation effect of supply chain Capabilities underwent factor examination. Table 5.6 confirmed the precis of consequences all the gadgets it is above then 0.5. So, the KMO and Bartlett’s take a look at equal 0.869 which is full-size (0.00). This end result indicates that the pattern dimension is ample for structural equation modelling (Gaskin, 2012, Kenny and McCoach, 2003).

Table 3 (**Pattern Matrix[a)] The pattern matrix to establish convergent and discriminant validity.**

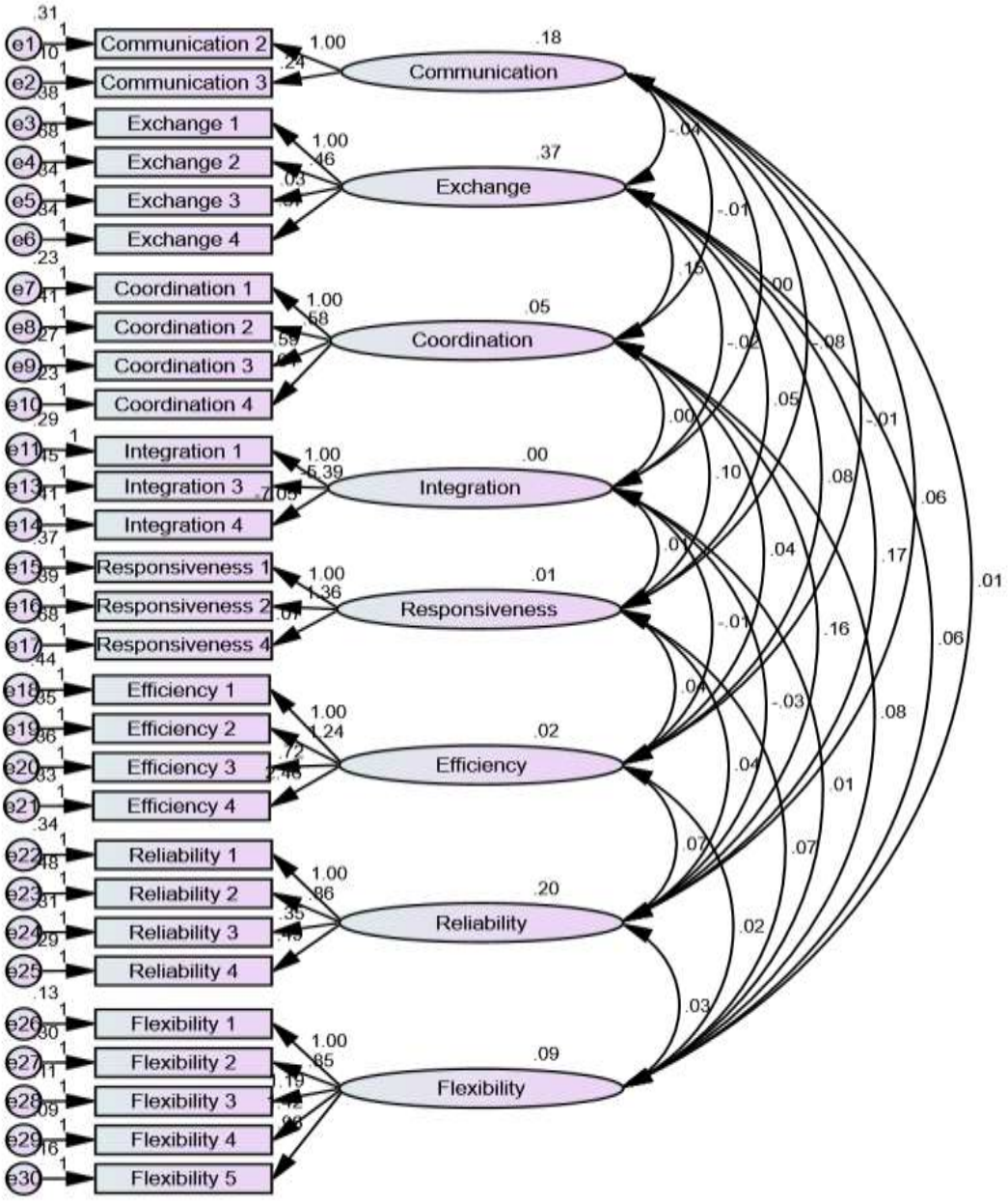
	Component							
	1	2	3	4	5	6	7	8
Communication 1	-.028	.385	-.388	.019	.456	.082	.083	.150
Communication 3	-.060	.285	-.087		-.315	-.034	.260	.947
Exchange 1	.068	.850	.176	-.119	.210	-.104	-.196	.144
Exchange 2	-.271	.125	-.085	.478	.182	.295	.222	.322
Exchange 3	.158	.011	-.124	.047	.348	.645	.161	-.215
Exchange 4	-.182	.077	.733	-.105	.221	-.025	.237	-.244

Coordination 1	-.164	.074	.838	.072	-.093	.155	-.152	.047
Coordination 2	.571	-.173	.375	.102	.312	.286	-.094	.028
Coordination 3	-.256	.161		.071	.736	-.306	-.253	-.212
Coordination 4	.523	.553	-.151	-.514	-.067	-.018	.110	.221
Integration 1	-.027	-.006	-.025	.198	-.122	-.181	.848	.250
Integration 3	-.056	.232	.139	.745	-.330	.243	-.135	.087
Integration 4	.490	.162	.138	.065	.175	.264	-.256	.277
Responsiveness 1	.141	-.100	-.049	-.183	.887	.142	.040	-.209
Responsiveness 2	-.543	.646	.206	.184	.104	.080	.257	.037
Responsiveness 4	.604	-.072	-.450	.103	.076	.052	-.122	.235
Efficiency 1	.171	-.133	.473	.116	.267	-.352	-.045	.300
Efficiency 2	.081	.688	-.043	.014	-.044	.095	.114	.173
Efficiency 3	.145	-.066	.619	-.265	-.027	-.133	.683	.214
Efficiency 4	-.101	.386	.261	-.080	.713	.021	-.074	-.116
Reliability 1	.157	-.010	.130	-.076	-.166	.922	-.219	.064
Reliability 2	.291	.262	.089	.115	-.037	.207	.595	-.045
Reliability 3	.431	.385	-.130	.167	.197	-.420	.063	.101
Reliability 4	.326	-.025	.035	.892	-.122	-.359	.137	-.124
Flexibility 1	.256	-.279	-.098	.755	.151	.029	.251	-.012
Flexibility 2	.412	.079	.616	.265	-.183	.094	.060	-.099
Flexibility 3	.861	-.029	-.088	.051	-.030	.086	.092	-.073
Flexibility 4	.388	.573	-.067	.086	.076	-.086	-.100	-.598
Flexibility 5	.875	.172	.091	.039	-.192	.159	-.084	-.174

The results were found substantial, and hence the result of factor analysis was accepted (Hair et al., 2005).

4.3.2 Confirmatory factor analysis (CFA)

Confirmatory factor analysis (CFA) was used to examine the validity and reliability of the records measuring tool, respectively. A multi-dimensional CFA model in (Figure 1) has been hypothesized and tested for its psychometric qualities in order to confirm the degree of correspondence between the apparent variables and latent aggregate of the tr Impact of exchange and communications technology on firm performance.



Following Fornell and Larcker (1981), we performed a confirmatory component evaluation (CFA) to determine the constructs in phrases of convergent validity, discriminant validity, and reliability. The effects of the CFA confirmed pretty desirable

Table 4 Fornell and Larcker (discriminant validity)

Exchange	Communication	Coordination	Integration	Responsiveness	Efficiency	Reliability	Flexibility
0.426							
-0.162	0.485						
1.157*	-0.115	0.288					
-0.649	-0.15	0.152	0.374				
0.83	-1.718†	4.360*	1.048	0.158			
0.875	-0.194	1.113	-1.449	2.423	0.347		
0.642*	0.316	1.634**	-1.137	0.787	0.962	0.453	
0.331	0.105	1.216**	0.388	2.141*	0.46	0.251	0.651

The fit statistics: $\chi 2(59) = 112.329$, RMSEA=0.067, NFI=0.90, CFI=0.95, IFI=0.95, GFI=0.92, and SRMR=0.052. We used composite reliability (CR) and Cronbach's alpha to determine the reliability of all constructs. As proven in Table 3, all values of CR (ranging from 0.695 to 0.814) are greater than 0.7, suggesting sufficient reliability (Fornell and Larcker, 1981)

Table 5 reliability and validity

	CR	AVE	MSV	MaxR(H)
Exchange	0.780	0.181	1.34	0.551
Communication	0.757	0.235	2.951	0.413
Coordination	0.651	0.083	19.012	0.274
Integration	0.699	0.14	2.099	0.349
Responsiveness	0.685	0.025	19.012	0.073
Efficiency	0.713	0.12	5.872	0.385
Reliability	0.688	0.205	2.67	0.532
Flexibility	0.779	0.423	4.584	0.818

4.1.3 Structural models and hypotheses test results.

In the current study, the hypotheses have been tested through constructing structural model using SEM. Structural model provides a direct effect on the output file as unstandardized and standardized

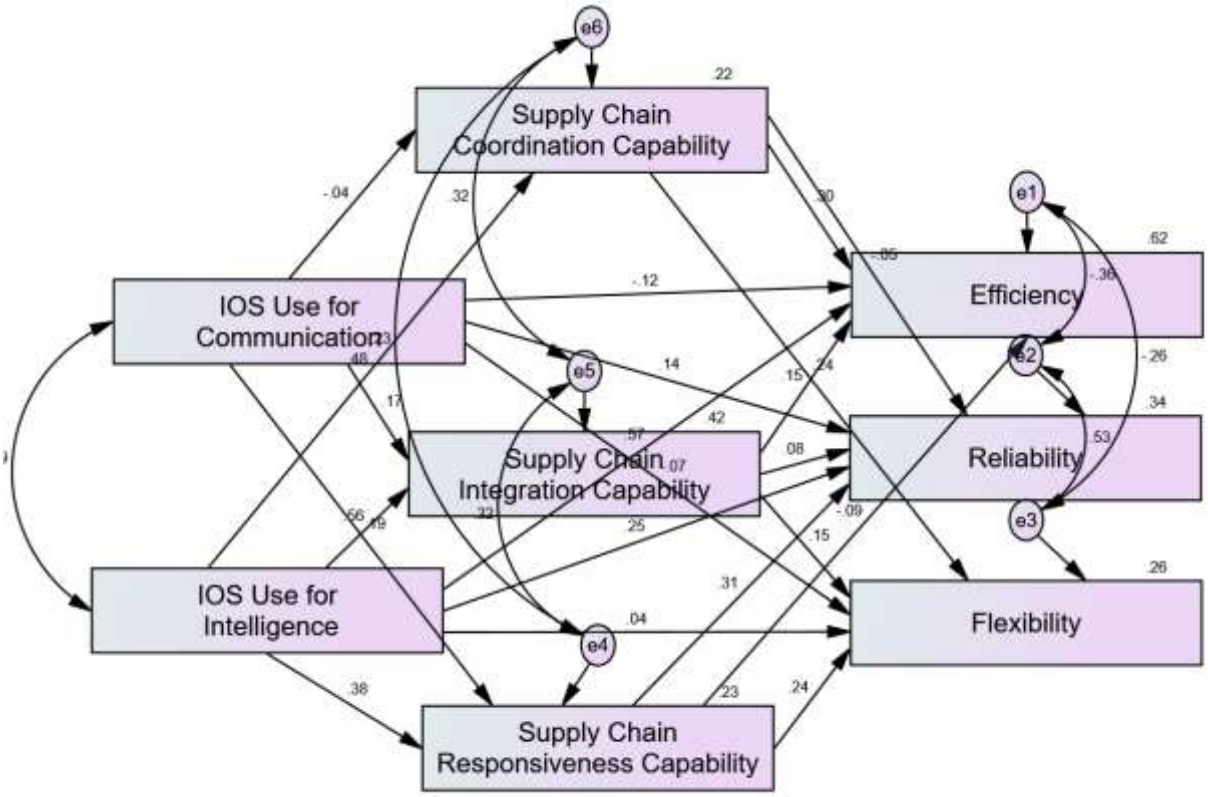


Figure 3 **Structural models and hypotheses test results.**

Figure 3 shows the estimation results of the structural model. The goodness of fit indices were $\chi 2=(2.277)$, DF=2, CMIN/DF= 1.138 with RMSEA=0.026, NFI=0.92,CFI=0.96, IFI=0.96,GFI=0.94, and SRMR=0.041, suggesting an acceptable fit.

Table 6 Direct Hypotheses Testing

			Estimate	S.E.	C.R.	P	Result
Coordination	<---	Communication	0.128	0.135	0.947	0.344	Not Supported
Integration	<---	Communication	0.222	0.128	1.735	0.083	Not Supported
Responsiveness	<---	Communication	0.18	0.118	1.529	0.126	Not Supported
Integration	<---	Exchange	0.484	0.154	3.149	0.002	**Supported**
Responsiveness	<---	Exchange	0.245	0.146	1.681	0.093	Not Supported
Efficiency	<---	Communication	-0.126	0.114	-1.103	0.27	Not Supported
Reliability	<---	Communication	0.13	0.134	0.965	0.334	Not Supported
Flexibility	<---	Communication	-0.084	0.175	-0.481	0.631	Not Supported
Efficiency	<---	Exchange	0.7	0.16	4.389	***	**Supported**
Reliability	<---	Exchange	0.272	0.188	1.452	0.146	Not Supported
Flexibility	<---	Exchange	0.053	0.244	0.217	0.828	Not Supported
Efficiency	<---	Coordination	0.362	0.139	2.61	0.009	**Supported**
Reliability	<---	Coordination	-0.054	0.163	-0.332	0.74	Not Supported
Flexibility	<---	Coordination	0.316	0.212	1.494	0.135	Not Supported
Efficiency	<---	Integration	0.162	0.148	1.097	0.273	Not Supported
Reliability	<---	Integration	0.078	0.174	0.448	0.654	Not Supported
Flexibility	<---	Integration	0.175	0.226	0.775	0.439	Not Supported
Efficiency	<---	Responsiveness	-0.12	0.156	-0.769	0.442	Not Supported
Reliability	<---	Responsiveness	0.377	0.184	2.05	0.04	**Supported**
Flexibility	<---	Responsiveness	0.352	0.239	1.471	0.141	Not Supported

*** Significant at .001 level ** Significant at .01 level NS Not Significant

After doing a statistical study on the hypothesis, it was determined that the findings were statistically significant (95% confidence interval, 5,000 bootstrapping). The key details about the potential relationship routes are presented in Table 5. Some hypotheses were supported when the P value for statistical significance was used (P value 0.05), which supports the corresponding hypothesis. The other path analysis showed statistically insignificant impacts; therefore, their predicted linkages were unsupported.

From the data in the above table, we can derive the following results

- *Communication do not have a positive influence on Coordination*
- *Communication do not have a positive influence on Integration*
- *Responsiveness do not have a positive influence on Communication*
- *Exchange has a positive influence on Responsiveness*
- *Exchange has a positive influence on Integration*
- *Communication does not have a positive influence on Efficiency*
- *Communication does not have a positive influence on Reliability*
- *Communication does not have a positive influence on Flexibility*
- *Exchange has a positive influence on Efficiency*
- *Exchange does not have a positive influence on Reliability*
- *Exchange does not have a positive influence on Flexibility*
- *Coordination has a positive influence on Efficiency*
- *Coordination does not have a positive influence on Reliability*
- *Coordination does not have a positive influence on Flexibility*
- *Integration does not have a positive influence on Efficiency*
- *Integration does not have a positive influence on Reliability*
- *Integration does not have a positive influence on Flexibility*
- *Responsiveness does not have a positive influence on Efficiency*
- *Responsiveness does not have a positive influence on Reliability*
- *Responsiveness does not have a positive influence on Flexibility*

4.1.4 The mediation tests: indirect effects using the bootstrap approach

The indirect effects using the bootstrap approach (Bollen and Stine, 1990, Preacher and Hayes, 2004, Shrout and Bolger, 2002) it's different from Baron-Kenny (1986) approach. the evidence are shows in the next Table.

Table 7 the Regression Path Coefficient for Indirect Effects

	Exchange	Result	Communication	Result
Coordination	...		...	
Flexibility	.250	**No mediation**	.356	**No mediation**
Reliability	.770	**No mediation**	.608	**No mediation**
Efficiency	.015	**Full mediation**	.551	**No mediation**

Table 7 Indirect Effects - Two Tailed Significance (BC) (Group number 1 - Default model)

	Exchange	Result	Communication	Result
Integration	...		...	
Flexibility	.032	**Full mediation**	.048	**Full mediation**
Reliability	.264	**No mediation**	.213	**No mediation**
Efficiency	.052	**No mediation**	.100	**No mediation**

Table 8 Indirect Effects - Two Tailed Significance (BC) (Group number 1 - Default model)

	Exchange	Result	Communication	Result
Responsiveness	...		...	
Flexibility	.024	**Full mediation**	.087	**No mediation**
Reliability	.020	**Full mediation**	.087	**No mediation**
Efficiency	.878	**No mediation**	.753	**No mediation**

- Coordination did not mediate the relationship between Exchange on Flexibility
- Coordination did not mediate the relationship between Communication on Flexibility
- Coordination did not mediate the relationship between Exchange on Reliability
- Coordination did not mediate the relationship between Communication on Reliability
- Coordination mediates the relationship between Exchange on Efficiency
- Coordination did not mediate the relationship between Communication on Efficiency
- Integration mediates the relationship between Exchange on Flexibility
- Integration mediates the relationship between Communication on Flexibility
- Integration did not mediate the relationship between Exchange on Reliability
- Integration did not mediate the relationship between Communication on Reliability
- Integration did not mediate the relationship between Exchange on Efficiency
- Integration did not mediate the relationship between Communication on Efficiency
- Responsiveness mediates the relationship between Exchange on Flexibility
- Responsiveness did not mediate the relationship between Communication on Flexibility
- Responsiveness mediates the relationship between Exchange on Reliability
- Responsiveness did not mediate the relationship between Communication on Reliability
- Responsiveness did not mediate the relationship between Exchange on Efficiency Responsiveness did not mediate the relationship between Communication on Efficiency

Table 8 Global Test

	X^2	DF
Unconstrained	15.089	2
Constrained	53.396	22
Difference	38.307	20
P-Value	0.008	

Interpretation: The p-value of the chi-square difference test is significant; the model differs across groups.

Table 9 Local Tests

Path Name	Male Beta	Female Beta	Difference in Betas	P-Value for Difference	Interpretation
Communication → Coordination.	0.218	0.096	0.123	0.841	NO
Communication → Integration.	0.159	0.301	-0.142	0.558	NO
Communication → Responsiveness.	0.091	0.415*	-0.323	0.193	YES
Exchange → Integration.	0.431†	0.493**	-0.062	1.000	NO
Exchange → Responsiveness.	0.101	0.380*	-0.279	0.365	YES
Communication → Efficiency.	-0.147	-0.085	-0.062	1.000	NO
Communication → Reliability.	0.054	0.118	-0.064	0.764	NO
Communication → Flexibility.	-0.370*	0.188	-0.558	0.112	YES
Exchange → Efficiency.	0.748***	0.553**	0.195	0.913	NO
Exchange → Reliability.	0.241	0.100	0.141	0.760	NO

Exchange → Flexibility.	-0.296	0.115	-0.410	0.286	NO
Coordination → Efficiency.	0.258	0.294†	-0.036	0.722	YES
Coordination → Reliability.	0.239	-0.226	0.466	0.192	NO
Coordination → Flexibility.	0.441*	0.187	0.254	0.453	YES
Integration → Efficiency.	-0.161	0.592**	-0.753	0.010	YES
Integration → Reliability.	0.037	0.106	-0.069	0.825	NO
Integration → Flexibility.	0.116	0.185	-0.070	0.786	NO
Responsiveness → Efficiency.	0.045	-0.418†	0.464	0.073	YES
Responsiveness → Reliability.	0.047	0.532†	-0.485	0.166	YES
Responsiveness → Flexibility.	0.171	0.172	-0.001	0.956	NO

YES = there is difference, NO = No difference

- The positive relationship between Responsiveness and Communication is only significant for Female.
- The positive relationship between Responsiveness and Exchange is only significant for Female.
- The negative relationship between Flexibility and Communication is only significant for Male.
- The positive relationship between Efficiency and Coordination is only significant for Female.
- The positive relationship between Flexibility and Coordination is only significant for Male.
- The positive relationship between Efficiency and Integration is stronger for Female.
- The negative relationship between Efficiency and Responsiveness is stronger for Female.
- The positive relationship between Reliability and Responsiveness is only significant for Female.

5 Discussion

The results of the study provide initial verification of the effectiveness of the IT artefact in explaining the level of Firm performance of firms.

First: the relationship between IOS Use for Intelligence (exchange) has positively and significant influence on firm Performance (Efficiency, Reliability and Flexibility) so, the rationale is to allow company to obtain information and then use it and exchange to get the benefit from the coordination and integration capabilities as it is supposed. In addition, companies are working to enhance the capabilities of information that helps business to became strong in their performance, which is directly reflected in the supply chain of companies. Therefore, this result is consistent with the results of previous studies that noted that the use of IOS in general enhances the ISO of supply chain management in general (Agbenyo et al. 2018; Asamoah et al. 2019; Asamoah et al. 2021a).

On the contrary, we find that IOS Use for Communication has not positively and significant influence on firm Performance (Efficiency, Reliability and Flexibility). consequently, this indicates that refer to Sudan Food Industry is not leading to a staggering improvement in supply chain management capabilities specifically in IOS Use for (Communication). However, Communication was not correlated with higher supply chain response.

The results provide empirical support for prior studies on the IOS (exchange) in predicting the level of Firm performance of firms (Asamoah et al., 2019; Hartono et al., 2010; Lee et al., 2014). The findings of the study revealed that the effect of IOS use on SCM performance was partially positive and significant. Accordingly, we find that the availability of integrated supply chain management systems for the company works to take advantage of opportunities to obtain insights from inside and outside the organization.

Second: the relationship between SCC (Responsiveness, Integration and Coordination) have not positively and significant influence on firm Performance (Efficiency, Reliability and Flexibility)

Where confirmed (Williamson, Harrison, & Jordan, 2004). higher SCC can be leveraged to propel attainment of higher levels of Firm performance. on the complex interrelationship of IOS use and SCM cap- abilities in driving

Firm performance, it is important for managers and business practitioners to aim at concurrently managing and deploying their IOS implementations and SCM capabilities, as this should create highest possible benefits in terms of Firm performance.

This result is confirmed by the results of the analysis of the mediator variable. Supply Chain Capabilities mediate the Inter-Organizational System use on firm Performance

5-3 Limitations and future research

There were some limitations to the work. IOS use, SCC, on firm performance. The complementary effect may not be linear and further examination of a potential non- linear relationship would provide additional insights. Also, as the study utilized data from only one context Sudan in Africa, specifically Sudan Food Industry future research may explore the phenomenon examined over multiple contexts.

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