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► **To cite this version:**

Caleb Amankwaa Kumi, David Asamoah, Benjamin Agyei-Owusu. How Does IOS-Enabled Business Intelligence Enhance Supply Chain Performance?. 20th Conference on e-Business, e-Services and e-Society (I3E), Sep 2021, Galway, Ireland. pp.441-453, 10.1007/978-3-030-85447-8_37. hal-03648109

HAL Id: hal-03648109

<https://inria.hal.science/hal-03648109>

Submitted on 21 Apr 2022

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How does IOS-enabled business intelligence enhance supply chain performance?

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Abstract. This study examines the mechanisms through which IOS-enabled business intelligence enhances supply chain performance of organizations. The study proposes that IOS-enabled business intelligence first impacts information exchange, coordination and integration capabilities, which subsequently enhance supply chain responsiveness and supply chain performance. A research model examining the proposed relationships was developed and tested using data from retail organizations operating in an emerging African country. Data analysis through partial least squares structural equation modelling confirmed that IOS-enabled business intelligence allowed firms to obtain information exchange, coordination, integration and supply chain responsiveness capabilities. With the exception of integration capabilities, supply chain capabilities directly enhanced supply chain performance as well. Finally, supply chain responsiveness partially mediated the relationship between information exchange capabilities and supply chain performance and fully mediated the relationship between integration capabilities and supply chain performance. The implications of these findings are discussed.

Keywords: Business Intelligence, Inter-Organizational Information Systems, Supply Chain Capabilities.

1 Introduction

Inter-organizational information systems (IOS) are network-enabled information systems that allow organizations to effectively manage business operations and supply chain activities across several organizations (Asamoah et al., 2021a). Adoption and use of IOS have grown in recent decades, and have become common place in many sectors. Researchers have identified that adoption and use of IOS can be patterned to achieve three possible objectives, namely, to enable communication, to achieve integration, and to enable business intelligence (Zhang and Cao, 2018; Subramani, 2004). Deploying IOS for business intelligence is of particular relevance in the present era of big data where large volumes of business data is created on a daily basis. Exploring and understanding business data can help firms gain new insights into their operations, customers

and market, and this can serve as the foundation of higher performance. IOS-enabled business intelligence refers to the extent to which the use of IOS facilitates learning and knowledge creation between members of a supply chain network (Zhang and Cao, 2018). Applications for IOS-enabled business intelligence may take the form of shared database and decision support systems, shared knowledge acquisition, and artificial intelligence (Mandal and Dubey, 2021).

Previous studies reveal that deploying IOS enhances outcomes such as firm performance (Hartono et al., 2010), supply chain capabilities (Rajaguru and Matanda, 2013), and supply chain performance (Cho et al., 2017; Asamoah et al., 2021a). The extant literature in exploring outcomes of IOS however often lump different dimensions of IOS use together, largely examining IOS use at the second order level, and failing to examine how specific dimensions of IOS use may enhance performance of firms. This means that there still exists a gap in our understanding on whether and how IOS-enabled business intelligence enhances firm performance. There have been multiple calls by researchers to examine the influence of different dimensions of IOS use on performance (Asamoah et al., 2021a; Agbenyo et al., 2018). Further, there is very little understanding into the mechanisms through IOS-enabled business intelligence enhances firm performance. This study addresses these research gaps by examining the role of information exchange, coordination, integration and supply chain responsiveness capabilities in explaining the outcomes of IOS-enabled business intelligence. The study proposes that IOS-enabled business intelligence initially enables firms to obtain information exchange, coordination and integration capabilities. These supply chain capabilities are then leveraged to achieve higher supply chain responsiveness, and ultimately, supply chain performance. These assertions are tested using data obtained from firms operating in an emerging economy.

The study is significant in a number of ways. This study is the first to empirically examine how IOS-enabled business intelligence drives supply chain performance, to the best of our knowledge. The study provides new insight into the business intelligence-supply chain performance link by proposing and empirically confirming that IOS-enabled business intelligence first creates information exchange, coordination and integration capabilities, which are leveraged for greater supply chain responsiveness and supply chain performance. The study additionally provides insights on the outcomes of business intelligence deployment within an African country context, a context that has been very little studied. The study also provides insights for owners and managers of firms by creating a clear understanding of how IOS-enabled business intelligence may enhance their supply chain performance.

The rest of the paper is organized as follows. The research model and hypotheses is presented next, followed by the methodology of the study. This is immediately followed by a discussion of the results of the study. The study then concludes by discussing the implications of the study for research and practice.

2 Research model and hypotheses

This study is underpinned by the resource-based view theory. The resource-based view theory argues that for organizations to gain competitive advantage, they must possess resources that are rare, valuable, inimitable, non-substitutable and can be deployed in manner that is difficult for competitor to duplicate (Barney, 1991; Peteraf, 1993). In this study, we argue that IOS-enabled business intelligence is an important intangible resource, that can be leveraged to obtain supply chain capabilities such as information exchange, integration, coordination and responsiveness, which ultimately help organizations to gain superior performance in the form of improved supply chain performance. The research model is presented in Figure 1 below. The hypotheses of the study are discussed next.

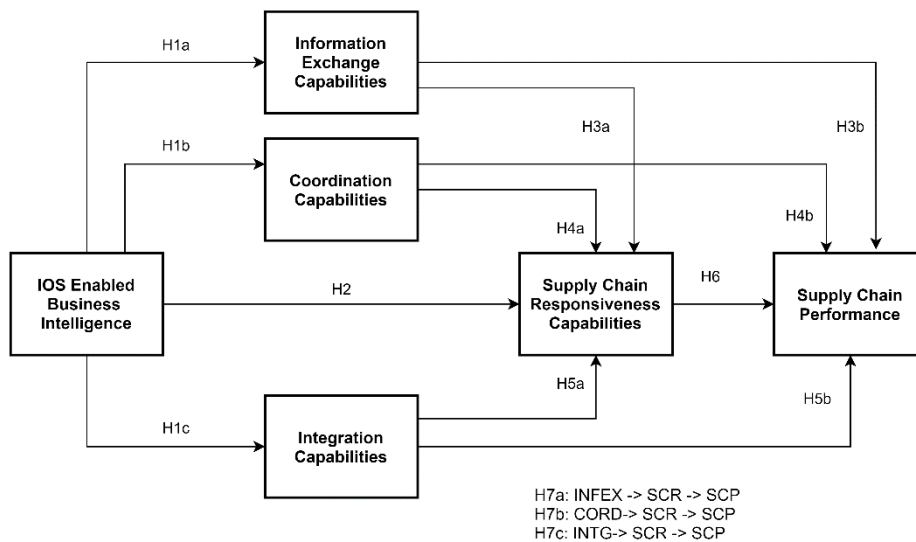


Fig. 1. Research model

2.1 IOS-enabled business intelligence and supply chain capabilities

IOS enabled business intelligence allows supply chain partners to work collaboratively to attain mutual benefits (Nissen et al., 2014). Additionally, the shared knowledge enabled by IOS allows effective and efficient synchronization of the supply chain processes, and joint planning and execution (Ayoub et al., 2017). Mandal and Dubey (2021) observed that using IOS for intelligence enhances IOS use for integration, collaboration, and coordination. IOS-enabled business intelligence allows organizations to jointly plan with their supply chain partners to address the needs customers in a responsive manner (Mandal and Dubey, 2021; Yu et al., 2018). Through the use of IOS, firms can derive useful insights towards improving their supply chain capabilities (Asamoah et al., 2021a; Asamoah et al., 2019). From the purview of the resource-based view

theory and the discussions above, we argue that the IOS-enabled business intelligence is a valuable, rare and inimitable organizational resource that can be exploited by organizations to develop supply chain capabilities such as information exchange, coordination, integration, and responsiveness. Drawing from the discussion above we propose the following hypotheses:

H1a: Higher levels of IOS-enabled business intelligence will lead to higher levels of information exchange capabilities.

H1b: Higher levels of IOS-enabled business intelligence will lead to higher levels of coordination capabilities.

H1c: Higher levels of IOS-enabled business intelligence will lead to higher levels of integration capabilities.

H2: Higher levels of IOS-enabled business intelligence will lead to higher levels of supply chain responsiveness capabilities

2.2 Information exchange capabilities, supply chain responsiveness and supply chain performance

Information exchange capabilities refers to the ability of an organization to share relevant information with its supply chain partners effectively and efficiently (Wu et al., 2006; Yenyurt et al., 2019). Information exchange helps to enhance interorganizational integration and coordination between supply chain partners and gain useful insight about the business environment (Kim et al., 2018; Yu et al., 2018). Effective and efficient supply chain information exchange leads to higher levels of supply chain responsiveness (Liu et al., 2013; Yu et al., 2018). Yu et al. (2018) affirms that through information exchange, organizations are able to improve their performance. Following the discussion above, we propose that:

H3a: Information exchange capabilities is positively related to supply chain responsiveness.

H3b: Information exchange capabilities is positively related to supply chain performance.

2.3 Coordination capabilities, supply chain responsiveness and supply chain performance

Coordination capabilities refers to the ability of organizations to effectively and efficiently coordinate business activities with their supply chain partners (Wu et al., 2006). Supply chain coordination has been identified as a key antecedent of organizational performance (Yenyurt et al., 2019). Kumar and Singh (2017) assert that effective supply chain coordination helps to manage interdependencies and reduce uncertainties. Improved supply chain coordination leads to benefits such as reduced transaction costs and improved operational efficiency among supply chain partners (Wu et al., 2006). A healthy supply chain coordination fosters the entire supply chain to be more responsive (Kim and Lee, 2010). Thus, it is expected that coordination capabilities will result in enhanced supply chain responsiveness and supply chain performance. Accordingly, we propose the following hypothesis:

H4a: Coordination capabilities is positively related to supply chain responsiveness.

H4b: Coordination capabilities is positively related to supply chain performance.

2.4 Integration capabilities, supply chain responsiveness and supply chain performance

Integration capabilities refers to the ability of organization efficiently integrate their internal and external supply chain activities. Wong et al. (2011) argues that activity integration helps to creates opportunities for leveraging the knowledge embedded in collaborative processes to enhance value creation, delivery performance and reduce cost. A number of studies have emphasized that supply chain integration helps practicing firms to improve their efficiency and effectiveness (Escorcia-Caballero et al., 2019). Similarly, Danese et al. (2013) maintain that supply chain integration helps improve responsiveness. Based on the discussions above, we propose the following hypotheses:

H5a: Integration capabilities is positively related to supply chain responsiveness.

H5b: Integration capabilities is positively related to supply chain performance.

2.5 Supply chain responsiveness and supply chain performance

Supply chain responsiveness capabilities refers to extent to which members of a supply chain are able to cooperatively respond to changes presented by the environment (Wu et al., 2006; Yenyurt et al., 2019). In today's market place plagued with several levels of uncertainties and competition, supply chain responsiveness becomes a very useful organizational capability (Asamoah et al., 2021b). Yu et al. (2018) found that supply chain responsiveness has a positive effect on firm financial performance. Similarly, the study of Kim and Lee (2010) found that supply chain responsiveness positively influences market performance. Drawing from the discussions above, it is conceivable that supply chain responsiveness capabilities will result in supply chain performance. Accordingly, we propose that:

H6: Supply chain responsiveness capabilities is positively related to supply chain performance

2.6 Mediating role of supply chain responsiveness

Drawing on the discussions in the previous sections, this study hypothesizes that supply chain responsiveness intervenes the direct effects of integration capabilities, coordination capabilities and information exchange capabilities on supply chain performance. Specifically, we argue that supply chain capabilities such as coordination, supply chain information exchange, and integration drives supply chain responsiveness which in turn influences firm performance. Accordingly, we postulate that:

H7a: Supply chain responsiveness capabilities mediates the relationship between integration capabilities and supply chain performance.

H7b: Supply chain responsiveness capabilities mediates the relationship between information exchange capabilities and supply chain performance.

H7c: Supply chain responsiveness capabilities mediates the relationship between coordination capabilities and supply chain performance.

3 Methodology

3.1 Measurement items development

Measurement items for the research items were sourced from existing literature with IOS-driven business intelligence sourced from Asamoah et al. (2021a) and Zhang and Cao (2018). Measures for information exchange capabilities, coordination capabilities, integration capabilities and supply chain responsiveness capabilities were sourced from Wu et al. (2006) and Asamoah et al. (2021a). The measures of supply chain performance were sourced from Koçoğlu et al. (2011) and Won Lee et al., (2007). All constructs were conceptualized at the first level, with the exception of supply chain performance, which was conceptualized as a second level construct with efficiency, flexibility and reliability as sub-dimensions. The measures were refined by three professors specializing in business intelligence and three top practitioner business intelligence experts. The measures were also subjected to pilot testing for further refinement.

3.2 Data collection

Data for the study was obtained from a survey of firms involved in retail trade in Ghana that use IOS. IOS, particularly vendor-managed inventory, has seen increasing adoption in the retail operations in Ghana, particularly for fast-moving consumer goods (Asamoah et al., 2021a). Five hundred firms directly involved in the wholesale and retail of fast-moving consumer goods were randomly selected from a database and targeted for data collection. Questionnaires were delivered to these organizations, together with a cover letter explaining the purpose of the study. In all, 161 usable responses were received from firms that indicated they were into wholesale and retail of fast-moving consumer goods.

4 Results

4.1 Demographic results

The demographic results revealed that largest categories of firms have been in operation for over 20 years (39.1%), had high revenues larger than 10 million Ghana cedis (31.7%), and had employee size larger than 500 (36%). This suggests IOS-enabled business intelligence is used more by larger firms, relative to smaller firms. The full demographic data is presented in Table 1 below.

Years of operation	Frequency	P
1 to 5 years	33	2
6	2	15.5

11 to 15 years	20	12.4
10 to 50	42	2
51 to 500	55	3
More than 500	58	3
Total	161	1

4.2 Measurement model results

Measurement model results were assessed by following the guidelines of Hair et al. (2019). Indicator loadings were found to be less than 0.708 as required, indicating good item reliability. Composite reliability values were greater than 0.7, indicating internal consistency reliability of the research constructs. The average variance extracted (AVE) values were larger than 0.5, indicating acceptable convergent validity of the model. These results are summarized in Table 2 below.

Table 2. Psychometric properties of research constructs

Constructs	Composite Reliability	AVE
Coordination Capabilities (CORD)	0.916	0.685
Efficiency (EFF)	0.930	0.767
Flexibility (FLEX)	0.925	0.712
Information Exchange Capabilities (INFX)	0.930	0.768
Integration Capabilities (INTG)	0.931	0.773
IOS-enabled business intelligence (INTL)	0.914	0.726
Reliability (REL)	0.927	0.718
Supply Chain Responsiveness (RESP)	0.905	0.703

In establishing discriminant validity, we used the Fornell-Larcker criterion. Comparing the square root of the AVE of each construct with the correlation between constructs and confirming if the former is larger than the latter establishes discriminant validity (Hair et al., 2019). In Table 3 below, the diagonal values in bold which represent the square root of the AVE of constructs are larger than the off-diagonal values which are correlations among constructs, establishing discriminant validity.

Table 3. Fornell-Larcker test results

	CORD	EFF	FLEX	INFX	INTG	INTL	REL	RESP
CORD	0.828							
EFF	0.672	0.876						
FLEX	0.614	0.708	0.844					
INFX	0.781	0.664	0.656	0.876				

INTG	0.638	0.530	0.492	0.615	0.879			
INTL	0.634	0.636	0.645	0.672	0.594	0.852		
REL	0.668	0.702	0.701	0.707	0.627	0.664	0.848	
RESP	0.717	0.663	0.697	0.765	0.712	0.766	0.726	0.839

The discriminant validity of the construct was also assessed using the heterotrait-monotrait (HTMT) ratio of the correlations test, which indicates that HTMT values should be less than 0.9 (Henseler et al., 2015). The HTMT values were within this range, confirming the discriminant validity of the model. The HTMT results are presented in Table 4 below.

Table 4. HTMT results

	CORD	EFF	FLEX	INFX	INTG	INTL	REL	RESP
CORD								
EFF	0.748							
FLEX	0.678	0.786						
INFX	0.867	0.738	0.725					
INTG	0.709	0.587	0.545	0.682				
INTL	0.717	0.716	0.725	0.757	0.669			
REL	0.741	0.782	0.776	0.786	0.696	0.747		
RESP	0.816	0.753	0.791	0.868	0.810	0.883	0.825	

4.3 Structural model results

Having established the validity of the measurement model, the structural model was assessed. The model's in-sample explanatory power was assessed by examining the R^2 of the endogenous variables, which ranged from a moderate level of 0.353 for integration capabilities to a high level of 0.749 for supply chain responsiveness. The R^2 values are presented inside the endogenous constructs in Figure 2 below. The predictive relevance of the model was also established since Q^2 values ranged from 0.260 to 0.596, which are significantly larger than zero (Hair et al., 2019).

To ascertain whether the direct effects were supported, the path co-efficient and p-values of the hypothesized direct paths were examined. The mediation paths were assessed by following the procedure outlined by Nitzl et al. (2016). The results of the hypotheses tests are summarized in Figure 2 below.

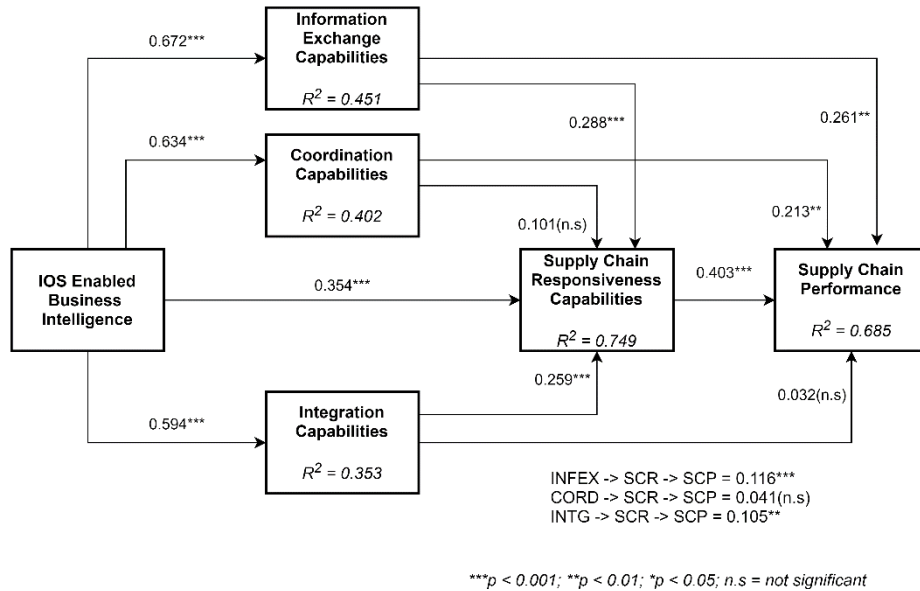


Fig. 2. Structural model results

4.4 Discussions

The study set out to examine whether and how IOS-enabled business intelligence enhances the supply chain performance of firms. The findings of the study confirmed that IOS-enabled business intelligence first allowed organizations to obtain information exchange, coordination and integration capabilities as hypothesized. Additionally, IOS-enabled business intelligence enhanced the supply chain responsiveness capabilities of firms. These findings are in line with the results of previous studies that observed that use of IOS in general enhances supply chain management capabilities in general (Agbenyo et al. 2018; Asamoah et al., 2019; Asamoah et al., 2021a). Whilst the specific effect of IOS-enabled business intelligence on these capabilities have not been studied in previous studies, the study of Mandal and Dubey (2021) can serve as a useful reference. They observed that IOS use for intelligence will occasion higher levels of IOS use for integration, collaboration, and coordination. Beyond these findings, the present study explores the interrelationship between supply chain management capabilities. It was revealed that information exchange capabilities and integration capabilities can be leveraged to achieve higher supply chain responsiveness. This suggests that IOS-enabled business intelligence occasions a staggered improvement in supply chain management capabilities. Coordination capabilities however were not associated with higher supply chain responsiveness.

Regarding the effect of supply chain capabilities, it was observed that information exchange, coordination and supply chain responsiveness capabilities all resulted in higher supply chain performance. Integration capabilities however did not enhance

supply chain performance. This mirrors the findings of Yu et al. (2018) that observed that data driven supply chains enabled information exchange, coordination, activity integration and responsiveness capabilities, and that all these supply chain capabilities with the exception of activity integration enhanced financial performance. The different ways in which supply chain capabilities impact on supply chain performance highlight the need for researchers to explore into detail how the individual dimensions of supply chain capabilities are influenced by IOS and they in turn influence supply chain performance.

Examining the mediation role of supply chain responsiveness in the effect of information exchange, coordination and integration capabilities on supply chain performance revealed interesting findings. A partial mediation role of supply chain responsiveness was observed for the effect of information exchange capabilities on supply chain performance. This means that information exchange capabilities partly enhance supply chain performance directly, and partly enhance it through enhanced supply chain responsiveness. The effect of integration capabilities on supply chain performance on the other hand was fully mediated through supply chain responsiveness, since the direct effect of integration capabilities on supply chain performance was not significant, but the mediation effect was positive and significant. Finally, examining the mediation role of supply chain responsiveness on how coordination capabilities enhance supply chain performance reveals that there was no mediating role of supply chain responsiveness. This indicates that supply chain responsiveness does not intervene the relationship between coordination capabilities and supply chain performance.

5 Conclusion

The study examined into detail the mechanisms through which IOS-enabled business intelligence enhances the supply chain performance of firms by proposing that supply chain capabilities play an important, individual and staggered role in explaining this relationship. The findings of the study largely support the assertions of the study, with IOS-enabled business intelligence enhancing all four identified supply chain management capabilities, and three of the capabilities having a significant effect on supply chain responsiveness and performance.

There are some implications of the study. The study provides a detailed understanding of how IOS-enabled business intelligence enhances supply chain performance, by bringing to light the role of that supply chain management capabilities in enhancing supply chain performance. The study also foment an understanding in the interrelationships between supply chain capabilities that can guide future researchers who are studying supply chain capabilities. The study also adds up to the nascent studies on business intelligence within the African context. By way of implications for practice, the findings of the study confirm that positive outcomes in terms of improved supply chain management capabilities and improved supply chain performance can be obtained from IOS-enabled business intelligence initiatives. Business owners and managers can therefore invest in IOS to enhance their performance outcomes. The study also

highlights the important role of supply chain management capabilities in achieving successful supply chain performance outcomes from IOS-enabled business intelligence.

There are some limitations of the study. Data was obtained from firms in the retail sector of Ghana, an emerging African country, and it is possible that the findings may not apply to firms in other industries or in other geographic contexts. Future research can consider expanding the scope of the study to examine other industries, examine similar relationships in other contexts, and explore possible constructs enhance the effect of IOS-enabled business intelligence on performance outcomes.

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