Assessing the effect of business intelligence on supply chain agility. A perspective from the Jordanian manufacturing sector

Ahmad Obidat[a*], Zaid Alziyadat[b] and Zaid Alabaddi[a]

[a]Department of Management Information Systems, College of Business Administration and Economics, Al-Hussein Bin Talal University, Ma'an, Jordan
[b]Department of Business Administration, College of Business Administration and Economics, Al-Hussein Bin Talal University, Ma'an, Jordan

A B S T R A C T

This study aimed to examine the effect of integrating Business Intelligence (BI) into the supply chain on supply chain agility, within the Jordanian manufacturing sector. Based on the resource-based view of the firm, this study developed and examined a research model, to achieve its goal. The impact of three dimensions of BI including managerial, technical, and cultural competencies was examined. Using an electronic questionnaire, data was gathered from 462 administrative personnel and employees. Structural equation modeling techniques were employed to analyze the data. Results revealed that the three dimensions of BI have statistically significant positive direct effects on supply chain agility. In addition to that, the results revealed that BI cultural competence has statistically significant positive direct effects on BI technical and managerial competencies. This study contributes to the literature on the role of BI in promoting supply chain agility, from the perspective of a developing country. The findings of this study are expected to help organizations' administrations in making better decisions regarding employing BI to achieve an agile supply chain.

1. Introduction

The interest in the supply chain by organizations is due to its role in improving efficiency and effectiveness in providing products at the lowest cost and at the right time (Craighead et al., 2020). The supply chain is critical for business success, and, in turn, customer convenience and satisfaction, and societal development (Koberg & Longoni, 2019).

Many organizations are at the pace to survive the fierce competition in a globalized world (Kostic, 2018). This requires reengineering the processes and procedures employed by organizations to respond to customers and beneficiaries quickly and credibly inside and outside the organization (Tallon et al., 2022). Information and Communication Technology (ICT) plays a critical role in helping organizations achieve that purpose. ICT has helped organizations in integrating the functions of the supply chain and coordinating the work processes inside organizations and with business partners (Irfan et al., 2019).

To achieve a competitive edge at the strategic, tactical, and operational levels, companies must have a better harmony with suppliers and customers to agile their operations (Al Humdan et al., 2020). This requires a level of coordination beyond within a single company itself. This purpose can be achieved by enabling an agile supply chain. Supply chain agility "is the result of integrating the supply chain's alertness to changes (opportunities/challenges) – both internal and environmental – with the supply chain's capability to use resources in responding (proactively/reactively) to such changes, all in a timely and flexible manner" (Li et al., 2008, p. 410). Supply chain agility enables organizations to maintain close relationships with their suppliers, distributors, and other business partners, which in turn, permits the exploration of market opportunities (Mukhsin & Suryanto, 2021).

* Corresponding author
E-mail address obidat.ahmad@gmail.com (A. Obidat)

Embracing ICT is one of the major enablers of supply chain agility (Al Humdan et al., 2020). Meanwhile, the capabilities of ICT are varying and evolving and so are the functions of the supply chain (O'Leary, 2020). ICT supports the supply chain with a wide range of technologies ranging from primitive ones to BI capabilities (Richter et al., 2022).

BI "is a collection of decision support technologies for the enterprise aimed at enabling knowledge workers such as executives, managers, and analysts to make better and faster decisions" (Chaudhuri et al., 2011, p. 88) BI supports decision processes by enabling data aggregation, integration of various data sources and types, warehousing and processing big data, new knowledge discovery, and forecasting capabilities (Wieder & Ossimitz, 2015). BI assists organizations in making informed decisions and actions by relying on information and knowledge provided by BI capabilities (Ahmad & Mustafa, 2022). That is it helps organizations' management in decision-making within highly changing environments, by relying on insights provided by sophisticated data analysis (Awawdeh et al., 2022), BI enables the supply chain to provide a competitive advantage by transforming sudden uncertainties and disruptions of markets into competitive opportunities by assembling information and knowledge with speed and timely manner (Elgendy, 2021).

Although the role of various ICTs in achieving an agile supply chain has been examined thoroughly, the role of BI has received little attention, especially in developing countries (Du et al., 2021; Duche-Pérez et al., 2022). Therefore, this study aims to assess the effect of integrating BI on supply chain agility within the Jordanian manufacturing sector. In this sense, the impact of the three dimensions of BI, including managerial, technical, and cultural competencies on supply chain agility will be examined in this study. This study will contribute to the literature on the role of BI in promoting supply chain agility, in the manufacturing sector, from the perspective of a developing country.

2. Literature review

2.1. Theoretical framework

This study is grounded in the Resource Based View (RBV) of the firm (Barney, 1991). This view posits that a firm should be able to achieve better returns by adopting and integrating resources that positively impact the manufacturing processes of products and the products themselves (Wernerfelt, 1995). According to this view, a firm's resources include raw materials, the firm's unique skills, technologies, knowledge, etc. (Prahalad & Hamel, 2009). Furthermore, this view claims that for a firm to achieve a sustainable competitive advantage, then it should possess valued and yet unmatchable resources including state-of-the-art technologies (Ivanov et al., 2010).

Therefore, according to RBV, integrating non-traditional ICT should positively impact supply chain agility (Ajibade et al., 2019; Riyadi et al., 2021). That is, to survive competition, uncertainty, and changing business environments, organizations should adopt competencies and capabilities that may help their sustainability (Costa et al., 2020; Pono & Munizu, 2021). BI provides a valued resource for organizations to agile their supply chain functions (Awan et al., 2022).

2.2. Supply chain agility

The supply chain agility concept emerged in the early 90s, and since ever it has received great attention in academia and industry (Fayezi et al., 2017). Supply chain agility is critical for achieving, sustaining, and enhancing a firm's competitive advantage (Chen, 2019). Moreover, an agile supply chain improves business sustainability and logistics (Bicocchi et al., 2019). Supply chain agility is a construct that encompasses a firm's responsiveness to change, ongoing scanning of the environment to predict change, ability to adjust operations, enablement of customers' customized requests, and integration of internal and external processes (Gligor et al., 2019).

Unforeseen events do always take place and they are indeed disruptive. Political and social turmoil, natural disasters, and supplier failures can have a dramatic impact on the entire supply chain (Sakib et al., 2021). Therefore, organizations should be equipped to forecast change to react to prospective problems and attain opportunities (Sheng et al., 2021). This requires the supply chain to be able to accelerate or decelerate its operations and invoke innovative customization by consumers (Jermsittiparsert et al., 2019). To be able to do so, the supply chain should have the capability to integrate business processes within the firm and with firm business partners (Bag et al., 2020).

An agile supply chain enables organizations to save on manufacturing costs, improve customer relationship management, eliminate unnecessary business processes and activities, and thus help organizations maintain a competitive position (Wu & Barnes, 2018). Research demonstrated that ICT is a proactive and reactive enabler of supply chain agility (Al Humdan et al., 2020; Dehgani & Jafari Navimipour, 2019). Compared to traditional ICT, which can only support reactive tactics, BI can support both reactive and proactive ones (Poll et al., 2018).

2.3. Business intelligence

2.3.1. Managerial competence

BI managerial competence relates to the set of practices that management adopts to transform organizational capabilities into valued output and to support competitive strategy (Yiu et al., 2020). Lack of BI managerial competence is expected to negatively affect the performance of an organization, especially the supply chain (Ellram et al., 2013). BI managerial

competence is known as a crucial enabler of supply chain agility. This is because it encompasses a wide spectrum of viable activities including business analysis and decision-making, information and knowledge management, business and staff management, and industry and competitive strategy awareness (Burin et al., 2020; Derwik & Hellström, 2017). Research demonstrated that BI managerial competence is a major enabler of supply chain agility (Kaur, 2021) and flexibility (Burin et al., 2020), and organizational agility (Asghari et al., 2018; Campos et al., 2019). Therefore, the following hypothesis is proposed:

Hypothesis 1 (H1*): BI managerial competence positively relates to supply chain agility.*

2.3.2. Cultural competence

BI cultural competence is concerned with the organization's belief in information and knowledge as valued resources in supporting decision-making processes in all aspects of business activities to achieve an agile supply chain (Sakas et al., 2021). BI cultural competence is an important ability for organizations in today's globalized world (Pasaribu et al., 2022). The culture of information and knowledge gathering, and sharing is critical for organizations to support their business strategies (Basten & Haamann, 2018; Ganguly et al., 2019). Research demonstrated that BI cultural competence is a major enabler of supply chain agility (Phutthiwat et al., 2020) and efficient business processes (Al-Maaitah, 2018). Therefore, the following hypothesis is proposed:

Hypothesis 2 (H2): *BI cultural competence positively relates to supply chain agility.*

In addition to that, BI cultural competence is a major enabler of BI technical and managerial competencies (Saidaxmedovna, 2022). Inconsistencies in cultural competence can negatively affect technical and managerial competencies, and, in turn, the agility of the supply chain. Cultural competence is influenced by organizational culture which is shaped by people's beliefs and attitudes (Al-Nazer, 2022). If the cultural norms in organizations are supportive of processes related to BI technical and managerial competencies, the laters should play a vital role in achieving an agile supply chain (Hou, 2020). Although BI technical tools are expected to be a major enabler of the agile supply chain, they should be supported by people in organizations to achieve their expected role. Therefore, the following hypotheses are proposed:

Hypothesis 3 (H3): *BI cultural competence positively relates to BI managerial competence.*

Hypothesis 4 (H4): *BI cultural competence positively relates to BI technical competence.*

2.3.3. Technical competence

With the increased value of information and knowledge gathering, analysis, and sharing in decision-making processes at all levels of management and in all business activities, BI tools are becoming a more integral part of organizations' resources (Jayakrishnan et al., 2022). To utilize BI capabilities in achieving an agile supply chain, organizations should have a supportive infrastructure and their human resources should possess the necessary skills (Lennerholt et al., 2021). BI technical competence is a key determinant of successful BI systems (Mudzana & Maharaj, 2017). Research that BI technical competence is a major enabler of efficient organizational performance (Dedić & Stanier, 2017; Miller, 2019) and agility (Trinh, 2015). Therefore, the following hypothesis is proposed:

Hypothesis 5 (H5): *BI technical competence positively relates to supply chain agility.*

Based on the literature review above, the developed research model is depicted in Fig. 1.
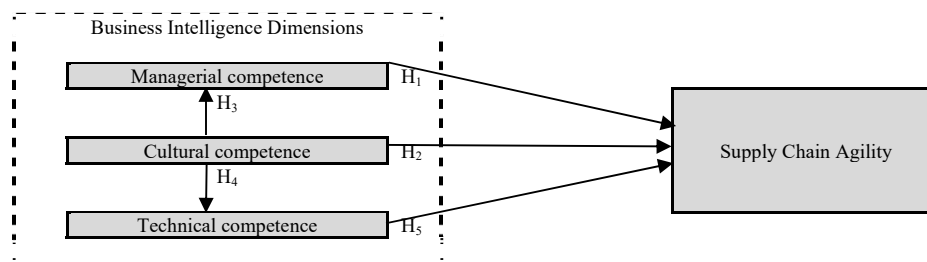

Fig. 1. Research model

3. Methodology

3.1. Data collection

A self-administered questionnaire was adopted to gather the data for this study. This type of questionnaire is relevant to this study because it's an information systems-exploratory quantitative study (Norderval et al., 2019). The questionnaire contained two parts including a part for collecting demographic information, and the other included Likert-type scale items to measure the constructs examined in this research. The questionnaire was delivered in electronic format to the target

population through a snowball sampling technique (Leighton et al., 2021). That is a considerable number of administrative personnel and employees, who work in the Jordanian manufacturing sector and are involved in BI activities related to supply chain, and they were asked to pass it to their colleagues who meet the same description. On the first page of the questionnaire, the purpose of the study was explained, and it was indicated that only managers and employees who work in the Jordanian manufacturing sector and involved in BI activities that related to supply chain should complete the questionnaire. All subjects consented before participating in the questionnaire.

3.2. Measures

Supply chain agility was assessed using seven items adopted from (Swafford et al., 2008). BI managerial, technical, and cultural competencies were measured using five, four, and six items, respectively, adopted from (Sangari & Razmi, 2015). All constructs were measured using a 5-point Likert scale (with 1 strongly disagree to 5 strongly agree).

4. Results

4.1. Demographic characteristics of the study's sample

The sample in this study consists of 462 participants including 280 (60.6%) males and 182 (39.4%) females. Participants were aged 22 to 64 years old. One hundred and fifty-three (33.2%) participants were managers and 309 (66.8%) were employees. Table 1 presents the demographic characteristics of this study sample.

Table 1
Demographics of participants

Criterion	Factor	Frequency	Percentage
Gender	Male	280	60.6%
	Female	182	39.4%
Age	20-30	182	39.4%
	31-40	139	30.09%
	41-50	82	17.74%
	51-60	46	9.96%
	61-70	13	2.81%
Position	Manager	153	33.2%
	Employee	309	66.8%

4.2. Convergent and discriminant validity of the measurement model

As recommended by Hair et al. (2018), the convergent validity was examined based on four indicators including Cronbach's alpha (α) and the Composite Reliability (CR) which are required to be greater than 0.80, each, the Average Variance Extracted (AVE) which is required to be greater than 0.5 for each construct, and the Factor Loading (FL) for the constructs items which are required to be greater than 0.5. Table 2 presents the results of examining the convergent validity. The results indicate that the measurement model's convergent validity is met.

As recommended by Hamid et al. (2017), the discriminant validity was evaluated by the heterotrait-monotrait (HTMT) criterion. This criterion requires that the HTMT, between every two constructs, must be less than 0.85. Table 3 presents the HTMT matrix for each pair of constructs. The results in the matrix indicate that the measurement model's discriminant validity is met.

4.3. Goodness-of-fit of the structural model

The Tucker-Lewis Index (Kline, 2015), the Comparative Fit Index (Baumgartner & Homburg, 1996), the Relative Non-Centrality Index (Bentler & Bonett, 1980), the Standardized Root Mean Square Residual (Hu & Bentler, 1999), and the Root Mean Square Error of Approximation (Steiger, 2007) were used to assess the goodness-of-fit of the structural model. The structural model met all the indices thresholds as presented in Table 4.

4.4. Hypotheses testing

The results of hypotheses testing indicated that managerial competence (z=3.654, p=0.000), cultural competence (z=10.117, p=0.000), and technical competence (z=3.719, p=0.000) have statistically significant positive direct effects on supply chain agility. In addition to that, the results revealed that cultural competence (z=8.134, p=0.000) has a statistically significant positive direct effect on technical competence. Finally, it was found that cultural competence (z=11.973, p=0.000) has a statistically significant positive direct effect on managerial competence. Table 5 presents the results of the hypothesis testing.

Table 2

Convergent validity of the measurement model assessment

Construct	FL	α	CR	AVE
Supply chain agility		0.91	0.81	0.56
Integrating BI into our supply chain resulted in:				
1. Speed in reducing manufacturing Lead time	0.63			
2. Speed in increasing frequencies of new product introductions	0.61			
3. Speed in increasing levels of product customization	0.59			
4. Speed in adjusting delivery capability	0.64			
5. Speed in improving customer service	0.91			
6. Speed in improving delivery reliability	0.96			
7. Speed in improving responsiveness to changing market needs	0.94			
Managerial competence		0.92	0.92	0.71
1. We have well-defined procedures and methods to constantly collect information & knowledge about our supply chain operations	0.85			
2. We have well-defined procedures and methods to integrate, analyze, and organize supply chain information and knowledge	0.90			
3. We have well-defined procedures and methods to effectively distribute and disseminate supply chain information and knowledge as well as the results of subsequent analyses	0.90			
4. We have easy and timely access to required information and knowledge when making supply chain decisions	0.96			
5. Our supply chain decisions are mostly made based on accurate, valid, and reliable information and knowledge	0.87			
Cultural competence		0.90	0.90	0.61
1. We believe that information and knowledge are effectively used in most aspects of our supply chain management	0.88			
2. We highly recognize the value and utility of information and knowledge in achieving strategic and operational success in our supply chain	0.74			
3. Information and knowledge are viewed as a strategic asset in our supply chain	0.98			
4. There is mutual trust between our company and its supply chain partners to share relevant information and knowledge	0.85			
5. We are committed and willing to share relevant information and knowledge with our supply chain partner	0.77			
6. We work closely with our supply chain partners in supply chain-related, problem-solving, and other information-based activities	0.69			
Technical competence		0.81	0.83	0.54
1. We continually invest in technological infrastructure that supports information/knowledge management in our supply chain	0.71			
2. We effectively use appropriate tools and technologies that support the collection of information and knowledge about our supply chain operations	0.63			
3. We effectively use appropriate tools and technologies that support integrating, analyzing, and organizing supply chain information and knowledge	0.75			
4. We effectively use appropriate tools and technologies that support the distribution and dissemination of supply chain information and knowledge as well as the results of subsequent analyses	0.58			

Table 3

HTMT matrix

Construct	Supply chain agility	Managerial competence	Technical competence	Cultural competence
Supply chain agility	1.000			
Managerial competence	0.593	1.000		
Technical competence	0.625	0.352	1.000	
Cultural competence	0.741	0.609	0.438	1.000

Table 4

Structural model goodness-of-fit indices

Fit indices	Value	Threshold
Tucker-Lewis Index (TLI)	0.938	> 0.9
Comparative Fit Index (CFI)	0.947	> 0.9
Relative Non-Centrality Index (RNI)	0.947	> 0.9
Standardized Root Mean Square Residual (SRMR)	0.069	< .08
Root Mean Square Error of Approximation (RMSEA)	0.066	< .07

Table 5

Hypotheses testing results

Path	Standardized coefficient	z-value	P(>|z|)	Decision
H1: MC → SCA	0.114	3.654	0.000 ***	Significant
H2: CC → SCA	0.465	10.117	0.000 ***	Significant
H3: TC→ SCA	0.128	3.719	0.000 ***	Significant
H4: CC → TC	0.339	8.134	0.000 ***	Significant
H5:CC → MC	0.570	11.973	0.000 ***	Significant

Note. Significance codes: 0.000 ***. MC: Managerial Competence, SCA: Supply Chain Agility, CC: Cultural Competence, TC: Technical Competence.

5. Discussion

The purpose of this study was to examine the impact of integrating BI into the supply chain on the agility of the supply chain. The effect of three dimensions of BI, including managerial, cultural, and technical competencies, on the agility of the supply chain, was examined. Furthermore, this study examined the effect of BI cultural competence on the other two dimensions of BI, managerial and technical competencies.

The results revealed that BI managerial competence is a key enabler of supply chain agility. This finding corroborates with previous research which examined the impact of BI managerial competence on supply chain agility (Kaur, 2021) and flexibility (Burin et al., 2020), and organizational agility (Asghari et al., 2018; Campos et al., 2019). Therefore, it can be inferred that BI managerial competence is a critical enabler of supply chain agility and flexibility, and organizational agility.

Furthermore, the findings revealed that BI cultural competence is a critical enabler of supply chain agility. This finding is in line with previous research which examined the effect of BI cultural competence on supply chain agility (Phutthiwat et al., 2020) and business processes efficiency (Al-Maaitah, 2018). Thus, it can be inferred that BI cultural competence is a critical enabler of supply chain agility and efficient business processes. In addition to that, the results indicated that BI cultural competence is a critical antecedent of BI managerial and technical competencies. This finding is in support with previous research which examined the effect of BI cultural competence on BI managerial and technical competencies (Saidaxmedovna, 2022). Hence, it can be concluded that BI cultural competence is a key enabler of BI managerial and technical competencies.

Moreover, the results of this study revealed that BI technical competence is a major enabler of supply chain agility. This finding is in support with previous research which examined the effect of BI technical competence on organizational performance efficiency (Dedić & Stanier, 2017; Miller, 2019) and agility (Trinh, 2015). Thus, it can be concluded that BI technical competence is a vital enabler of supply chain agility and organizational performance efficiency and agility.

6. Conclusion

The purpose of this study was to examine the impact of integrating BI into the supply chain on the agility of the supply chain. The effect of three dimensions of BI, including managerial, cultural, and technical competencies, on the agility of the supply chain, was examined. Furthermore, this study examined the effect of cultural competence on the other two dimensions of BI, managerial and technical competencies. The results revealed that all three dimensions of BI have statistically positive significant effects on the agility of the supply chain. Moreover, the results indicated that cultural competence has a statistically positive significant effect on managerial and technical competencies.

6.1. Practical implications

BI managerial competence was found to have a significant positive effect on supply chain agility. This implies that BI managerial competence is a major enabler of supply chain agility. Therefore, various management levels and employees should support and value the use of BI within their organizations to achieve supply chain agility. That is, an organization's management and employees should have well-defined activities to ongoingly gather, analyze, and disseminate information and knowledge about supply chain operations. Also, they should base their decisions on robust, verified, reliable, and valid knowledge while they have real-time access to them, efficiently.

BI cultural competence was found to have a significant positive effect on supply chain agility. This implies that BI cultural competence is a critical enabler of supply chain agility. Therefore, organizations should promote a culture of valuing information and knowledge within their units and employees and with their business partners. Moreover, organizations should work collaboratively with their partners to build trust which enables risk-free information exchange among them.

BI technical competence was found to have a significant positive effect on supply chain agility. This implies that BI technical competence is a significant enabler of supply chain agility. Therefore, organizations should ongoingly aim to have a BI infrastructure that supports knowledge and information management in the supply chain. Also, they should support the use of BI tools that support the gathering, integration, and analysis of information and knowledge about supply chain functions and operations. Also, organizations should provide their staff with the appropriate training to be competent with the use of BI technologies.

BI cultural competence was found to have a significant positive effect on BI managerial and technical competencies. This implies that BI cultural competence is a major predictor of BI managerial and technical competencies. Therefore, organizations should capitalize on cultural competence as it's a significant antecedent of managerial and technical competencies, which are critical enablers of supply chain agility.

6.2. Research implications

This study contributed to the literature on the role of BI in promoting supply chain agility, in the manufacturing sector, from the perspective of a developing country. The theoretical implications of examining the impact of three dimensions of BI including managerial, technical, and cultural competencies on supply chain agility indicated that the three dimensions of BI

positively affect supply chain agility. In addition to that, the results revealed that cultural competence positively relates to technical and managerial competencies.

6.3. Limitations

Although this study has various potentials, it has two limitations. First, it's limited to the manufacturing sector. Second, the sample in this study was limited to one developing country, Jordan. Future research should expand the scope of this study by examining data from different industrial sectors and countries.

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