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International Journal of Procurement Management

ISSN online: 1753-8440 - ISSN print: 1753-8432
https://www.inderscience.com/ijpm

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DOI: 10.1504/IJPM.2023.10061953

Article History:

Received:	10 September 2023
Last revised:	12 September 2023
Accepted:	20 September 2023
Published online:	30 December 2024

Exploring the impact of lean, agile, resilient, and green supply chain practices on organisational performance through mediating role of big data analytics

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Abstract: This research uses resource-based view and dynamic capabilities view to investigate the impact of lean, agile, resilient, and green supply chain (LARG-SC) practices on organisational performance through big data analytics. An online-based, self-administrative questionnaire was conducted from different companies in Egypt. Quantitative analysis was assessed through covariance based structural equation modelling for 622 responses using AMOS. The findings revealed that big data analytics could significantly mediate the relationship between LARG-SC practices and organisational performance. The findings provide an in-depth empirical illustration on understanding big data analytics and how it addresses the challenges of LARG-SC practices of companies in developing countries. This will help in extending both theoretical lenses resource-based view and dynamic capabilities view, especially that further studies are needed in emerging economies. In addition, the findings of this research will fall in line with Egyptian the strategic objective 2030 to be fully digitalised.

Keywords: lean practices; agile practices; resilient practices; green practices; organisational performance; big data analytics; BDA.

Reference to this paper should be made as follows: Saad, N.A. and Barakat, M.R. (2025) 'Exploring the impact of lean, agile, resilient, and green supply chain practices on organisational performance through mediating role of big data analytics', *Int. J. Procurement Management*, Vol. 22, No. 1, pp.81–103.

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1 Introduction

Lean, agile, resilient, and green supply chain (LARG-SC) practices are considered an integrated approach, which has affected industries in a positive way to compete and survive in tough business-environment conditions (Aisyah et al., 2021). LARG-SC practices help organisations to manage their activities in an efficient and effective way to enhance their overall performance (Anvari, 2021). However, as business environment is constantly changing, organisations need to enhance their analytical capabilities in order to continue operations during extreme market disruptions, such as COVID-19 (Jain et al., 2022; Gulfraz et al., 2023), and make quick and efficient decisions (Janatyan et al., 2019). COVID-19 implications and lockdowns (Nduhura et al., 2021) hit the organisational supply and demand sides (Pal and Altay, 2022; Chowdhury and Ghosh, 2022), which affected their steady flow revenue (Botlhale, 2022) and required organisations to implement emerging technologies to facilitate operational efficiencies (Metawa et al., 2021).

The important role that digital technology has played during COVID-19 (Jain et al., 2022; Alhiary, 2023) shifted the focus towards digitalisation era in business processes towards Industry 4.0 (Liu et al., 2022). The implementation of Industry 4.0 technologies, such as big data analytics (BDA), is essential (Barakat et al., 2023b) as it was recently identified in the top three of investment priorities to improve organisational revenue and to create customer value (Gurumurthy et al., 2020), through improving organisational products/services (Ashrafi and Zare Ravasan, 2018). This improvement is achieved through helping organisations create huge amounts of data from different sources and share them at high speed to various points to identify patterns and relationships (Jha et al., 2020; Mageto, 2021) in order to manage and analyse new insights for organisational decision-making processes (Jha et al., 2020; Mageto, 2021). This in return allows organisations to identify suitable ways to reduce inventory costs and communication gaps, in addition to monitoring equipment based on transmitted data, and to provide transparency along SC processes (Ammar et al., 2021).

Because of the benefits of LARG-SC practices and BDA, it can be argued that the integration between them can help in facilitating the SC processes, maximising organisational revenues, creating better consumers' value, and enriching organisational performance. This research focuses on investigating the impact of LARG-SC practices on

organisational performance through BDA in emerging markets, particularly Egypt, through utilising dynamic capabilities view (DCV) and resource-based view (RBV). This will help in extending both theories, especially that the impact of LARG-SC practices on organisational performance needs future investigation in emerging markets (Balakrishnan and Ramanathan, 2021). The operationalisation of these two theories by the research construct will help in exploring two research questions:

1 What are the LARG-SC practices that can be critical antecedents of BDA and organisational performance?

2 How do LARG-SC practices affect organisational performance through BDA?

The relationship between these construct requires further research as the focus of previous research was on some of the SCM paradigm, for instance, (i.e., lean and agile) (Raji et al., 2021b) and (i.e., lean and green) (Raut et al., 2021) and their impact on organisational performance and sustainability. Furthermore, previous studies, such as (Tortorella et al., 2020), revealed the importance of digital technologies, particularly Industry 4.0 implementation on operational performance of manufacturing companies. Moreover, Tortorella et al. (2019) revealed that Industry 4.0 implementation moderates the positive impact of lean production practices on operation performance as well as identified that lean production practices lead to better operation performance in manufacturing companies. Additionally, Tortorella and Fettermann (2018) and Shahin et al. (2016) exposed that lean practices lead to better organisational improvement and operational performance. Also Marodin et al. (2018) investigated the positive impact of lean practices on operational performance (i.e., quality and inventory performance). Mandal (2018) and Dubey et al. (2019) tested the relationship between BDA and supply chain agility. Bag et al. (2021a) tested the relationship between BDA and reverse logistics and its dimensions, while Bag et al. (2021b) focused on BDA and sustainable manufacturing. However, none of these studies introduced organisational performance or used agility in LARG-SC context (adding other dimensions). Ali et al. (2020) tested the impact of lean and environmental sustainability practices on organisational performance. Han and Huo (2020) focused on green practices impact on organisational performance. However, both of these studies did not add BDA, resilience, or agility in the model. Salam and Bajaba (2022) tested the impact of marketing capabilities and resilience on organisational performance; however, resilience was not used in LARG-SC context, and BDA was not the focus of the study. Finally, Gu et al. (2021) tested the relationship between BDA and organisational performance; however, the focus was supplier development and not LARG-SC.

Based on the above, it can be argued that LARG-SC paradigms have extensively been researched independently, and it is important to emphasise on the integration of full paradigm and how it helps organisations to become more efficient and sustainable (Azfar et al., 2017).

Investigating the impact of digital technology and illustrating its impact on organisational performance in Egypt are important as the Egyptian market is not fully supporting digital business initiatives (Metawa et al., 2021). However, the potential of using it is very promising (Khalifa et al., 2021), as the Egyptian government targets digital transformation as one of the strategic objectives by 2030 (Metawa et al., 2021). Digital transformation offers the Egyptian market new and unique opportunities for businesses in several economic sectors, (i.e., financial sectors, retailing, healthcare,

agriculture, and manufacturing sectors) to create opportunities for enterprises, to impact inclusive development and growth, and to achieve faster growth (Metawa et al., 2021). Thus, there is still a need for empirical evidence in different socio-economic contexts to incorporate the organisational performance to support SCM practices among Industry 4.0 technologies implementation (Raji et al., 2021b). In addition, there is still a lack of research on empirically investigating the impact of LARG-SC paradigm on organisational performance, especially in Industry 4.0 technologies context (Balakrishnan and Ramanathan, 2021). This research will help in extending the theoretical lenses, DCV, and RBV, through empirically testing the relationships among the research variables using evidence from the Egyptian market (an emerging market) and focusing on different sectors. In addition, using the combination of LARG-SC practices, BDA and organisational performance was not covered in previous studies (e.g., Tortorella et al., 2020, 2019; Balakrishnan and Ramanathan, 2021; Raji et al., 2021b; Raut et al., 2021).

The remainder of this research is organised as follows: the following section reviews the literature, presents theoretical foundation, and forms a set of hypotheses that serve as the research model background; the third section outlines the methodology that the study follows, and the fourth section represents the research results and discussion, while the fifth section presents conclusion and research limitations and recommendations for further studies.

2 Conceptual foundation

The combination of lean practices and digital technologies can lead to enhancement of organisations' dynamic capabilities (Buer et al., 2021). Additionally, digital technology enhances the benefits of green activities and facilitates its adaptation (Chung and Lee, 2020; Mohamed et al., 2023; Chen and Liang, 2023), as it provides real time information (Chung and Lee, 2020; Ibusuki et al., 2023) and allows organisations to capitalise on environmental knowledge (Ayarkwa et al., 2020), which leads to enhancement of customer satisfaction (Andjelkovic and Radosavljevic, 2019) and eventually organisational performance (Andjelkovic and Radosavljevic, 2019, Bataineh, 2021; Vandchali et al., 2021). In general, it can be argued that digital technologies develop organisations resources and capabilities through allowing organisations to promote their analytical capabilities (Fernando and Mukui, 2023). Furthermore, because of BDA analytical capability, it can be argued that it can also magnify agility (Bag et al., 2021b) and resilience (Mandal, 2018) as it helps organisations respond quickly to market changes and build flexibility. In addition, this notion is supported by RBV and DCV, where RBV focuses on the internal resources of the organisations to keep sustainable competitive advantage in the marketplace (Collins, 2021), such as green and lean practices, while DCV theory focuses on the dynamic and changing market requirements (Barakat et al., 2023a, 2020) as well as consumers' expectations and behaviour and how organisations can cope with these changes through building dynamic capabilities (Zahra et al., 2022), such as resilience and agility, in addition to BDA through its ability to enhance organisations analytical capability (Hassanin and Hamada, 2022).

Thus, the combination of both theories helps organisations to use their internal resources wisely and efficiently, in addition to developing these resources in order to cope with the changes in the external environment and sustain their competitive environment (Chen et al., 2021). BDA importance comes from the fact that the only

constant thing in business is the changing environment (Narwane et al., 2021), where organisations need to efficiently and effectively acquire, analyse, and share huge amounts of information internally (organisation's departments) and externally (organisation's business partners) in high speed (Jha et al., 2020; Mageto, 2021; Sariyer et al., 2022; Morales-Serazzi et al., 2023) to identity risk (Arvidsson et al., 2021; Saeed et al., 2023; Zamani et al., 2022) and perform better decision making (Jha et al., 2020; Mageto, 2021; Sariyer et al., 2022; Choi et al., 2018), which in return enhances overall organisational performance (i.e., operational and financial performance) (Gupta et al., 2020). In addition, it enhances LARG-SC practices' benefits, such as elimination of wastes and cost and overall organisational capabilities (Gupta et al., 2020). Drawing on DCV theory (Zahra et al., 2022), it can be argued that BDA is considered as a source to develop organisations' resources to create distinctive competencies that allow organisations to sustain their performance in a dynamic business environment (Hassanin and Hamada, 2022).

Even though previous studies used RBV and DCV to test the relationship between some of the variables used in this research, the combined conceptualisation of the research variables was not previously covered. For example, Mandal (2018) and Dubey et al. (2019) used DCV to test the relationship between BDA and supply chain agility. Bag et al. (2021a) also used DCV to test the impact of BDA in reverse logistics and its dimensions, while Bag et al. (2021b) utilised RBV to test the impact of BDA on sustainable manufacturing. However, none of these studies introduced organisational performance or used agility in LARG-SC context. Ali et al. (2020) utilised RBV to test the impact of lean and environmental sustainability practices on organisational performance; however, BDA, resilience and agility was not added in the model. Han and Huo (2020) used RBV to test the impact of green practices on organisational performance. Salam and Bajaba (2022) utilised DCV and RBV to test the impact of marketing capabilities and resilience on organisational performance.

3 Literature review and hypothesis development

3.1 Mediating role of BDA between LARG-SC practices and organisational performance

Lean Practices have been generally translated into enhancing customer satisfaction through increasing value-added activities in order to enhance performance levels (Nath and Agrawal, 2020). This is achieved through a set of activities or solutions that focus on eliminating wastes, improving value-added activities, and reducing non-value-added operations (Dora et al., 2014). Lean practices can be achieved through just in time (JIT) approach and zero inventory strategy (Lyu et al., 2020), which have been developed and adopted by several organisations that wish to improve their overall performance on global and local scale (Shah et al., 2017). Previous studies identified the positive, significant impact of lean practices on firms' performance in research and development (R&D-based) manufacturers in Malaysia (Tan et al., 2022). Moreover, Tortorella et al. (2019) exposed the positive significant impact of lean manufacturing practices on operational performance of Brazilian manufacturing companies.

LARG-SC practices help organisations decrease their transportation time and production lead-time, improve level of integration between SC partners, and attain effective exchange of information (Alqudah et al., 2020). However, with the increase of multitudes of flowing information in and out of the organisational daily work; the importance of having a faster and more efficient ways to analyse organisational data, such as BDA, was recognised, as it assists in warehousing, manufacturing, procurement, transportation/logistics, demand management, and general SC activities (Govindan et al., 2018). BDA application helps organisations to organise warehousing activities, (i.e., order picking, storage assignment, inventory control) to investigate consumer behaviour and purchasing attitude in order to manage demand processes, (i.e., data sensing, data forecasting) (Raut et al., 2021).

LARG-SC practices help organisations eliminate waste, mitigate risks, and increase flexibility (Amjad et al., 2021). However, digital technology is essential to achieve organisational goals (Peter et al., 2020; Elkady and Samrat, 2021). The implementation of BDA, along with LARG-SC practices, can enhance overall organisational excellence (Amjad et al., 2021), as BDA provides deep data-driven insights about gaining competitive advantage (Wang et al., 2018), which helps organisations to take the full benefits of applying LARG-SC principles through synergising their application (Amjad et al., 2021). In this sense, it can be argued that adoption of BDA in manufacturing and transportation/logistics activities can result in a better organisational performance (Inamdar et al., 2021).

BDA is considered as a mature tool and technique for improving organisational performance (Zhong et al., 2015). It is one of the antecedents of innovation (ZareRavasan, 2023), competition, and productivity as well as the value derived towards organisational goals (Mikalef et al., 2018). Literature exposed that BDA deployment enables organisations to sense emerging opportunities and threats, generate critical insight, and adapt organisational operations based on trends observed in competitive business environment (Chen et al., 2012; Oduro et al., 2023). BDA has provided organisations with informed decision-making, as the managers nowadays focus more on real-time insights generated from BDA (Mikalef et al., 2019). Furthermore, the adoption of BDA in SC differs from one country to another. Present studies focused mainly on LARG-SC practices and BDA for SC (Nguyen et al., 2018). Based upon previous discussion, the following hypotheses and sub-hypotheses could be proposed:

H_1 BDA mediates the relationship between lean practices and organisational performance.

H_2 BDA mediates the relationship between agile practices and organisational performance.

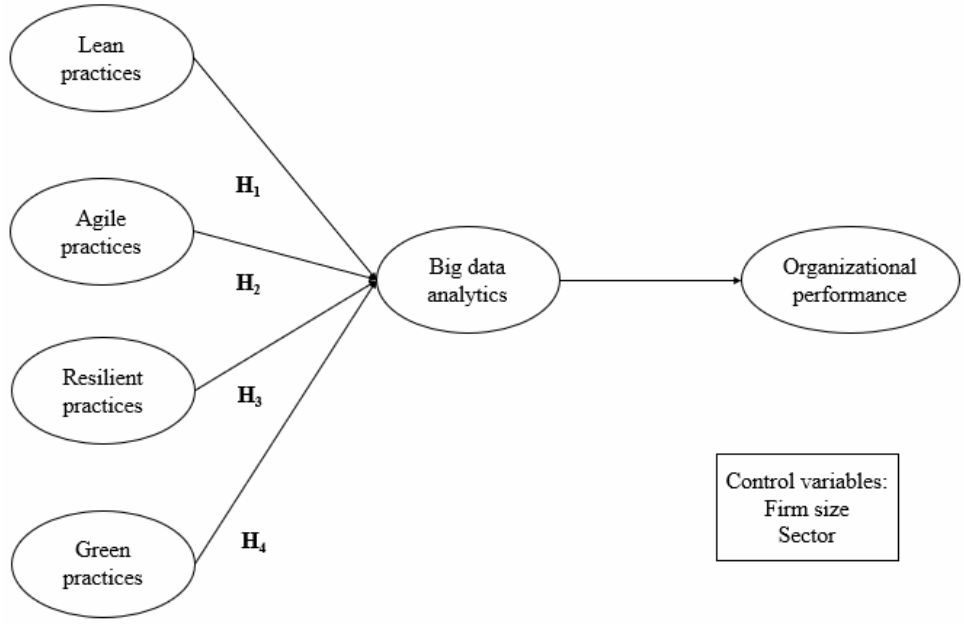
H_3 BDA mediates the relationship between resilient practices and organisational performance.

H_4 BDA mediates the relationship between green practices and organisational performance.

Based on the previous discussion and combination between RBV and DCV, it can be argued that lean, agile, green and BDA can be organised as organisational resources to be used in an efficient way, and the adaptation of resilience, BDA, and agile practices can

help organisation to adapt to the dynamic environment, which is aligned with DCV theory. Therefore, the hypothesised framework is developed and illustrated in Figure 1.

Figure 1 Hypothesised framework



4 Research methodology

4.1 Sampling and data collection

Due to the competitive environment and globalisation, SCM activities need to be optimised through reducing costs and providing rapid responsiveness to survive in the dynamic business environment. Illustrating for organisations' managers in Egypt the importance of using digital technology in enhancing organisations' capabilities and eventually its performance is important, as the business environment in Egypt is not fully supporting embracing digital technologies (Metawa et al., 2021). However, the Egyptian business environment bounces its promising indicators to go for digitalisation era and implement artificial intelligence (AI) in order to provide more successful and error-less environment (Khalifa et al., 2021) and achieve the Egyptian vision 2030 for digital transformation (Metawa et al., 2021). Thus, this research has collected data from an emerging market, particularly Egypt.

To validate and test the hypothetical framework, a self-administrated questionnaire was used to collect the data required from December 2021 to January 2022, where the research participants have senior management positions with at least ten years of experience. The rationale for choosing senior management positions as research

respondents lies in their knowledge and reliable information they have about their organisations as well as their ability to complete the questionnaire. Senior managers are responsible for achieving the organisations' goals and ensuring the efficient use of resources. In addition, they are responsible for evaluating subordinates and overall organisational performance. Finally, they ensure the achievement of the organisations' goals in a dynamic business environment (Bangchokdee and Mia, 2016). Data were mainly collected from manufacturing and service organisations located in the three governorates: Cairo, Alexandria, and Giza as they are considered to be holding the majority of business in Egypt (Aboelmaged and Hashem, 2019).

The technique of snowball sampling was adopted for both pilot and main study. The researchers distributed a total of 250 surveys for the pilot study using online-based questionnaires. A total of 230 respondents replied with eight incomplete questionnaires and 222 complete questionnaires, with a response rate of 88.80% for pilot study. While a total of 750 online-based questionnaires were distributed for the main study, and a total of 645 questionnaires were collected with 23 incomplete questionnaires and 622 valid questionnaires, with response rate of about 82.93%. The table (Table 1) illustrates the sample characteristics of the main study's respondents.

Table 1 Sample characteristics of the main study's respondents

Characteristics	*Sub-characteristics*	*Frequency*	*Percentage*
Firm size (employees)	10–50	179	28.8%
	51–250	123	19.8%
	> 250	320	51.4%
City	Cairo	178	28.6%
	Alexandria	209	33.6%
	Giza	200	32.2%
	Others	35	5.6%
Sector	Manufacturing	289	46.5%
	Service	333	53.5%
Years of experience	10–20	297	47.7%
	> 20	325	52.3%
Gender	Male	274	44.1
	Female	348	55.9
Education	Bachelor's degree	201	32.3
	Bachelor's degree and professional diploma	220	35.4
	MSc	138	22.2
	PhD	63	10.1
Age	30–40	48	7.7
	41–50	283	45.5
	51–60	141	22.7
	60–65	150	24.1

Table 2 Questionnaire items

Research variable	*Code*	*Statement*	*Reference*
Lean practices	LP1	Your organisation adopts lean practices effectively	Raut et al. (2021)
	LP2	Your organisation follows principles to minimise seven wastes	
	LP3	With lean practices, your organisation can develop value-added SC	
	LP4	Your organisation has successfully implemented JIT and pull system	
	LP5	Due to lean practices, there is reduction in lead time in your organisation	
	LP6	Cellular manufacturing/group technology minimises material movement in your organisation	
	LP7	Your organisation is compatible for mass customisation	
	LP8	Lean practices help in standardisation in work and operation in your organisation	
Agile practices	AP1	Your organisation responds quickly to changes in aggregate consumer demand	Tallon and Pinsonneault (2011) and Ashrafi et al. (2019)
	AP2	Your organisation customises a product/service to suit an individual customer	
	AP3	Your organisation reacts to new product or service launches by competitors	
	AP4	Your organisation introduces new pricing schedules in response to changes in competitors' prices	
	AP5	Your organisation expands into new regional or international markets	
	AP6	Your organisation continually strives to change, (i.e., expand or reduce) the variety of products/services available for sale	
	AP7	Your organisation adopts new technologies to produce better, faster, and cheaper products and services	
	AP8	Your organisation switches suppliers to avail of lower costs, better quality or improved delivery times	
Resilient practices	RP1	Your organisation is able to adequately respond to unexpected disruptions by quickly restoring its product flow	Golgeci and Ponomarov (2013)
	RP2	Your organisation quickly returns to its original state after being disrupted	
	RP3	Your organisation can move to a new, more desirable state after being disrupted	

Table 2 Questionnaire items (continued)

Research variable	*Code*	*Statement*	*Reference*
Resilient practices	RP4	Your organisation is well prepared to deal with financial outcomes of supply chain disruptions	Golgeci and Ponomarov (2013)
	RP5	Your organisation has the ability to maintain a desired level of control over structured and function at the time of disruption	
	RP6	Your organisation has the ability to extract meaning and useful knowledge from disruptions and unexpected events	
Green practices	GP1	Your organisation must balance environmental and social benefits	Raut et al. (2021)
	GP2	Your organisations focus on improving recycling efficiency in your organisation	
	GP3	Your organisations focuses on minimises environmental cost in your organisation	
	GP4	Your organisations focus on eco-packaging	
	GP5	Your organisation is focusing on reduction of carbon footprints	
	GP6	Your organisation is striving for standardisation	
Big data analytics	BDA1	Your organisation is capable of parallel computing to address voluminous data	
	BDA2	Real-time assess of data and information has helped your organisation in better decision making	
	BDA3	System is capable to handle semi-structured and unstructured data in your organisation	
	BDA4	Truthfulness and accuracy of data has helped your organisation	
	BDA5	Data driven intelligence has made decision making in your organisation more effective	
	BDA6	Your organisation has good infrastructure and facilities	
	BDA7	Interchange ability of services (cloud, mobile, and analytics) plays key role in your organisation	
	BDA8	Analytics personnel are proficient in your organisation with programming, data management, new tools, etc.	
Organisational performance	OP1	Market position is improved in your organisation	El-Kassar and Singh (2019)
	OP2	Your organisation enhances its sale volume	
	OP3	Your organisation enhances its profit rate	
	OP4	Your organisation enhances its reputation	

4.2 Survey instrument and design

This research adopted questionnaire-based survey method to capture causal relationships between research variables, and the data were collected using structured questionnaires. In this research, the instruments of questionnaire were adapted from previous research studies. The questionnaire is divided into four sections, where Section (1) illustrates demographic characteristics of research respondents, including firm's size, years of experience, firm's operating sector, and firm's location as mentioned in Table 1. It is important to mention that firm sector and size are serving as a control variable. Section (2) is classified into four sub-sections for LARG-SC practices (lean, agile, resilience and green practices), whereas Section (3) and (4) represent BDA and organisational performance, respectively. All measurement items were assessed using a seven-point Likert scale, ranging from one (totally disagree) to seven (totally agree). Furthermore, the questionnaire has been translated into Arabic from English version, and then a back translation process was carried out. The table (Table 2) summarises the questionnaire items along with references after pilot analysis results.

Table 3 Pilot analysis based on CFA

Construct	*Items*	*Factor loadings*	*CR*	*AVE*
Lean practices	LP1	0.850	0.873	0.634
	LP2	0.713		
	LP3	0.812		
	LP4	0.803		
Agile practices	AP1	0.807	0.874	0.583
	AP2	0.700		
	AP3	0.731		
	AP4	0.717		
	AP5	0.852		
Resilient practices	RP1	0.745	0.892	0.674
	RP2	0.832		
	RP3	0.896		
	RP4	0.803		
Green practices	GP1	0.798	0.885	0.659
	GP2	0.726		
	GP3	0.892		
	GP4	0.823		
Big data analytics	BDA1	0.832	0.866	0.619
	BDA2	0.706		
	BDA3	0.744		
	BDA4	0.856		
Organisational performance	OP1	0.762	0.841	0.639
	OP2	0.824		
	OP3	0.811		

4.3 Pre-test and pilot study

The questionnaire was presented to 6 experts (3 academic and 3 practitioners), in order to ensure face validity and translation accuracy. A pilot study was conducted using 622 valid questionnaires, in order to ensure the reliability and validity of the data collected instrument. In order to assess the validity and reliability of collected data, confirmatory factor analysis (CFA) was adopted. According to the CFA, all items with factor loadings (FL) less than 0.4 were removed (Sarstedt et al., 2014). In addition, the panel of experts in the pre-test was consulted regarding the elimination of these four items. After their feedback and according to the statistical results, the four items were removed from the questionnaire that will be distributed in the main study. Furthermore, since the constructs in this study are reflective and not formative, items can be deleted based on FL (Sarstedt et al., 2014). Table 3 illustrates the CFA analysis of the pilot study.

The model fit indices were evaluated to the final research model that contained 24 items to confirm the overall fitness of the model, where p-value should be less than 0.01, GFI and AGFI should be more than 0.8, and NFI, IFI, TLI, and CFI should be more than 0.9, as recommended by (Kamble et al., 2021). The model fit indices were demonstrated in the following table (Table 4).

Table 4 Model fit indices for pilot study

Fit indices									
Chi-square (X^2)	*P-value*	*Degree of freedom (df)*	X^2/df	*GFI*	*AGFI*	*NFI*	*IFI*	*TLI*	*CFI*
316.707	0.000	233	1.359	0.898	0.868	0.904	0.973	0.967	0.972

5 Research findings

5.1 Common method bias and non-response rate

Common method bias was tested through single factor test (Jha and Alam, 2022), where it exposed that no single factor exceeded the 50% in variance explanation (Mani and Gunasekaran, 2018). Secondly, non-response bias was tested through comparing significant differences between late and early responses, where the results indicated that there is no non-response bias as the P-values were more than 0.05 (Bhatt and Chakraborty, 2021). Then, measurement model testing and structural model testing are illustrated in the coming sub-sections.

5.2 Measurement model testing

The testing of research hypotheses was carried out through covariance-based structural equation modelling (CB-SEM). CFA was carried out to assess reliability and validity of the measurement model. Firstly, the reliability analysis was measured by the CR indicator, where all constructs exceed 0.7. Secondly, convergent validity was assessed through FL, where all items exceed 0.4. Moreover, the AVE for each item exceeds 0.5. Therefore, the results of reliability and convergent validity were demonstrated in Table 5.

Table 5 Reliability and convergent validity for main study

Construct	*Items*	*Factor loadings*	*CR*	*AVE*
Lean practices	LP1	0.688	0.808	0.514
	LP2	0.695		
	LP3	0.757		
	LP4	0.725		
Agile practices	AP1	0.804	0.892	0.625
	AP2	0.779		
	AP3	0.714		
	AP4	0.833		
	AP5	0.816		
Resilient practices	RP1	0.677	0.842	0.573
	RP2	0.688		
	RP3	0.812		
	RP4	0.837		
Green practices	GP1	0.874	0.898	0.687
	GP2	0.813		
	GP3	0.826		
	GP4	0.801		
Big data analytics	BDA1	0.857	0.897	0.686
	BDA2	0.854		
	BDA3	0.876		
	BDA4	0.716		
Organisational performance	OP1	0.885	0.900	0.750
	OP2	0.863		
	OP3	0.849		

The previous table mentioned that all constructs' items reached a statistically adequate level. Thus, the discriminant validity will be tested through comparing square root of AVE with correlations between research constructs in Table 6.

Table 6 Discriminant validity of the main study

	LP	*AP*	*RP*	*GP*	*BDA*	*OP*
LP	(0.717)					
AP	–0.240	(0.790)				
RP	0.208	–0.372	(0.757)			
GP	–0.023	–0.072	0.050	(0.829)		
BDA	0.018	0.319	–0.024	0.055	(0.828)	
OP	0.033	–0.065	0.136	0.432	0.137	(0.866)

Note: Diagonal numbers between brackets represent square root of AVE.

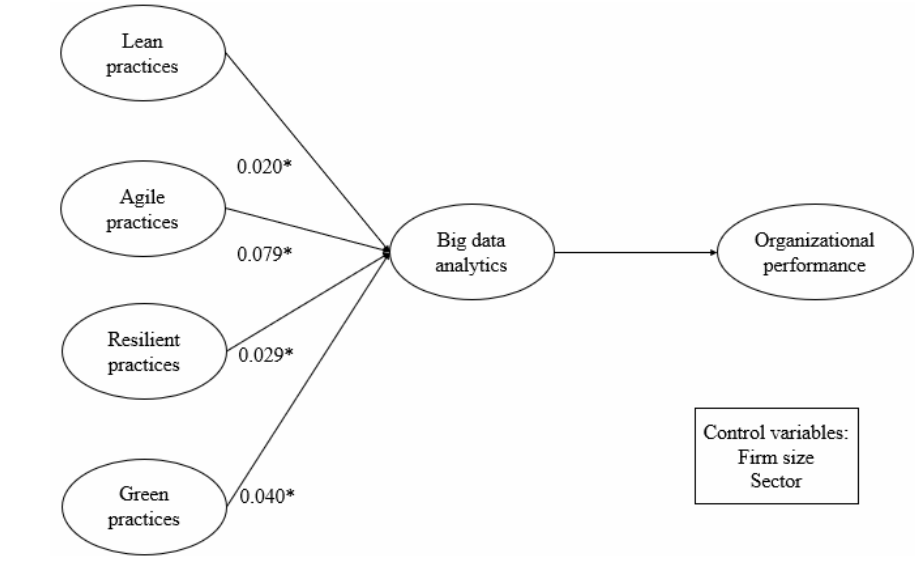
5.3 Structural model testing

After testing the measurement model, the structural model will be tested through model fit indices illustrated in the following table (Table 7), where all results confirmed the overall fitness of research model through achieving an acceptable level that showed reasonable fit values with no substantive differences. Therefore, the hypothesised framework illustrated in Figure 1 is considered an acceptable representation for the entire set of causal relationships.

Table 7 Model fit indices for the main study

Fit indices									
Chi-square (X^2)	*P-value*	*Degree of freedom (df)*	*X^2/df*	*GFI*	*AGFI*	*NFI*	*IFI*	*TLI*	*CFI*
555.759	0.000	271	2.051	0.937	0.918	0.936	0.966	0.959	0.966

Figure 2 Results of research model



Note: *means indicates a significant level at 5%.

Table 8 Research hypotheses testing

Path	*Hypothesis testing*
Lean practices → big data analytics → organisational performance	H_1 – accepted
Agile practices → big data analytics → organisational performance	H_2 – accepted
Resilient practices → big data analytics → organisational performance	H_3 – accepted
Green practices → big data analytics → organisational performance	H_4 – accepted

Figure 2 exposed the estimated path coefficient and significant level along with structural model. The results indicated that there is a direct, significant relationship between lean, agile, resilient, and green practices and organisational performance through BDA, where (β = 0.020 and p-value < 0.05; β = 0.029 and p-value < 0.05; β = 0.079 and

p-value < 0.05; $\beta = 0.040$ and p-value < 0.05), respectively. This means that H_1, H_2, H_3 and H_4 are accepted. Table 8 illustrates a summary for hypotheses testing.

6 Discussion and conclusions

This research aimed at exploring the impact of lean, agile, resilient, and green practices on organisational performance in both manufacturing and service sectors in Egypt through the mediating role of BDA. Based on literature review and the theoretical lenses RBV and DCV, the research model was developed. Based on the empirical evidence, it can be concluded that BDA can mediate the relationship between LARG-SC practices and organisational performance.

The significant mediating role of BDA between LARG practices and organisational performance confirms the notion that BDA allows for an instant flow information among supply chain members, which enhances visibility and decision making (Jha et al., 2020; Mageto, 2021), which in return facilitates LARG-SC practices and leads to better organisational performance (Gupta et al., 2020). Even though the combination of LARG-SC practices and their impact on BDA was not explored in previous research, (i.e., Balakrishnan and Ramanathan, 2021; Raji et al., 2021b), the positive and significant influence of LARG-SC practices (lean, agile, green and resilience) on BDA can still be supported by empirical studies, (i.e., Dubey et al., 2016; Gunasekaran et al., 2017; Raut et al., 2021; Jeble et al., 2018; Raji et al., 2021a), where the focus was on only one LARG-SC practice: agility (Raji et al., 2021a) or resilience (Amjad et al., 2021) and their impact on Industry 4.0 technologies (Raji et al., 2021a; Amjad et al., 2021). Finally, the positive and significant impact of BDA on organisational performance was supported by the findings of Fosso Wamba et al. (2020), Gu et al. (2021) and Ying et al. (2021), where the authors exposed the positive and significant impact of BDA on organisational performance.

Based on the previous results and discussion, the present research has empirically investigated and confirmed the underlying mechanisms for lean, agile, resilient, and green practices, BDA, and organisational performance with a dataset collected from Egyptian context, where this research worked to fill the research gap and respond to research calls on investigating the conceptualised framework linking LARG-SC paradigm and Industry 4.0 technologies (Amjad et al., 2021). Moreover, previous studies focused on investigating each practice separately on different markets; however, this research filled the gap through survey-based approach to strengthen the framework with each LARG-SC constituent. Furthermore, this research discusses the mechanism of LARG-SC practices, BDA, and organisational performance from the perspective of DCV and RBV, where the study examines the impact and relationship between such variables, which enriches the existing literature on SCM context and extend theoretical theories through empirical results.

6.1 Theoretical contribution

The developed hypotheses were tested while controlling for firm size and business sector, which helps in extending the two theoretical lenses RBV and DCV, especially that the relationship between LARG-SC practices and organisational performance needs future

investigation in emerging markets (Balakrishnan and Ramanathan, 2021). In addition, this research answers the call of Amjad et al. (2021) and Raut et al. (2021) as the authors asserted that there is a need for empirical studies linking LARG-SC practices to Industry 4.0 technologies, (e.g., DBA) and the importance of this synergy to enhance overall organisational performance. Previous studies highlighted the importance of LARG-SC practices on organisational performance, and also the impact of lean and green practices on organisation performance was conducted separately, (e.g., Raji et al., 2021b; Raut et al., 2021); however, this paper integrated the full paradigm (lean, agile, resilient, green) and investigated its impact on overall business performance of the organisations through mediating the impact of implementation of BDA based on calls suggested from (Balakrishnan and Ramanathan, 2021; Raji et al., 2021a).

6.2 Practical contributions

This research has shed light on the importance of combining LARG-SC practices and BDA in order to enhance organisational performance in a developing country. The Egyptian business environment is still in the early stages in the digital transformation era (Metawa et al., 2021). This research will help decision makers in Egypt and similar developing countries to promote the use of technology and help in achieving the transition toward digitisation era (Khalifa et al., 2021), which will help the Egyptian government achieve its vision 2030 of digital transformation (Metawa et al., 2021). In addition, it will help organisations in Egypt to cope with the dynamic business environment, enhance their competitive advantage, and allow them to compete in the international markets. In return, this will help organisations enhance their exports and increase overall economic growth. This study will guide supply chain professionals and practitioners to identify the critical factors that affect their overall performance through BDA implementation. It also emphasises on green practices' role in enhancing organisational performance in a dynamic business environment, which will push organisations to adopt green practices, especially that environmental practices were not the main focus after COVID-19 pandemic, as governments were focusing on quick economic recovery.

6.3 Limitation and recommendations for future research

This research focuses on investigating the impact of LARG-SC practices on OP through the mediating role of BDA in Egypt. Future research studies could focus on several directions: the proposed model could be replicated for micro and entrepreneurial/startup enterprises in Egypt. In addition, organisational performance could be extracted into several dimensions, (i.e., operational, market, financial performance) as well as other Industry 4.0 technologies, rather than BDA, could be involved in future studies. Even though this study used firm size and business's type as control variables, generalisability is still an issue, where the developed framework could be carried out for other developed/developing countries to establish a more generalisable framework. Moreover, a longitudinal study could be carried out to offer more in-depth understanding of the dynamic relationships between the research variables. Finally, a qualitative study is needed to provide steps for organisations in Egypt of how they can train their employees and acquire funding to implement new technologies in order to enhance their capabilities and eventually their performance.

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