Impact of big data analytics capabilities on supply chain sustainability

A case study of Iran

Sajjad Shokouhyar, Mohammad Reza Seddigh and Farhad Panahifar
Department of Management and Accounting, Shahid Beheshti University, Tehran, Iran

Received 7 June 2019
Revised 8 September 2019
Accepted 3 October 2019

Abstract

Purpose – The purpose of this paper is to develop a theoretical model to explain the impact of big data analytics capabilities (BDAC) on company's supply chain sustainability (CSCS). The secondary objective of the study is to assess the relationship between different dimensions of supply chain sustainability and companies' BDAC.

Design/methodology/approach – This research was carried out by conducting a survey among 234 pharmaceutical companies in Iran (a case study of Iran), using a standard questionnaire of BDAC and United Nations (UN) online self-assessment on supply chain sustainability. However, the respond of managers of 188 companies were usable in this research. Smart PLS3 was used to employ partial least squares method to examine the validity and reliability of the measurement and structural model.

Findings – The results of this study demonstrate that BDAC have a strong impact on both pharmaceutical supply chain sustainability, and the dimensions including vision, engage and internal. It is found that the relationships between BDAC and the other dimensions of supply chain sustainability including expect, scope and goals are not significant but positive.

Research limitations/implications – Research on the relationship between BDAC and CSCS, especially in the pharmaceutical supply chain, is scanty, and this gap is highlighted in developing countries and the pharmaceutical supply chain that plays a prominent role in public health. This paper discusses several important barriers to forming a sustainable supply chain and strong BDA capabilities.

Practical implications – This paper could be a guide to managers and consultants who are involved in big data analytics and sustainable development. Since UN urges companies do the online self-assessment, the results of this paper would be attractive and useful for UN global compact specialists.

Originality/value – No study has directly measured the relation between BDAC and CSCS and different dimensions of CSCS, using a comprehensive survey throughout all pharmaceutical companies in Iran. Moreover, this research assesses the different dimensions of BDA capabilities and supply chain sustainability. This paper represents the facts about situation of sustainability of pharmaceutical supply chain and BDAC in these companies, and discloses several related issues that are serious barriers to forming a sustainable supply chain and strong BDAC. In addition, this paper provided academic support for UN questionnaire about CSCS and used it in the survey.

Keywords Sustainable development, Pharmaceutical supply chain, Big data analytics, Global compact, Supply chain issues

Paper type Research paper

1. Introduction

Due to exploitation of natural resources, to accomplish economic growth, and poor policies in terms of reprocessing or disposing industrial wastes in many counties, human will encounter different issues such as natural resources scarcity, more environmental pollution and many other problems (Winston, 2014). So that it turned into a global concern. Thus, many researchers and international organizations discussed the topic of sustainable development. Sustainable development is defined as managing the processes for achieving goals such as economic and social development, in which there is no depletion or destruction of natural resources, sustaining the ability of natural systems to provide services and resources, and avoiding contamination of the environment on which the economy and society depend

World Journal of Science, Technology and Sustainable Development
Vol. 17 No. 1, 2020
pp. 33-57

2042-5945
DOI 10.1108/WJSTSD-06-2019-0031

(Hak *et al.*, 2016). In this respect, the document of sustainable development goals (SDGs) was adopted at the United Nations (UN) sustainable development summit in New York City, USA in September 2015. There is a collection of 17 global goals set by the UN. Indicating that "Transforming our World: the 2030 Agenda for Sustainable Development." That has been shortened to "2030 Agenda." The goals are broad and interdependent; each has a separate list of targets to achieve (United Nations Sustainable Development Summit, 2015). The United Nations Global Compact is a UN pact to encourage businesses worldwide to adopt sustainable and socially responsible policies, and to report on their implementation. Under the Global Compact, companies that are different members of supply chain are brought together with UN agencies to follow particular principles and have commitment to make their corporate and the whole supply chain, sustainable (Brown *et al.*, 2016).

In the recent years, the volume of data in the world is increasing sharply. This flood of digital data is known as Big Data (BD) (Gandomi and Haider, 2015). BD have been defined primarily with five characteristics: volume of data, variation of data, velocity (referring to frequency or speed by which data is generated and delivered), data quality and value (referring to the benefits from the analysis and use of BD) (Wamba *et al.*, 2015). Some researchers have emphasized that analyzing BD is a powerful approach to create competitive advantages for organization and is the key point of decision-making and the primary source for responsibility. This framework is called "Big data analytics" (BDA) (Wamba and Gunasekaran, 2017; Shokouhyar *et al.*, 2017). BDA is founded on the earlier data analysis methods using statistical techniques such as factor analysis, regression, correlations and many different statistical tests and machine learning (Iniesta *et al.*, 2016; Rezaei *et al.*, 2017). It includes data mining from high-speed data streams and sensor data to obtain real time analytics (Chen *et al.*, 2012). Thus, it is an interdisciplinary field, which uses the knowledge of computer science, data science, statistics and mathematical models. Considerable progress in data science now makes it possible to analyze BD in real time. New insights into the real life and facts from such data mining and analysis can be gleaned, which could complement official statistics and survey data could be gathered from different sources specially social networks such as Instagram (Shokouhyar, Siadat and Razavi, 2018). This new data and the traditional data must become integrated in order to produce high-quality information that is more accurate, timely and relevant (Wang and Kung, 2018).

Although there are many studies of different functions of BDA, sustainable development and supply chain and related subjects such as supply chain management, retailers and customer satisfaction (Shokouhyar *et al.*, 2018), there is not enough studies that measure the impact of BDA on sustainability of supply chain. Since health is a crucial issue in human life and pharmaceutical supply chain plays an important role in public health. This study focused on pharmaceutical supply chain. Iran as a developing country, owing to the increase of competition among various companies and demand for healthcare services, needs to be evaluated on sustainability. Thus, in order to fill the existing gap, the aim of this paper is to assess the impact of BDA capabilities (BDAC) on pharmaceutical supply chain sustainability and also its dimensions. So, the main questions of this research is raised as follows:

RQ1. How are BDA capabilities are measured and how much have Iranian pharmaceutical companies developed BDA capabilities?

RQ2. What are the different dimensions of supply chain sustainability and to what extent is Iranian pharmaceutical supply chain sustainable?

RQ3. Do BDA capabilities have a significant and positive impact on of supply chain sustainability of companies and its different dimensions?

The rest of this paper is structured as follows. First presents an overview of the major research and studies on BD and sustainable development. Second states theoretical

foundations and conceptual research model and hypotheses, the next part, includes research methodology. In the next part, presents discussion, limitations and direction for further research, and ultimately the paper finishes with drawing a conclusion.

2. Literature review and research background

2.1 Sustainable development

The concept of sustainability was formally defined in 1987 after the World Commission on Environmental and Development (WCED) published the Brundtland Report titled "Our Common Future." In this report, the commission introduced sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Years later, Elkington (1994) reshaped the three dimensions, defining them as "People, Planet and Profits." Sustainable development is a very attractive topic among social and economic scientists, environmental conservation practitioners and experts. In this respect, there is a huge number of papers, guidelines, reports, and books throughout the world; and numerous conferences are being held. Creating motivation for social sustainability is extremely essential, there are five main categories of motivators in healthcare supply chain that are Attitude, Organizational Practice, Technology and Innovation, Excellence and Awards and Media and Reputation (Hussain *et al.*, 2018). In addition to motivation, clear frameworks and practical plan is expected, especially the boundary works for sustainable development must be determined. Different types of boundary works have been introduced based upon items like enlightenment, decision and negotiations and different strategies are required to organize each distinctive kinds of boundary work properly (Clark *et al.*, 2011). Many researchers attempted to develop models for sustainable development management and global business organizations and recognized necessary attributes for their models (Sealy *et al.*, 2010). As for the frame work of pharmaceutical supply chain, there is an emphasis on sourcing of primary materials, features of suppliers (Low *et al.*, 2016) which is crucial to produce sustainable products (Arabi *et al.*, 2017). According to the work of Hueting (2011), green supply chains must have certain conditions to become environmentally sustainable; and the choices between production growth and safeguarding is emphasized. Science and technology should form effective frameworks for UN 17 SDGs and 169 targets and for developing this framework in-depth understanding of the concept of sustainable development and technological change is indispensable (Imaz and Sheinbaum, 2017). There are more academic papers in this respect, which will be reviewed in hypotheses development and research model section to provide strong academic support for UN questionnaire.

2.2 Big data analytics

Recently, the topic of BDA has attracted many researchers because the ability to analyze large amounts of data and extract useful information has resulted in revolution in a wide range of industries (Bilal *et al.*, 2016). Some researchers believe BDA can be used to solve a wide range of issues and could be a game changer and significantly improves firm performance (Wamba and Gunasekaran, 2017; Jeble and Dubey, 2017; Gupta and George, 2016). In fact, BDA systems creates competitive advantage against rivals and enhances enterprise agility (Côrte-Real and Oliveira, 2016). Based on the research by Ajayi *et al.* (2019), in which the relation between BD platform and safety accident prediction was assessed. This paper results showed that a significant improvement was obtained in information management. BDA can be tremendously helpful for uncertainties and analyzing batter vague situations (Wu *et al.*, 2015). Analyzing BD also can be used for prediction, the frame work is called big data predictive analytics which significantly improves operational and strategic abilities in supply chain (Hazen and Skipper, 2018). Future opportunities and challenges of BDA systems also

must be taken into account (Zhong, 2016). Thus, it is very essential to understand the types and constructs of BDA and classify different frameworks (Nguyen *et al.*, 2016). Wang and Kung (2018) identified five BDAC, from carrying out content analysis of several BD implementation cases in the field of health care, the five BDA capabilities they introduced are analytical capability for patterns of care, unstructured data analytics capability, decision support capability, predictive capability and traceability. They also suggested several strategies for healthcare organizations. In addition, obtaining BD alone, does not mean gaining useful and informative data, because powerful analytic methods and tools are required to interpret BD properly and turn it into high quality information (Jeble and Dubey, 2017; Gupta and George, 2016; Bowman, 2018). It is important to consider the role of statistics and machine learning as strong tools to analyze BD (Torrecilla and Romo, 2018; Iniesta *et al.*, 2016). To verity that statistics is a strong tool to deal with BD, researches discussed impact of several statistical methods to analyze the data gathered on environmental challenges. They stated that BDA could improve the life quality of people (Gupta and Mateu, 2018). However, a common problem that many statisticians face, is they do not know where to start and how to deal with BD (Qing Shi, 2018).

2.3 Big data analytics and sustainable development

Owing to sustainable development is a critical issue and analyzing BD was considerably helpful in different studies, researchers tried to measure the extent to which BDA could increase sustainability. In addition, green Information Technology (IT) services has been discussed (Shokouhyar *et al.*, 2017). According to the work of Cuquet and Fensel (2018), using BD enormously helped the economic, social and ethical, legal and political benefits in Europe which can be applicable to other places as well. Strong and reliable models are required to use BDA to forecast different situations. In fact, predictive analytics capabilities have a significant effect on environmental, social and economic performance of supply chain (Jeble and Dubey, 2017). Papadopoulos *et al.* (2017) developed a theoretical framework to assess resilience in supply chain with the use of BD. This paper argues that proper usage of BD is helpful for supply chain recuperation. However, BDA might have insufficiencies. In a case study in the banking sector, it was shown that some policies in terms of quality control and data gathering procedures need to be modified continuously. It was proved that statistical analysis has to be conducted on the newest collected data in order to obtain the best and timeliest information from the past. These findings imply data processing inefficiencies (Fuschi and Tvaronavičienė, 2014).

After a comprehensive review of the related papers, it could be said that there is not enough research and investigation into different dimensions of economic, social, and environmental sustainability in supply chain, especially in developing countries. Since pharmaceutical supply chain is tremendously important in healthy human life, a study about the relation between BDAC and sustainability in pharmaceutical supply chain is required, to provide more information and glean new insights into different aspects of BDA capabilities and various parts of sustainable pharmaceutical supply chain and measuring to what extent BDA capabilities could affect pharmaceutical supply chain sustainability.

3. Hypotheses development and research model

In order to make reasonable decisions on different issues of companies, decision makers must learn about the social, economic and environmental facts as much as possible. Managers must be able to gather accurate, timely, and complete data from different sources that are providing them with large and complex data (BD), and, then carry out the process of integrating, classifying, and analyzing big data (BDA), to provide the decision makers with the high quality information. BDAC is widely defined as a firm's ability to gather, integrate huge volume of data and deploy its BD-specific resources, which consists of infrastructure

(technology) and talent (personnel) capability to make business as competitive as possible (Wamba and Gunasekaran, 2017; Kiron *et al.*, 2014). BDAC contains three dimensions that are BDA infrastructure flexibility, BDA management capability and BDA personnel expertise capability. BDA infrastructure flexibility is the ability of the BDA infrastructure (e.g. applications, hardware, data and networks) to enable the BDA personnel to quickly develop, deploy and support necessary system components for a firm and is composed of connectivity, compatibility and modularity; BDA management capability refers to the BDA unit's ability to deal with routines in a structured manner to manage IT resources according to business priorities and consists of planning, investment, coordination and control (Kim *et al.*, 2012; Wamba and Gunasekaran, 2017); BDA personnel expertise capability refers to the BDA personnel's professional ability (e.g. skills or knowledge) to perform tasks assigned by chief managers and comprises technical knowledge, technology management capability, business knowledge and relational knowledge (Kim *et al.*, 2012; Wamba and Gunasekaran, 2017).

Supply chains, fulfill a crucial role in the sustainability of the world, since the major parts of social, economic and environmental interactions are conducted through different supply chains (Linton *et al.*, 2007). According to a paper on sustainability criteria, in spite of the increased focus on sustainable development in recent years, currently there are no standardized methods to guide companies in measuring sustainability (Gasparatos and Scolobig, 2012). Based upon statement of some researchers, "sustainability assessment is any process that aims to contribute to a better understanding of the meaning of sustainability and its contextual interpretation (interpretation challenge); integrate sustainability issues into decision-making by identifying and assessing (past and/or future) sustainability impacts (information-structuring challenge; foster sustainability objectives (influence challenge)" (Waas and Huge, 2014; Gasparatos *et al.*, 2008; Gibson *et al.*, 2005; Ness *et al.*, 2007; Pope, 2006; Bond *et al.*, 2012; Devuyst *et al.*, 2001). As Babcicky (2013) believe, the indistinct and multi-dimensional nature of sustainable development with its vagueness makes the measurement complicated.

Amongst several questionnaires to measure sustainability of supply chain, in different articles and websites, UN online-self assessment was selected; because, the questionnaire measures the same dimensions of supply chain sustainability as researchers introduced in literature; moreover, in contrast to other questionnaires, UN online self-assessment questionnaire, contains much more comprehensive introduction and explanation of the same dimensions, to make the respondents more knowledgeable and aware of the concept of supply chain sustainability and make sure the respondents know what they are responding to; since, sustainability means different things to different organizations (Jeble and Dubey, 2017). Furthermore, UN urges companies to carry out the online self-assessment and share the results (UN guideline, 2015). Therefore, introducing UN online self-assessment to all pharmaceutical companies in Iran, and sharing the results is useful for UN practitioners (UN Global Compact, 2018). The main hypothesis in this study is:

H1. BDA capabilities have a positive and significant impact on companies' supply chain sustainability.

In academic literature, researchers have assessed dimensions of supply chain sustainability. Some researchers believe that in order to achieve sustainability, a comprehensive vision about sustainability is required. They have mentioned several items such as gender equality, attention to morality, nutritional status of the meal served in the canteen and poverty reduction (Elkington, 1994; Svensson and Wagner, 2015; Wilson, 2015; Dubey *et al.*, 2016; Jeble and Dubey, 2017). In another study, researchers say supply chain visibility refers to the capability to access or share information, which is beneficial to supply chain processes and provides mutual benefits (Christopher and Lee, 2004). Plus, visibility and collaboration are required to obtain information and ultimately make better decisions

(Butner, 2010; Panahifar *et al.*, 2015) and as Wu and Pagell (2011), discussed the process of information sharing among the members in complicated supply chains network is highly challenging. Based upon the work of Kurniawan *et al.* (2017), greater visibility of important information from suppliers is an important factor to improving under-performing supply bases and decreasing the cost of internal inefficiencies. As an illustration, supply chain visibility, bridges the gap between planning and execution to ameliorate cost and resilience and proposes a complete view of the production process from outbound suppliers to the final customers. In accordance with an essay, an enhancement in visibility is positively correlated to reduced cost and increased business performance (Christopher and Lee, 2004). Another paper discussed that companies within a supply chain have to always enhance interactions with their partners to ensure visibility in improving efficiency and responsiveness to encounter a competitive market (Kaufmann *et al.*, 2012). As some researchers discuss, demand visibility increases manufacturing effectiveness (Christopher and Peck, 2004; Caridi *et al.*, 2010). Some researchers talk about engagement. They state supply chain network involves numerous players and the supply chain network is complex (Barratt and Oke, 2007; Brandon-Jones *et al.*, 2014; Gunasekaran *et al.*, 2017; Panahifar *et al.*, 2018). UN defines "Vision and objectives for supply chain sustainability" as the extent to which the company has understood the concept of sustainable development and has defined business visibility and plans to address its environmental, social and economic impacts in the supply chain. UN also declares that "Establishing supply chain expectations and requirements" means the extent to which the company has defined and communicated expectations and requirements for suppliers related to complying with relevant laws and regulations. UN defines the concept of "Engaging with suppliers and other businesses in the supply chain" as the extent to which, the company communicates and evaluates suppliers' capabilities and performance against expectations prior to starting the relationship (UN Global Compact, 2018). Based on these theoretical justifications the following hypotheses are stated:

H1(a). BDA capabilities have a positive and significant impact on vision and objectives for supply chain sustainability (Vision).

H1(b). BDA capabilities have a positive and significant impact on establishing supply chain expectations and requirements (expect).

H1(c). BDA capabilities have a positive and significant impact on engaging with suppliers and other businesses in the supply chain (engage).

Researchers also address to three challenges of sustainability that are interpretation, information structuring and influence (Waas and Huge, 2014). Some researchers discuss that implementation means that the sustainability discourse should be translated into actions (Boehmer-Christiansen, 2002). As Waas and Huge (2014) say, if sustainable development is to be a helpful approach, it must enter the field of decision-making.

Kurniawan *et al.* (2017), state that one approach to achieve supply chain effectiveness is to develop collaborative relationships with suppliers. To clarify, supplier development programs can remarkably help lessen risk and enhance efficiency and play an important role in promoting performance improvement and contribute strategically to the overall organizational effectiveness and enable companies to better apply their resources, enhance the value added and allow manufacturing firms to be more effective in facing changing needs. Therefore, outsourcing allows firms to exploit the capabilities and utilizes supplier technology to shorter product development and manufacturing cycle time in enhancing supply chain efficiency. Some researchers' opinion is that outsourcing operations are strategic responses to conditions of uncertainty and dependence from the shortage of resources within the organization (Hatonen and Eriksson, 2009; Malhotra, 2014). They emphasize that outsourcing operations enable the firm to manage labor and manufacturing more effectively to decrease overall

production cost. In general, the contingency theory suggests that magnificent performance of the company results from of the proper alignment of internal and external variables (Burns and Stalker, 1961; Lawrence and Lorsch, 1967). Wilson (2015), has introduced a framework to assess the impact of world class sustainable manufacturing practices (WSCM) on firm sustainability. This paper identified various practices such as leadership, regulatory pressure, supplier relationship management, employee involvement. In addition, some researchers recommend setting goals, communicating and discussing with the stockholders in terms of some issues like adopting adequate measures for reduction of air emission and for recycling wastewater, as well as preventing discharge of solid waste and preventing consumption harmful toxic materials (Elkington, 1994; Svensson and Wagner, 2015; Wilson, 2015; Dubey *et al.*, 2016). UN introduces "Determining scope of activities," that means the extent to which the company has established boundaries for company's supply chain strategy and implementation; since supply chain sustainability can be a very broad field. UN introduces the concept of "Assigning internal roles and responsibilities," by asking a question: Is there any senior executive in charge of leadership to build and develop the supply chain sustainability approach, in the company? Also states the meaning of "Creating goals and tracking and communicating performance" that is the extent to which the company has set goals related to the implementation of supply chain policies and programs and related to supplier performance (UN Global Compact, 2018). The following hypotheses represent such view:

H1(d). BDA capabilities have positive and significant impact on determining scope of activities (scope).

H1(e). BDA capabilities have positive and significant impact on assigning internal roles and responsibilities (internal).

H1(f). BDA capabilities have positive and significant impact on creating goals and tracking and communicating performance (goals).

In this online assessment, the respondents are asked to answer six multiple-choice questions which are associated with six criteria of supply chain sustainability. As Figure 1 shows, regarding to the different dimensions of BDAC and the six major dimensions of companies' supply chain sustainability maturity, this study assesses the relation between these two, and also measures the impact of BDA capabilities (BDAC) on different dimensions of companies' supply chain sustainability (CSCS).

4. Research method

4.1 Sample and data collection

Based on BDA and supply chain sustainability criteria in literature review and UN online self-assessment of companies' supply chain sustainability maturity, a standard questionnaire was designed. The questionnaire was pre-tested to ensure that the construction and format of the questionnaire was appropriate which yielded a standard deviation of 1.27. The researchers sent the questionnaire to 50 managers who were experts in terms of pharmaceutical supply chain (10 pharmacists of supplier companies, 18 pharmacists in the manufacturing companies and 22 pharmacists in distributor companies). In addition to the fact that the questionnaire was standard based on literature, the expert panel approved that it is entirely usable to Iranian pharmaceutical supply chain. Since the statistical population in this research is limited (there is only 512 chief managers in Iran pharmaceutical supply chain), based on statistical formula and confidence level of 95 percent, the calculated sample size is 396. The questionnaire was submitted through e-mail for 512 chief directors and chairpersons of all 234 pharmaceutical companies in Iran, so this research is a case study of Iran because the data are collected only from Iranian pharmaceutical companies. Also respondents were asked to send us a copy of UN online – self assessment results including scores, recommendations and all parts of their

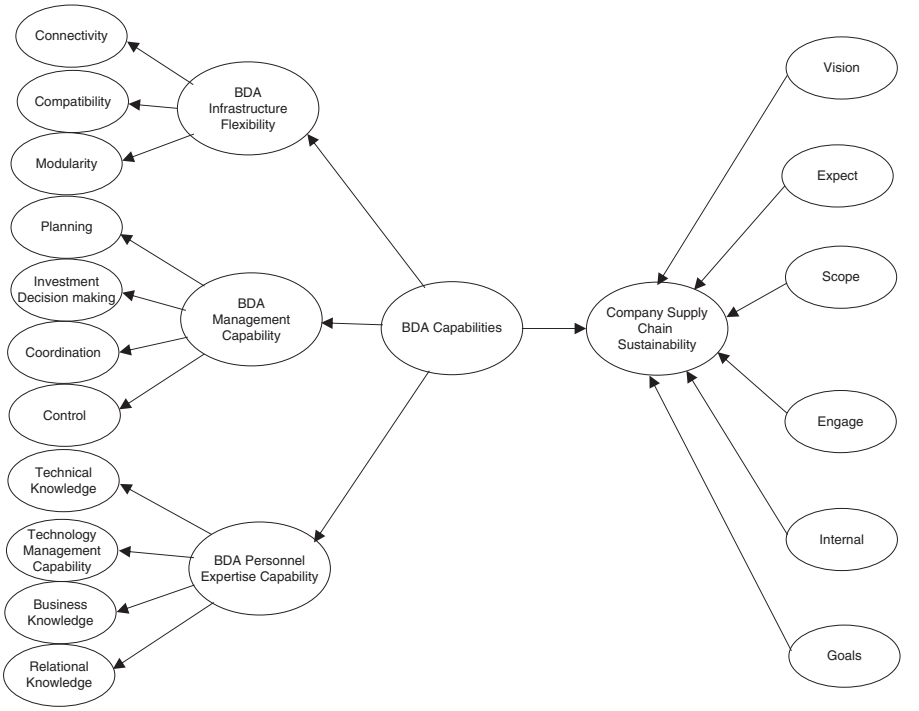

Figure 1.
Conceptual model

result page. After the end of the deadline as Baruch and Holtom (2008) suggest, in order to raise the response rate, company's visitors were assigned to remind the managers of different companies in addition, many reminder e-mails were sent to those managers who had not sent their responses, asking them to respond the questionnaire and send it back as soon as possible. After six months regular follow up and continuous reminding, 437 questionnaires were finally received with a response rate of 85.35 percent. After eliminating 29 incomplete questionnaires, 408 questionnaires from 188 companies were deemed accurate and usable (Tables I and II).

Considering Likert scale, respondents were asked to indicate the extent to which each item of BDA capability, is practiced in their organizations ranging from 1 (strongly disagree) to 5 (strongly agree). And also to capture economic, social, and environmental facts in pharmaceutical supply chain, respondents were asked to do UN online self-assessment,

Demographic variables	Level	Frequency (%)
Gender	Male	74
	Female	26
Educational background	Information technology	14
	Pharmacy (PharmD)	61
	Pharmacy (PhD)	6
	Economics	16
	Law	3
Position	Chief manager	100
Age	25–35	11
	36–45	46
	Above 46	43

Table I.
Demographics of respondents

Companies' properties	Level	Frequency (%)
Position in supply chain	Supplier	3.2
	Manufacturer	27.7
	Importer	55.9
	Distributer	13.2
Structure	Government-own corporation	7.4
	Privately held company	67.9
	Public company	24.7
Size	10–249 personnel	82.9
	250–4,999	16.9
	5,000 or more	0.2

Table II.
Companies' properties

and then share the results. The questionnaire included 41 questions about BDA capabilities to assess the companies' abilities to deal with social, economic and environmental issues using BDA; and also UN online self-assessment which consists of six major questions, the answer of each question ranges from 1 (no current action) to 5 (best practices) to measure the extent to which companies have understood the concept of sustainable development and have involved in developing sustainability in supply chain. It is important to mention that based upon the research frameworks suggested by Creswell (2003) collecting measurable data to conduct surveys in which statistical procedures can be applied is included in quantitative methods. Therefore, the methodology of this paper is quantitative.

4.2 Avoiding bias

In order to avoid bias, respondents were informed that their name and company's name are not required for the survey (Chong *et al.*, 2011). The survey comprises two main parts. In order to avoid non-response bias based upon the recommendation of Baruch and Holtom (2008) wave analysis was performed. The responses of early and late waves of returned surveys based on the assumption that the answers of late respondents are representative of the answers of non-respondents. According to the results, the differences between early-wave and late-wave groups was not statistically significant, demonstrating that non-response bias was not a problem in this research (Prajogo and McDermott, 2011(. In addition, it was tested whether the principal factor accounted for the majority of the variance explained. In order to identify a potential common method bias (Podsakoff and Organ, 1986). The correlation matrix (Table VI) shows that the highest inter-construct correlation is 0.773, while common method bias is usually reported by extremely high correlations ($r > 0.90$) (Bagozzi and Yi, 1988). Therefore, based on the results, common method bias is not a concern.

5. Data analysis

5.1 Data analysis method and tool

This paper, conceptualized the research model by developing a survey and validated the hypothesized relationships using partial least squares (PLS) based on structural equation modeling (SEM). In accordance with the work of Moqbel *et al.* (2013), the advantages of PLS algorithm are as follows "(1) a latent variable-based multivariate technique enabling concurrent estimation of structural and measurement models under nonparametric assumptions. (2) Variance-based SEM is a multivariate analysis technique that shares similarities with covariance-based SEM, but differs from it in that it builds on techniques, such as resampling, which do not require parametric assumptions to be met. (3) Variance-based SEM is more suitable when the criterion of multivariate normality is not met in a data set." For this purpose, according to the work of Kwong and Wong (2013), all tests were conducted using Smart PLS 3. Moreover, the model developed in this paper was assessed using this software.

5.2 Validity and reliability

Prior to testing the research hypothesis and the conceptual model, an examination of validity and reliability is necessary. Discriminant (divergent) validity is the extent to which a construct is truly distinct from other constructs. A high degree of divergent validity demonstrates that a construct uniquely captures the propensity of the represented concept that other constructs do not (Shi and Liao, 2012). Confirmatory factor analysis (CFA) and Cronbach's α coefficient are the major items to verify the validity and reliability of the conceptual model however, this paper also tested the reliability and validity through different tests.

5.3 Confirmatory factor analysis (CFA)

Discriminant validity and convergent validity were tested by CFA. In CFA, after diagnosing high and low factor loadings in different items, the numbers of CFA are shown in Table III. The dimensions invest and planning were eliminated from the management capabilities of the second order; and finally BDA personnel expertise capability of the third order was removed from the model.

5.4 Cronbach's α coefficient

Cronbach's α coefficient was measured to assess the reliability of the two parts of the questionnaire, i.e. BDAC and CSCS items; which are shown in Table III. When the Cronbach's α coefficients are greater than the 0.7 threshold, which is considered acceptable for internal scale reliability (Nunnally, 1978).

5.5 Standardized loadings of the latent constructs

The BDA capabilities model is a third-order model with 3 second-order constructs and 11 first-order constructs with a total of 41 indicators. Also the convergent validity of the rest of the model was assessed, and the results of factor loadings in Table IV show that all the factor loadings are greater than 0.7, which demonstrates convergent validity. Based upon the paper of Anderson and Gerbing (1988) the convergent validity as all remained items were significantly loaded on their designated latent variables. A higher-order CFA (Bentler, 1989) was carried out to assess the convergent validity of each construct. The standardized CFA loadings in Table IV present evidence of convergent validity. All the item loadings were greater than the threshold of 0.70 (Fornell and Larcker, 1981a).

5.6 Unidimensionality

We ensured unidimensionality of the measurement model using four criteria. First, unidimensionality was supported by higher internal consistency (i.e. loadings No. 707, p b 0.01) of items under each construct (Chin, 2010). Second, unidimensionality was established

Table III.
Confirmatory factor analysis, AVE, Cronbach's α coefficient

SD	Mean	CR	AVE	α	
1.563	3.442	0.9608	0.8908	0.965	Connectivity
1.595	2.721	0.9773	0.9348	0.972	Compatibility
1.543	3.384	0.9814	0.9463	0.965	Modularity
1.040	3.259	0.9772	0.9345	0.782	Planning
1.499	3.279	0.8538	0.6606	0.979	Invest and decision making
1.628	2.568	0.9833	0.9074	0.972	Coordination
1.544	2.623	0.9818	0.9473	0.963	Control
1.547	2.798	0.9778	0.9362	0.974	Technical knowledge
1.210	2.820	0.9815	0.9299	0.947	Technology management capability
1.117	4.243	0.9741	0.9495	0.938	Business knowledge
1.234	2.972	0.9803	0.9614	0.960	Relational knowledge

First-order constructs	Indicators	Loadings	Second-order constructs and their loadings	Third-order construct and loadings
Compatibility	Com1	0.9781***	Infrastructure Flexibility (0.75–0.94)	Big data analytics capability (0.78–0.91)
	Com2	0.9713***		
	Com3	0.9689***		
Connectivity	Con1	0.9695***		
	Con2	0.9614***		
	Con3	0.9696***		
Modularity	Modu1	0.9365***		
	Modu2	0.9317***		
	Modu3	0.9188***		
Coordination	Coor1	0.9712***	Management capabilities (0.94-0.97)	
	Coor2	0.9752***		
	Coor3	0.9735***		
Control	Control1	0.9777***		
	Control2	0.9595***		
	Control3	0.9654***		
	Control4	0.9612***		
	Control5	0.9514***		

Note: ***$p < 0.001$

Table IV. Standardized loadings of the latent constructs in the model

by Cronbach's α, which exceeds 0.70 for all the constructs (Nunnally and Bernstein, 1994). Third, the AVEs of each construct were greater than 0.50, which adequately reflects unidimensionality (Fornell and Larcker, 1981b). Higher AVEs indicate that the observed items explain more variance than the error terms. Finally, unidimensionality was supported by the composite reliability of each construct, which exceeds the 0.80 cut-off value (Hair *et al.*, 2013; Segers, 1997). Composite reliability has been introduced as the most robust assessment of a construct's internal consistency because it prioritizes items by their reliability in estimating measurement model (Hair *et al.*, 2011).

5.7 Correlation matrix

This paper also ensured discriminant validity by calculating the square root of the AVEs in the diagonals of the correlation matrix in Table VI. The findings show that the square root of AVE of a construct was higher than its correlations with other constructs, suggesting that the measurement model in this study has good discriminant validity. This test highlights that the latent constructs have different items and they are conceptually distinct from each other (Chin, 2010) (Tables V and VI).

5.8 Goodness of fit

The goodness of fit is a criterion for how well a model fits a set of observations. Measures of goodness of fit typically summarize the difference between observed values and the

	AVE	Composite reliability
Compatibility	0.9463	0.9814
Connectivity	0.9348	0.9773
Control	0.9362	0.9778
Coordination	0.9473	0.9818
Modularity	0.9478	0.9732

Table V. Criteria of AVE and CR

values expected under the model in question. The goodness of fit was estimated, $GOF = \sqrt{\overline{\text{Communality}} \times \overline{R^2}}$ following Tenenhaus *et al.* (2005) for PLS path modeling and the results show that the model has adequate goodness-of-fit as it exceeds the 0.36 suggested by Wetzels *et al.* (2009). In this study, GOF equals to 0.84 which is higher than 0.36. In order to evaluate the structures forming CSCS, multicollinearity, collinearity diagnostics for constructs were also conducted. The results show that the collinearity indicator (variance inflation factor) is lower the acceptable cut-off point (VIF < 5) (Hair *et al.*, 2006) suggesting that multicollinearity is not an issue in this research.

6. Results and final outcomes

In this study, there are seven hypotheses; the main hypothesis was the relation between BDAC and CSCS which is supported; this research also aims to measure the relation between first order items (including connectivity, compatibility, modularity, planning, decision making, coordination, control, technical knowledge, technology management, business knowledge, relational knowledge), second order items (infrastructure capability, management capability, personal expertise capability) and third order item (BDA capability) and also the impact of BDA capabilities on different dimensions of CSCS which are, vision and objectives, expectations and requirements, scope, engagement with supply chain, internal roles and responsibilities and goals and communicating), which shows BDAC have a positive and significant impact on the paths vision objectives, engagement with supply chain, and internal roles responsibilities. BDAC have a positive relation with the paths expectations and requirements, scope, goals and communicating; but the relation is not as strong as the other paths. Thus, as Table VII shows among the seven hypotheses of this research, *H1*, *H1(a)*, *H1(c)* and *H1(e)* are accepted and *H1(b)*, *H1(d)* and *H1(f)* are rejected. The structural model indicates that, BDA capabilities have a positive and significant impact on CSCS, with path coefficient of 0.943 (p-value < 0.001) explaining 88.9 percent of the variance. Thus the main hypothesis of this research is strongly supported since the path coefficient was significant at $p <$ 0.001. In sum, the R^2 scores for main variable (BDAC: 88.9 percent) explained by the research model were significantly large in accordance with the effect sizes defined for R^2 by Cohen (1988) and Chin (2010) (Figures 2 and 3).

Table VI.
Correlation matrix

	Compatibility	Connectivity	Control	Coordination	Modularity
Compatibility	0.973				
Connectivity	0.582	0.967			
Control	0.773	0.560	0.968		
Coordination	0.766	0.557	0.703	0.973	
Modularity	0.620	0.761	0.595	0.598	0.974

Table VII.
The final results of seven hypotheses

Hypotheses direct effect	Path coefficient	STERR	z-statistic	Test result
BDAC→ Engage	0.3945	0.044	8.9684***	Accepted
BDAC→ Expect	0.0934	0.0511	1.8282	Rejected
BDAC→ Goals	0.0311	0.0491	0.6329	Rejected
BDAC→ Internal	0.8861	0.0097	91.2732***	Accepted
BDAC→ Scope	0.0788	0.05	1.5745	Rejected
BDAC→ Vision	0.1625	0.0493	3.2995**	Accepted
BDAC→ CSCS	0.9429	0.005	188.5301***	Accepted

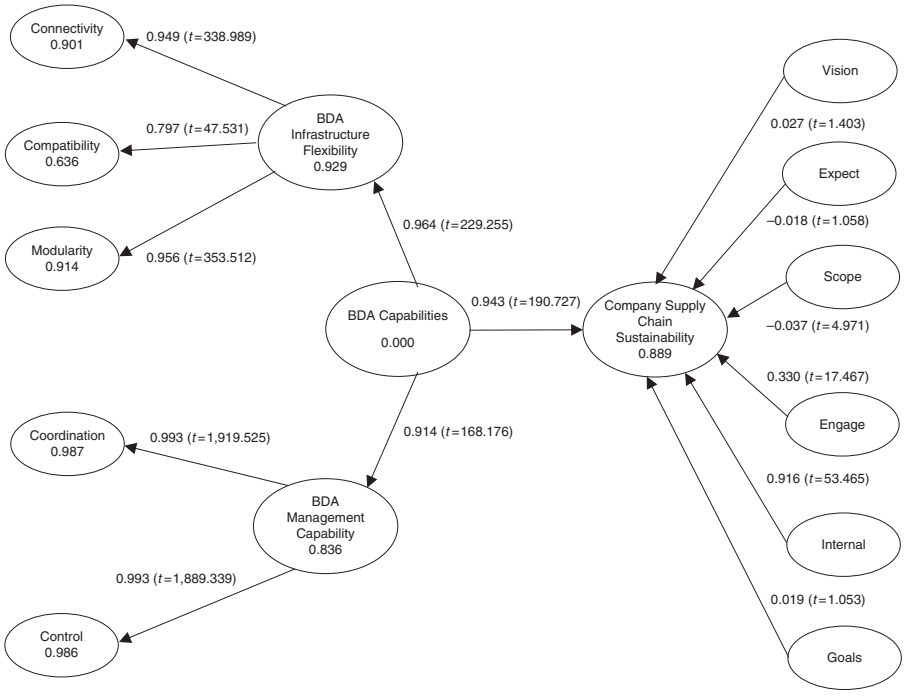

Figure 2.
Impact of BDAC on CSCS (standard estimation and significance estimation)

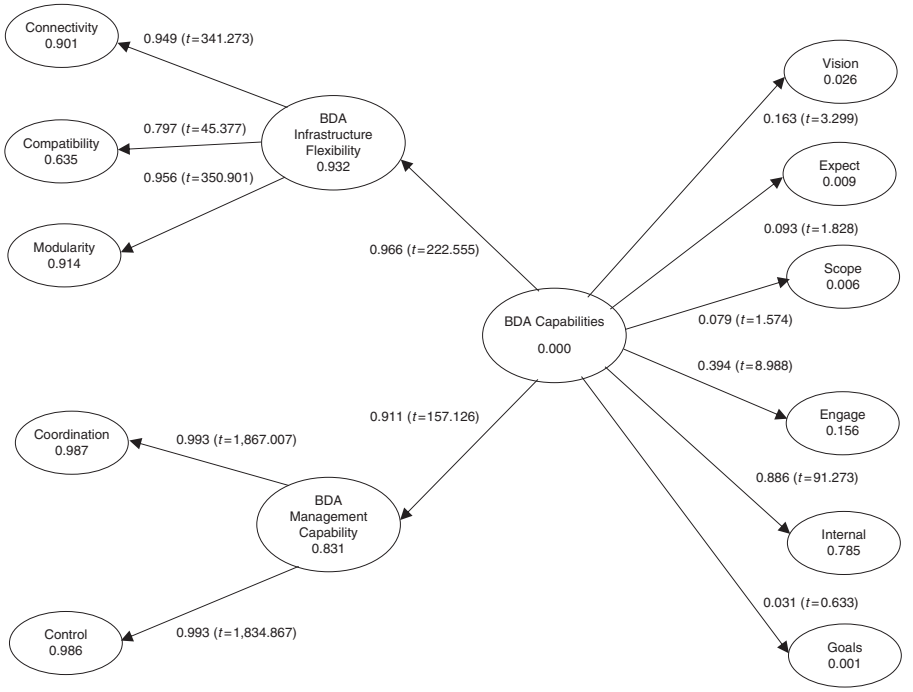

Figure 3.
Impact of BDAC on different aspects of CSCS standard estimation and significance estimation

7. Discussion and implications

7.1 Key findings

The objective of this study was measuring the relationship between BDAC and CSCS and its different aspects. The empirical results, strongly suggest that BDAC have a positive and significant impact on sustainability of pharmaceutical supply chain. There is also a strong and positive relationship between BDAC and vision objectives, BDAC and engagement with supply chain, and BDAC and internal roles and responsibilities. Since vision and objectives for supply chain sustainability is the level of understanding about sustainable supply chain development, and commitment to managing social, environmental and economic impacts in its supply chain, the more companies have better vision and objectives, the more they provide the company with strong BDA construction; to be able to gather, integrate and analyze the high quality data and information. Assigning internal roles and responsibilities means setting up a group or committee to determine how to manage sustainability in the supply chain. The companies must recruit BDA personnel who demonstrate capability in terms of technical knowledge management, business understanding, data understanding, data preparation, modeling, evaluation and deployment; then organizing the personnel into different groups to perform various data mining and data analysis processes; that is why this hypothesis is strongly supported in the results. Engaging with suppliers and other businesses in the supply chain communicating and evaluates suppliers' capabilities and performance against firm's expectations prior to starting the relationship and regularly thereafter. And even asking suppliers to remediate issues of poor performance. Obviously a strong BDA system is required to engage the other plants and suppliers effectively, share integrated data and information, having common cause, objective and commitment. And IT department of each company must be able to support all the procedures. The relationship between BDAC and expectations and requirements, scope of activities and goals and communicating were not strong but still positive; Establishing supply chain expectations and requirements is having a code of conduct or related contract language and including ethical or corporate social responsibility clauses in some contracts with suppliers. Determining scope of activities means exploring and assessing sustainability impacts in related supply chain. Also identifying firm's highest priority supply chain issues (e.g. by strategic supplier and by risk). And the amount of resources that are invested to address the most significant risks in its supply chain. Creating goals and tracking and communicating performance setting goals related to the implementation of supply chain policies and programs and related to supplier performance and discussing company's progress with stakeholders. These three aspects of CSCS which do not have significant relationship with BDAC, are more related to business knowledge, strategy, planning, policy and company annual budget (investment) than BDA infrastructure flexibility and BDA management capabilities. There are several companies that know their scope of activities, created goals and established supply chain expectations, but have not put them into practice for several reasons that financial problems, is one of important reasons. CSCS has six different aspects that three of them were significantly related to BDAC and three of them were not but still positive. Thus the main hypothesis of this research that is the relationship between BDAC and CSCS is strongly supported.

Although this study used a standard questionnaire on BDA capabilities, some parts of the whole model were eliminated in CFA. Therefore, we attempted to find out the reasons. After identifying high and low factor loadings in different items the dimensions invest and planning were eliminated from the management capabilities of the second order; because many companies are confident about the quality of their coordination and control inside the companies, but they continuously change the companies' budget, policy and plan, due to economic instabilities in the country. Many pharmaceutical companies encounter serious financial problems so they could afford only very necessary expenditures. Some companies believe that they have invested enough resources in building BDA, managers

of some other companies are not confident about it, and some other companies announced that they have not invested enough resources in BDA but they have projected the impact of BDA on environmental conservation, support a precautionary approach to environmental challenges and projected the cost of training, that users need; In the same way, this paper can discuss the elimination of BDA planning, since continuous adapting analytics plans to new conditions, optimizing BDA usage for assessment of good governance practices and constant examination new opportunities to use BDA in management of environmental, social and economic impacts would be expensive and requires organized and strong support of IT department. A few managers, considered BDA to be a luxurious item that only increases the expenditures of the company. Thus the managers' response on these dimensions, was vague; therefore, their answers about BDA planning and BDA investment are not lucid enough to be formative factors of BDA management capabilities. Finally, BDA personnel expertise capability of the third order was removed from the whole model because there is a variety of capability levels in different companies, which are not suitable to the BDA infrastructure or BDA management capabilities. For instance, in several companies, very high-qualified BDA personnel are recruited but the company does not have a prepared data analytics infrastructure, or the chairpersons have not set any plan to conduct big data analysis. Some managers either are not attuned to the BDA capabilities of their personnel or do not know about data mining or have various definitions of data science; therefore, their response in terms of technological management knowledge was not a formative factor of BDA capability. Another issue is lack of an effective information sharing system between members of supply chain, thus the respondents were not sure about the situation of rival's sustainability and BDA capabilities, to be able draw a comparison, therefore some items do not have significant loading to be a formative of the latent factor (the loading factor < 0.3).

7.2 Research implications

This paper assesses the different dimensions of BDA capabilities, supply chain sustainability, and discovers the extent to which BDAC have impact on CSCS and its different dimensions. Therefore, this paper could give a better insight to researchers into structures of sustainable supply chain and BDAC so, they do more research on different functions of BDA in other subjects such as marketing, customer behavior. BDA constructions and functions in various industries in different countries or in other types of supply chains. Some parts of the whole model of this paper were eliminated and the authors explored the reasons, which reflect several major problems that Iranian pharmaceutical supply chain faces and the barriers to forming a flawless sustainable supply chain and strong BDA capabilities consequently, researchers might be encouraged to assess the challenges of sustainable supply chain and barriers to form a strong and flexible supply chain in various industries and also opportunities and challenges in terms of BDA and look for effective solutions. This paper also used UN online-self assessment and provided academic support from literature to justify using UN questionnaire in academic papers. Thus more investigations on different types of measurements that international organizations like UN presented, could be evaluated to be used in academic researches.

7.3 Practical implications

Since UN urges companies do the online self-assessment and share the results, the finding of this paper would be attractive and useful for UN global compact specialists, because many Iranian pharmaceutical companies did the assessment and shared the results because of participating in this research. It is important to consider that many Iranian pharmaceutical companies did not even know such an online self-assessment existed.

This paper suggests that BDA helps to sustainability of pharmaceutical supply chain. Therefore, pharmaceutical companies' chief managers, need to set lucid plans and strategies in terms of investing adequate resources in BDA and create organized BDA system. The findings in this research, reflects the real situation of BDAC and sustainability of pharmaceutical supply chain in Iran. This study illuminated the facts in terms of pharmaceutical supply chain sustainability and BDA capabilities and related issues in Iran as a developing country. Therefore, this paper could be a guidance to managers and consultants who are involved in BD and sustainable development. Companies have to create organized and secure information sharing system to form an integrated supply chain. The results also show that in many Iranian pharmaceutical companies, different parts of BDA capabilities exist but are not well organized and there is not any coordination between employee's specialty and companies' structures and polices which results in wasting resources. Therefore, the managers should be looking for remedies. In addition, managers need to examine the microstructure of BDA planning, investment, coordination and control to ensure BDA management capability.

7.4 Limitations and recommendation for future research

Although this research model is firmly grounded in theory and is tested with standard questionnaires and dependable data, some issues and limitation should be mentioned. First, the model is tested using cross-sectional data, therefore, to investigate its stability, retesting the model using both cross-sectional and time series data (panel data) is recommended. Second BDA by its nature is context specific, owing to the variations in different factors in different industries, developing of the conceptual model in other contexts would increase its generalizability. Third, this paper focuses on firms' perception on BDAC and sustainability, so objective measures are highly recommended to investigate actual impact. Fourth, this study was limited to pharmaceutical supply chain in Iran, which testing the model on other sorts of supply chains in other countries would clear more the relation between BDAC and sustainability of supply chain. Fifth, there are several aspects of supply chain that have influence on the companies' strategies, decision making and sustainability, that are not assessed in this paper; factors like company location, position in supply chain, company size, partnership status, type of products, organizational culture level of innovation, profitability and market share that could be useful topic for future research. In addition, more research on the issues that caused the elimination of some parts of the study model is highly recommended.

8. Conclusion

Based on the importance of supply chain sustainability and the usefulness of big data analysis, this study tried to assess the relation between BDAC and CSCS and impact of BDAC on the different aspects of supply chain sustainability through conducting a comprehensive survey to chief managers of pharmaceutical companies in Iran. Some parts of the model were eliminated, which reveals that there are several impediments to forming sustainable supply chain and strong BDAC in Iran. The most prominent detected obstacles are economic instabilities, vagueness of the market, lack of effective information sharing system and lack of coordination between personnel capabilities and companies' BDA infrastructures and policies.

As a general conclusion, the results demonstrate that BDA capabilities have a strong and positive impact on pharmaceutical supply chain sustainability, and the dimensions including vision, engage and internal. In addition, it is found that there is a positive relation between BDA capabilities and the dimensions expect, scope and goals but not as strong as the other dimensions. This paper could be a helpful guide for sustainable development practitioners and pharmaceutical chief managers in Iran.

References

Ajayi, A., Oyedele, L., Delgado, J., Akanbi, L., Bilal, M., Akinade, O. and Olawale, O. (2019), "Big data platform for health and safety accident prediction", *World Journal of Science, Technology and Sustainable Development*, Vol. 16 No. 1, pp. 2-21, available at: https://doi.org/10.1108/WJSTSD-05-2018-0042

Anderson, J.C. and Gerbing, D.W. (1988), "Structural equation modeling in practice: a review and recommended two-step approach", *Psychological Bulletin*, Vol. 103 No. 3, pp. 411-423, available at: https://psycnet.apa.org/buy/1989-14190-001

Arabi, M., Mansour, S. and Shokouhyar, S. (2017), "Optimizing a warranty–based sustainable product service system using game theory", *International Journal of Sustainable Engineering*, Vol. 11 No. 5, pp. 330-341, available at: https://doi.org/10.1080/19397038.2017.1387187

Babcicky, P. (2013), "Rethinking the foundations of sustainability measurement: the limitations of the Environmental Sustainability Index (ESI)", *Social Indicators Research*, Vol. 113 No. 1, pp. 133-157, available at: https://ideas.repec.org/a/spr/soinre/v113y2013i1p133-157.html

Bagozzi, R.P. and Yi, Y. (1988), "On the evaluation of structural equation models", *Journal of the Academy of Marketing Science*, Vol. 16 No. 1, pp. 74-94, available at: https://link.springer.com/article/10.1007/BF02723327

Barney, J. (1991), "Firm resources and sustained competitive advantage", *Journal of Management*, Vol. 17 No. 1, pp. 99-120, available at: https://doi.org/10.1177%2F014920639101700108

Barratt, M. and Oke, A. (2007), "Antecedents of supply chain visibility in retail supply chains: a resource-based theory perspective", *Journal of Operations Management*, Vol. 25 No. 6, pp. 1217-1233, available at: https://doi.org/10.1016/j.jom.2007.01.003

Baruch, Y. and Holtom, B.C. (2008), "Survey response rate levels and trends in organizational research", *Human Relations*, Vol. 61 No. 8, pp. 1139-1160, available at: https://doi.org/10.1177%2F0018726708094863

Bentler, P.M. (1989), *EQS 6 Structural Equations Program Manual*, Multivariate Software, Los Angeles, CA, available at: www.econ.upf.edu/~satorra/CourseSEMVienna2010/EQSManual.pdf

Bilal, M., Oyedele, L., Qadir, J., Munir, K., Ajayi, S., Akinade, O., Owolabi, H., Alaka, H. and Pasha, M. (2016), "Big data in the construction industry: a review of present status, opportunities, and future trends", *Advanced Engineering Information*, Vol. 30 No. 3, pp. 500-521, available at: https://doi.org/10.1016/j.aei.2016.07.001

Boehmer-Christiansen, S. (2002), "The geo-politics of sustainable development: bureaucracies and politicians in search of the holy grail", *Geoforum*, Vol. 33 No. 3, pp. 351-365, available at: https://doi.org/10.1016/S0016-7185(02)00018-0

Bond, A., Morrison-Saunders, A. and Pope, J. (2012), "Sustainability assessment: the state of the art", *Impact Assessment and Project Appraisal*, Vol. 30 No. 1, pp. 53-62, available at: https://doi.org/10.1080/14615517.2012.661974

Bowman, A. (2018), "Big questions, informative data, excellent science", *Statistics and Probability Letters*, Vol. 136, May, pp. 34-96, available at: https://doi.org/10.1016/j.spl.2018.02.017

Brandon-Jones, E., Squire, B., Autry, C.W. and Petersen, K.J. (2014), "A contingent resource- based perspective of supply chain resilience and robustness", *Journal of Supply Chain Management*, Vol. 50 No. 3, pp. 55-73, available at: https://doi.org/10.1111/jscm.12050

Brown, J., Cynthia Clark, C. and Buono, A. (2016), "The United Nations global compact: engaging implicit and explicit CSR for global governance", *Journal of Business Ethics*, Vol. 147 No. 4, pp. 721-734, available at: https://doi.org/10.1007/s10551-016-3382-5

Burns, T.E. and Stalker, G.M. (1961), *The Management of Innovation*, Tavistock Publications, London, available at: www.worldcat.org/title/management-of-innovation/oclc/228964

Butner, K. (2010), "The smarter supply chain of the future", *Strategy and Leadership*, Vol. 38 No. 1, pp. 22-31, available at: https://doi.org/10.1108/10878571011009859

Caridi, M., Crippa, L., Perego, A., Sianesi, A. and Tumino, A. (2010), "Measuring visibility to improve supply chain performance: a quantitative approach", *Benchmarking: An International Journal*, Vol. 17 No. 4, pp. 593-615, available at: https://doi.org/10.1108/14635771011060602

Carmeli, A. and Tishler, A. (2004), "Resources, capabilities, and the performance of industrial firms: a multivariate analysis", *Managerial and Decision Economics*, Vol. 25 Nos 6-7, pp. 299-315, available at: https://doi.org/10.1002/mde.1192

Chen, H., Chiang, R.H. and Storey, V.C. (2012), "Business intelligence and analytics: from big data to big impact", *MIS Quarterly*, Vol. 36 No. 4, pp. 1165-1188, available at: www.semanticscholar.org/paper/Business-Intelligence-and-Analytics%3A-From-Big-Data-Chen-Chiang/3320d97bf6ec4a467712577eb1f74f18fbeadba7

Chin, W.W. (2010), "Chapter 29: How to write up and report PLS analyses", in Wang, H. (Ed.), *Handbook of Partial Least Squares*, Springer, Berlin, Heidelberg, pp. 655-690, available at: https://link.springer.com/chapter/10.1007/978-3-540-32827-8_29

Chong, A.Y.L., Chan, F.T.S., Ooi, K.B. and Sim, J.J. (2011), "Can Malaysian firms improve organizational/innovation performance via SCM?", *Industrial Management and Data Systems*, Vol. 111 No. 3, pp. 410-431, available at: https://doi.org/10.1108/02635571111118288

Christopher, M. and Lee, H. (2004), "Mitigating supply chain risk through improved confidence", *International Journal of Physical Distribution and Logistics Management*, Vol. 34 No. 5, pp. 388-396, available at: https://doi.org/10.1108/09600030410545436

Christopher, M. and Peck, H. (2004), "Building the resilient supply chain", *The International Journal of Logistics Management*, Vol. 15 No. 2, pp. 1-14, available at: https://doi.org/10.1108/09574090410700275

Clark, W.C., Tomich, T.P. and Noordwijk, M.V. (2011), "Boundary work for sustainable development: Natural resource management at the Consultative Group on International Agricultural Research (CGIAR)", *National Academy of Sciences*, Vol. 17 No. 113, pp. 4615-4622, available at: https://doi.org/10.1073/pnas.0900231108

Cohen, J. (1988), *Statistical Power Analysis for the Behavioral Sciences*, Routledge Academic, Beijing, available at: www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/journal/Home.aspx?IssueID=9462

Côrte-Real, N. and Oliveira, T. (2016), "Assessing business value of big data analytics in European firms", *Journal of Business Research*, Vol. 70, January, pp. 379-390, available at: https://doi.org/10.1016/j.jbusres.2016.08.011

Creswell, J.W. (2003), *Research Design: Qualitative, Quantitative, and Mixed Methods Approach*, 2nd ed., Sage Publications, Thousand Oaks, CA, available at: https://pdfs.semanticscholar.org/73b7/18e508fa943dfb22a9cb5fb17f888239ad0e.pdf

Cuquet, M. and Fensel, A. (2018), "The societal impact of big data: a research roadmap for Europe", *Technology in Society*, Vol. 54, August, pp. 74-86, available at: https://doi.org/10.1016/j.techsoc.2018.03.005

Davenport, T. (2014), "How strategists use 'big data' to support internal business decisions, discovery and production", *Strategy and Leadership*, Vol. 42 No. 4, pp. 45-50, available at: https://doi.org/10.1108/SL-05-2014-0034

Davenport, T.H. and Dyché, J. (2013), "Big data in big companies", International Institute for Analytics, Portland, Oregon.

Davenport, T.H. and Patil, D.J. (2012), "Data scientist", *Harvard Business Review*, Vol. 90 No. 5, pp. 70-76.

Devuyst, D., Hens, L. and de Lannoy, W. (2001), *How Green is the City? Sustainability Assessment and the Management of Urban Environments*, Columbia University Press, New York, NY.

Dubey, R., Gunasekaran, A., Childe, S.J., Wamba, S.F. and Papadopoulos, T. (2016), "The impact of big data on world-class sustainable manufacturing", *The International Journal of Advanced Manufacturing Technology*, Vol. 84 Nos 1-4, pp. 631-645, available at: https://link.springer.com/article/10.1007/s00170-015-7674-1

Elkington, J. (1994), "Towards the sustainable corporation: win-win-win business strategies for sustainable development", *California Management Review*, Vol. 36 No. 2, pp. 90-100, available at: https://doi.org/10.2307%2F41165746

Fornell, C. and Larcker, D.F. (1981a), "Evaluating structural equation models with observable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50, available at: https://doi.org/10.1177%2F002224378101800104

Fornell, C. and Larcker, D.F. (1981b), "Evaluating structural equation models with unobservable variables and measurement error", *Journal of Marketing Research*, Vol. 18 No. 1, pp. 39-50, available at: https://doi.org/10.1177%2F002224378101800104

Fuschi, D. and Tvaronavičienė, M. (2014), "Sustainable development, big data and supervisory control: service quality in banking sector", *Journal of Security and Sustainability Issues*, Vol. 3 No. 3, pp. 5-14, available at: http://dx.doi.org/10.9770/jssi.2014.3.3(1)

Gandomi, A. and Haider, M. (2015), "Beyond the hype: big data concepts, methods, and analytics", *International Journal of Information Management*, Vol. 35 No. 2, pp. 137-144, available at: https://doi.org/10.1016/j.ijinfomgt.2014.10.007

Gasparatos, A. and Scolobig, A. (2012), "Choosing the most appropriate sustainability assessment tool", *Ecological Economics*, Vol. 80, August, pp. 1-7.

Gasparatos, A., el-Haram, M. and Horner, M. (2008), "A critical review of reductionist approaches for assessing the progress towards sustainability", *Environmental Impact Assessment Review*, Vol. 28 Nos 4-5, pp. 286-311, available at: https://doi.org/10.1016/j.eiar.2007.09.002

Gibson, R., Hassan, S., Holtz, S., Tansey, J. and Whitelaw, G. (2005), *Sustainability Assessment – Criteria and Processes*, Earthscan, London, available at: www.taylorfrancis.com/books/9781849772716

Grant, R.M. (1991), "The resource-based theory of competitive advantage: implications for strategy formulation", *California Management Review*, Vol. 33 No. 3, pp. 114-135, available at: https://doi.org/10.2307%2F41166664

Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S.F., Childe, S.J., Hazen, B. and Akter, S. (2017), "Big data and predictive analytics for supply chain and organizational performance", *Journal of Business Research*, Vol. 70, January, pp. 308-317, available at: https://doi.org/10.1016/j.jbusres.2016.08.004

Gupta, M. and George, J.F. (2016), "Toward the development of a big data analytics, capability", *Information and Management*, Vol. 53 No. 8, pp. 1049-1064, available at: https://doi.org/10.1016/j.im.2016.07.004

Gupta, S. and Mateu, J. (2018), "Quality of life, big data and the power of statistics", *Statistics and Probability Letters*, Vol. 136, May, pp. 101-104, available at: https://doi.org/10.1016/j.spl.2018.02.030

Hair, J.F., Hult, G.T.M., Ringle, C. and Sarstedt, M. (2013), *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, SAGE Publications, Incorporated, Thousand Oaks, CA, available at: https://ssrn.com/abstract=2233795

Hair, J.F., Ringle, C.M. and Sarstedt, M. (2011), "PLS-SEM: indeed a silver bullet", *The Journal of Marketing Theory and Practice*, Vol. 19 No. 2, pp. 139-152, available at: https://doi.org/10.2753/MTP1069-6679190202

Hair, J.F., Tatham, R.L., Anderson, R.E. and Black, W. (2006), *Multivariate Data Analysis*, Pearson Prentice Hall. Bill Black, Louisiana State University, Baton Rouge, NJ, available at: http://wiki.biomine.skelleftea.se/wiki/images/3/37/Multivariate_data_analysis_wiki.doc

Hak, T., Janouskova, S. and Moldan, B. (2016), "Sustainable development goals: a need for relevant indicators", *Ecological Indicator*, Vol. 60, January, pp. 565-573, available at: https://doi.org/10.1016/j.ecolind.2015.08.003

Hatonen, J. and Eriksson, T. (2009), "30+ years of research and practice of outsourcing–exploring the past and anticipating the future", *Journal of International Management*, Vol. 15 No. 2, pp. 142-155, available at: https://doi.org/10.1016/j.intman.2008.07.002

Hazen, B. and Skipper, J. (2018), "Big data and predictive analytics for supply chain sustainability: a theory-driven research agenda", *Computers and Industrial Engineering*, Vol. 101, November, pp. 592-598, available at: https://doi.org/10.1016/j.cie.2016.06.030

Hueting, R. (2011), "Sustainable national income: information for attaining sustainability", *Management Research Review*, Vol. 34 No. 11, pp. 1190-1201, available at: https://doi.org/10.1002/sd.1922

Hussain, M., Khan, M. and Ajmal, M. (2018), "Exploration and assessment of the motivators of social sustainability in healthcare supply chains: multistake holder's perspective", *Sustainable Development*, online version of record, Vol. 27 No. 4, pp. 573-586, available at: https://doi.org/10.1002/sd.1922

Imaz, M. and Sheinbaum, C. (2017), "Science and technology in the framework of the sustainable development goals", *World Journal of Science, Technology and Sustainable Development*, Vol. 14 No. 1, pp. 2-17, available at: https://doi.org/10.1108/WJSTSD-04-2016-0030

Iniesta, R., Stahl, D. and McGuffin, P. (2016), "Machine learning, statistical learning and the future of biological research in psychiatry", *Psychological Medicine*, Vol. 46 No. 12, pp. 2455-2465, available at: https://doi.org/10.1017/S0033291716001367

Jeble, S. and Dubey, R. (2017), "Impact of big data and predictive analytics capability on supply chain sustainability", *The International Journal of Logistics Management*, Vol. 29 No. 2, pp. 513-538, available at: https://doi.org/10.1108/IJLM-05-2017-0134

Kaufmann, L., Carter, C. and Buhrmann, C. (2012), "The impact of individual debiasing efforts on financial decision effectiveness in the supplier selection process", *International Journal of Physical Distribution & Logistics Management*, Vol. 42 No. 5, pp. 411-433, available at: https://doi.org/10.1108/09600031211246492

Kim, G., Shin, B. and Kwon, O. (2012), "Investigating the value of sociomaterialism in conceptualizing IT capability of a firm", *Journal of Management Information Systems*, Vol. 29 No. 3, pp. 327-362, available at: https://doi.org/10.2753/MIS0742-1222290310

Kiron, D., Prentice, P.K. and Ferguson, R.B. (2014), "The analytics mandate", *MIT Sloan Management Review*, Vol. 55, pp. 1-25, available at: https://sloanreview.mit.edu/projects/analytics-mandate/

Kurniawan, R., Zailani, S.H., Zailani, S.H., Iranmanesh, M., Iranmanesh, M., Rajagopal, P. and Rajagopal, P. (2017), "The effects of vulnerability mitigation strategies on supply chain effectiveness: risk culture as moderator", *Supply Chain Management: An International Journal*, Vol. 22 No. 1, pp. 1-15, available at: https://doi.org/10.1108/SCM-12-2015-0482

Kwong, K. and Wong, K. (2013), "Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS", *Marketing Bulletin*, Vol. 24 No. 1, pp. 166-199, available at: www.scribd.com/document/266313116/PLS-SEM-Techniques-Using-Smartpls

Laney, D. (2001), "3d data management: controlling data volume, velocity and variety", *Application Delivery Strategies*, Vol. 3 No. 4, pp. 240-255, available at: https://blogs.gartner.com/doug-laney/files/2012/01/ad949-3D-Data-Management-Controlling-Data-Volume-Velocity-and-Variety.pdf

Lawrence, P.R. and Lorsch, J.W. (1967), "Differentiation and integration in complex organizations", *Administrative Science Quarterly*, Vol. 12 No. 1, pp. 1-47, available at: www.jstor.org/stable/2391211?seq=1#page_scan_tab_contents

Linton, J.D., Klassen, R. and Jayaraman, D. (2007), "Sustainable supply chain", *Journal of Operations Management*, Vol. 25 No. 6, pp. 1075-1082, available at: https://doi.org/10.1016/j.jom.2007.01.012

Low, Y., Halim, I., Adhitya, A. and chew, W. (2016), "Systematic framework for design of environmentally sustainable pharmaceutical supply chain network", *Journal of Pharmaceutical Innovation*, Vol. 11 No. 3, pp. 250-263, available at: https://link.springer.com/article/10.1007/s12247-016-9255-8

McAfee, A., Brynjolfsson, E., Davenport, T.H., Patil, D.J. and Barton, D. (2012), "Big data. The management revolution", *Harvard Bus Rev*, Vol. 90 No. 10, pp. 61-67, available at: http://tarjomefa.com/wp-content/uploads/2017/04/6539-English-TarjomeFa-1.pdf

Malhotra, S. (2014), "Impact of outsourcing on the organisations opting for IT", *International Journal of Marketing and Technology*, Vol. 4 No. 3, pp. 115-122, available at: http://search.proquest.com/openview/131fb2841e5e708fc44d2b0b8f3312e3/1.pdf?pq-origsite=gscholar&cbl=1626341

Mata, F.J., Fuerst, W.L. and Barney, J.B. (1995), "Information technology and sustained competitive advantage: a resource-based analysis", *MIS Quarterly*, Vol. 19 No. 4, pp. 487-505, available at: https://search.proquest.com/info/openurldocerror

Moqbel, M., Nevo, S. and Kock, N. (2013), "Organizational members' use of social networking sites and job performance: an exploratory study", *Information Technology and People*, Vol. 26 No. 3, pp. 240-264, available at: https://doi.org/10.1108/ITP-10-2012-0110

Ness, B., Urbel-Piirsalu, E., Anderberg, S. and Olsson, L. (2007), "Categorising tools for sustainability assessment", *Ecological Economics*, Vol. 60 No. 3, pp. 498-508, available at: https://doi.org/10.1016/j.ecolecon.2006.07.023

Nguyen, T., ZHOU, L. and Spiegler, V. (2016), "Big data analytics in supply chain management: a state-of-the-art literature review", *Computers and Operations Research*, Vol. 98, October, pp. 254-264, available at: https://doi.org/10.1016/j.cor.2017.07.004

Nunnally, J.C. (1978), *Psychometric Theory*, 2nd ed., McGraw-Hill, New York, NY.

Nunnally, J.C. and Bernstein, I. (1994), "The assessment of reliability", *Psychometric Theory*, Vol. 3, pp. 248-292, available at: https://scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/ReferencesPapers.aspx?ReferenceID=1960143

Panahifar, F., Heavy, C. and Byrne, P.J. (2015), "Developing retailer selection factors for collaborative planning, forecasting and replenishment", *Industrial Management & Data Systems*, Vol. 115 No. 7, pp. 1292-1324.

Panahifar, F., Byrne, P., Salam, M. and Heavey, C. (2018), "Supply chain collaboration and firm's performance", *Journal of Enterprise Information Management*, Vol. 31 No. 3, pp. 358-379, available at: https://doi.org/10.1108/JEIM-08-2017-0114

Papadopoulos, T., Gunasekaran, A., Dubey, R. and Altay, N. (2017), "The role of big data in explaining disaster resilience in supply chains for sustainability", *Cleaner Production*, Vol. 142 Part 2, pp. 1108-1118, available at: https://doi.org/10.1016/j.jclepro.2016.03.059

Podsakoff, P.M. and Organ, D.W. (1986), "Self-reports in organizational research: problems and prospects", *Journal of Management*, Vol. 12 No. 4, pp. 531-544, doi: 10.1177%2F014920638601200408.

Pope, J. (2006), "What's so special about sustainability assessment?", *Journal of Environmental Assessment Policy and Management*, Vol. 8 No. 2, pp. v-x, available at: www.jstor.org/stable/pdf/enviassepolimana.8.3.v.pdf?seq=1#page_scan_tab_contents

Prajogo, D.I. and McDermott, C.M. (2011), "The relationship between multidimensional organizational culture and performance", *International Journal of Operations and Production Management*, Vol. 31 No. 7, pp. 712-735, available at: https://doi.org/10.1108/01443571111144823

Qing Shi, J. (2018), "How do statisticians' analyses big data – our story", *Statistics and Probability Letters*, Vol. 136, May, pp. 130-133, available at: https://doi.org/10.1016/j.spl.2018.02.043

Rezaei, S., Shokouhyar, S. and Zandieh, M. (2017), "A neural network approach for retailer risk assessment in the aftermarket industry", *Benchmarking: An International Journal*, Vol. 6 No. 3, pp. 326-350, available at: https://doi.org/10.1108/BIJ-06-2018-0162

Ross, J.W., Beath, C.M. and Goodhue, D.L. (1996), "Develop long-term competitiveness through IT assets", *Sloan Management Review*, Vol. 38 No. 1, pp. 31-43, available at: http://layoftheland.net/archive/web/mis575/course_docs/topic_4/ross.beath.goodhue.ITassets.pdf

Sealy, I., Wehrmeyer, W., France, C. and Leach, M. (2010), "Sustainable development management systems in global business organizations", *Management Research Review*, Vol. 33 No. 11, pp. 1083-1096, available at: https://doi.org/10.1108/01409171011085912

Segers, A.H. (1997), "Assessing the unidimensionality of measurement: a paradigm and illustration within the context of information systems", *Omega*, Vol. 25, February, pp. 107-121, available at: https://doi.org/10.1016/S0305-0483(96)00051-5

Shi, X. and Liao, Z. (2012), "The mediating effects of inter firm business process integration and joint teamwork on firm performance in supply chains", *Asia Pacific Journal of Management*, Vol. 30 No. 4, pp. 1243-1264, available at: https://link.springer.com/article/10.1007/s10490-012-9308-6

Shokouhyar, S., Noorbakhsh, A. and Aalirezaei, A. (2017), "Evaluation of green IT services with fuzzy screening approach", *Australasian Journal of Information Systems*, Vol. 21, pp. 254-270, doi: http://dx.doi.org/10.3127/ajis.v21i0.1548.

Shokouhyar, S., Safari, S. and Mohsenian, F. (2018), "Improving candy industry competitiveness: retailers' perception regarding customer satisfaction", *Journal of Food Products Marketing*, Vol. 24 No. 6, pp. 761-783, available at: https://doi.org/10.1080/10454446.2017.1389666

Shokouhyar, S., Siadat, S. and Razavi, M. (2018), "How social influence and personality affect users' social network fatigue and discontinuance behavior", *Aslib Journal of Information Management*, Vol. 70 No. 4, pp. 344-366, available at: https://doi.org/10.1108/AJIM-11-2017-0263

Shokouhyar, S., Seifhashemi, S., Siadat, H. and Ahmadi, M.M. (2017), "Implementing a fuzzy expert system for ensuring information technology supply chain", *International Journal of Sustainable Engineering*, Vol. 11 No. 5, pp. 330-341, available at: https://doi.org/10.1080/19397038.2017.1387187

Svensson, G. and Wagner, B. (2015), "Implementing and managing economic, social and environmental efforts of business sustainability: propositions for measurement and structural models", *Management of Environmental Quality: An International Journal*, Vol. 26 No. 2, pp. 195-213, available at: https://doi.org/10.1108/MEQ-09-2013-0099

Tenenhaus, M., Vinzi, V.E., Chatelin, Y.-M. and Lauro, C. (2005), "PLS path modeling", *Computational Statistics and Data Analysis*, Vol. 48 No. 1, pp. 159-205, available at: https://doi.org/10.1016/j.csda.2004.03.005

Torrecilla, J. and Romo, J. (2018), "Data learning from big data", *Statistics and Probability Letters*, Vol. 136, May, pp. 15-19, doi: 10.1016/j.spl.2018.02.038.

UN Global Compact (2018), "Online quick self-assessment and learning tools", available at: http://supply-chain-self-assessment.unglobalcompact.org/start-your-assessment/ (accessed January 6, 2019).

UN guideline (2015), "Supply chain sustainability, UN practical Guide for Continuous Improvement Second Edition", available at: www.unglobalcompact.org/library/205 (accessed January 6, 2019).

United Nations Sustainable Development Summit (2015), available at: https://sustainabledevelopment.un.org/post2015/summit

Waas, T. and Huge, J. (2014), "Sustainability assessment and indicators: tools in a decision-making strategy for United Nations Sustainable Development Summit 2015", *Sustainability*, Vol. 6 No. 9, pp. 10-23, available at: https://doi.org/10.3390/su6095512

Wamba, S.F. and Gunasekaran, A. (2017), "Big data analytics and firm performance: effects of dynamic capabilities", *Journal of Business Research*, Vol. 70, January, pp. 356-365, doi: 10.1016/j.jbusres.2016.08.009.

Wamba, S.F., Akter, S., Edwards, A., Chopin, G. and Gnanzou, D. (2015), "How 'big data' can make big impact: findings from a systematic review and a longitudinal case study", *International Journal of Production Economics*, Vol. 165, July, pp. 234-246, available at: https://doi.org/10.1016/j.ijpe.2014.12.031

Wang, Y. and Kung, L. (2018), "Big data analytics: understanding its capabilities and potential benefits for healthcare organizations", *Technological Forecasting and Social Change*, Vol. 126, January, pp. 3-13, available at: https://doi.org/10.1016/j.techfore.2015.12.019

WCED (1987), *Our common Future: (World Commission on Environment and Development)*, Oxford University Press, London, available at: https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/152/WCED_v17_doc149.pdf?sequence=1

Wetzels, M., Odekerken-Schroder, G. and Van Oppen, C. (2009), "Using PLS path modeling for assessing hierarchical construct models", *Guidelines and Empirical Illustration. MIS Quarterly*, Vol. 33 No. 1, pp. 177-195, available at: www.jstor.org/stable/20650284?seq=1#page_scan_tab_contents

Wilson, J.P. (2015), "The triple bottom line: undertaking an economic, social, and environmental retail sustainability strategy", *International Journal of Retail and Distribution Management*, Vol. 43 Nos 4/5, pp. 432-447, available at: https://doi.org/10.1108/IJRDM-11-2013-0210

Winston, A. (2014), "Resilience in a hotter world", *Harvard Business Review*, Vol. 92 No. 4, pp. 56-64, available at: https://europepmc.org/abstract/med/24830282

Wixom, B.H. and Watson, H.J. (2001), "An empirical investigation of the factors affecting data warehousing success", *MIS Quarterly*, Vol. 25 No. 1, pp. 17-41, available at: www.jstor.org/stable/3250957?seq=1#page_scan_tab_contents

Wu, K., Liao, C.J. and Tseng, M.L. (2015), "Toward sustainability: using big data to explore the decisive attributes of supply chain risks and uncertainties", *Journal of Cleaner Production*, Vol. 142 No. 2, pp. 663-676, available at: https://doi.org/10.1016/j.jclepro.2016.04.040

Wu, Z. and Pagell, M. (2011), "Balancing priorities: decision-making in sustainable supply chain management", *Journal of Operations Management*, Vol. 29 No. 6, pp. 577-590, available at: https://doi.org/10.1016/j.jom.2010.10.001

Zhong, R. (2016), "Big data for supply chain management in the service and manufacturing sectors: challenges, opportunities, and future perspectives", *Computers and Industrial Engineering*, Vol. 101, November, pp. 572-591, available at: https://doi.org/10.1016/j.cie.2016.07.013

Appendix

Big data analysis capabilities criteria Please score from 1 (strongly disagree) to 5 (strongly agree) according to what is applicable to your organization		
Sub-dimensions	Indicators	Sources
Connectivity	Con1: You have the best accessible data analytics system in your industry Con2: You have an organized network within the different offices of the organizations, in order to share data or information effectively in an integrated system Con3: You have surmounted the obstacles that could delay or stop the data sharing and analyzing process	BDA infrastructure flexibility (Kim *et al.*, 2012; Jeble and Dubey, 2017; Davenport, 2014; Gupta and George, 2016)
Compatibility	Com1: Your software system is user-friendly so that could be used conveniently in different offices Com2: All analytics platforms are easily and transparently accessible Com3: Information shared smoothly throughout the company from different locations and in different situations	
Modularity	Mod1: Your system information design, subdivided into smaller parts that can be independently created and then used in different systems Mod2: Your information system is characterized by functional partitioning into discrete scalable, reusable modules Mod3: Analytics personnel or legacy information system could not constrain employees from creating new applications	
Planning	Plan1: Constantly, you examine new opportunities to use big data analytics in management of environmental, social and economic impacts Plan2: Frequently, you optimize big data analytics usage for assessment of good governance practices, throughout the lifecycles of goods and services Plan3: You impose suitable plans to reinforce your information system to accomplish the sustainable development goals in a systematic way Plan4: You are always adapting your analytics plans to new conditions	BDA management capability (Kim *et al.*, 2012; Laney, 2001; McAfee *et al.*, 2012; Ross *et al.*, 1996; Davenport and Dyché, 2013; Davenport and Patil, 2012; Barney, 1991; Grant, 1991; Gupta and Mateu, 2016; Mata *et al.*, 1995; Wixom and Watson, 2001; Jeble and Dubey, 2017; Davenport, 2014)
Investment and Decision-making	Inv1: You invest adequate resources in building and implementing big data analytics to achieve sustainable development goals in your organization Inv2: You project the impact of BDA on business and economic development, creating new jobs Inv3: You estimate the impact of BDA on environmental conservation, support a precautionary approach to environmental challenges Inv4: You estimate the impact of BDA on social welfare, the protection of internationally proclaimed human rights; and making sure the organization is not complicit in human rights abuses, and the elimination of all forms of forced and compulsory labor and discrimination in respect of employment and occupation Inv5: You project the impact of BDA on work against	

(*continued*)

Table AI. Appendix (questionnaire)

	corruption in all its forms, including extortion and bribery Inv6: You project the time required and the cost of training, that users need Inv7: You estimate the time and cost that managers need to spend supervising the change	
Coordination	Coor1: Data analysis department, organizes regular meetings with different departments to coordinate their endeavors harmoniously Coor2: Data analysis department, makes sure the data or information that has been gathered from different offices and departments is valid and integrated Coor3: Data analysis department, shares integrated information widely with the chairmen who make strategic decisions	
Control	Control1: You are confident that the responsibility of analytics department to do big data analysis is clear Control2: You make sure that the performance criteria of BDA department are lucid Control3: Continuously, managers and supervisors monitor the performance of BDA department Control4: In contrast to your rivals, your BDA department is better at bringing detailed information, and share it effectively Control5: In contrast to your rivals, your BDA department shares accurate and timely information effectively in contrast to your competitors	
Technical knowledge	TK1: Your BDA personnel are highly qualified in programming skills for instance web-based application, structured programs, and other related tools TK2: Your BDA personnel are capable in terms of using data mining and statistical analysis software such as Python, R, SPSS Statistics, and SPSS modeler TK3: Your BDA personnel are very capable in decision support systems (for instance, artificial intelligence, data warehouse, marts and so on) TK4: Your BDA personnel demonstrate a high level of proficiency with distributed computing, data management and maintenance, and managing project life cycles	BDA personnel expertise capability (Kim *et al.*, 2012; Jeble and Dubey, 2017; Mata *et al.*, 1995; Carmeli and Tishler, 2004; Gupta and George, 2016; Davenport, 2014)
Technology management capability	TMC1: Your BDA personnel have extensive knowledge about statistics, data mining, information technology systems, business intelligence and other related subjects TMC 2: Your BDA personnel demonstrate capability to learn new technologies TMC 3: Your BDA personnel are very knowledgeable about the role of big data analysis in the success of sustainable firms	
Business knowledge	BK1: Your BDA personnel have an excellent command on business administration and supply chain management. They understand business problems and could develop appropriate solutions BK2: Your BDA personnel understand the organization's policies and plans at a high level BK3: Your BDA personnel are highly knowledgeable about business functions and environments	

Table AI. (*continued*)

Relational knowledge	RK1: Your BDA personnel maintain productive customer/user/client relationship RK2: Your BDA personnel are capable in terms of trading and educating others RK3: Your BDA personnel are highly qualified for managing projects, and execute a good teamwork and communication	
Sustainability		
Please share the result of on-line self-assessment on UN Global Compact website. from 1 (No current action) to 5 (Best practices). http://supply-chain-self-assessment.unglobalcompact.org/start-your-assessment/		
Dimensions	Sources	score
Vision and objectives for supply chain sustainability	Elkington (1994), Svensson and Wagner (2015), Wilson (2015), Dubey *et al.* (2016), Jeble and Dubey (2017), Devuyst *et al.* (2001), Gasparatos *et al.* (2008), Gibson *et al.* (2005), Ness *et al.* (2007), Pope (2006), Bond *et al.* (2012), Wu and Pagell (2011), Butner (2010), Christopher and Peck (2004), Caridi *et al.* (2010)	
Establishing supply chain expectations and requirements	Waas and Huge (2014), Devuyst *et al.* (2001), Gasparatos *et al.* (2008), Gibson *et al.* (2005), Ness *et al.* (2007), Pope (2006), Bond *et al.* (2012), Wu and Pagell (2011), Butner (2010)	
Determining scope of activities	Devuyst *et al.* (2001), Gasparatos *et al.* (2008), Gibson *et al.* (2005), Ness *et al.* (2007), Pope (2006), Bond *et al.* (2012), Wu and Pagell (2011), Butner (2010), Dubey *et al.* (2016)	
Engaging with suppliers and other businesses in the supply chain	Barratt and Oke (2007), Brandon-Jones *et al.* (2014), Gunasekaran *et al.* (2017), Devuyst *et al.* (2001), Gasparatos *et al.* (2008), Gibson *et al.* (2005), Ness *et al.* (2007), Pope (2006), Bond *et al.* (2012), Wu and Pagell (2011), Butner (2010), Kurniawan *et al.* (2017), Hatonen and Eriksson (2009), Malhotra (2014), Gunasekaran *et al.* (2017), Christopher and Lee (2004), Wu and Pagell (2011), Burns and Stalker (1961), Lawrence and Lorsch (1967), Kaufmann *et al.* (2012), Dubey *et al.* (2016)	
Assigning internal roles and responsibilities	Burns and Stalker (1961), Lawrence and Lorsch (1967), Dubey *et al.* (2016), Devuyst *et al.* (2001), Gasparatos *et al.* (2008), Gibson *et al.* (2005), Ness *et al.* (2007), Pope (2006), Bond *et al.* (2012), Wu and Pagell (2011), Butner (2010)	
Creating goals and tracking and communicating performance	Devuyst *et al.* (2001), Gasparatos *et al.* (2008), Gibson *et al.* (2005), Ness *et al.* (2007), Pope (2006), Bond *et al.* (2012), Wu and Pagell (2011), Butner (2010), Elkington (1994), Svensson and Wagner (2015), Wilson (2015), Dubey *et al.* (2016)	

Table AI.

Corresponding author
Mohammad Reza Seddigh can be contacted at: mrseddigh@yahoo.com