Systematic literature review on application of business analytics and information technology in supply chain performances

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Abstract: Supply chain management (SCM) functions are having applications of business analytics (BA). Supply chain managers' uses BA as competitive tool. Application of BA in key SCM functions, with information technology (IT) innovations has been a topic of tremendous interest to both practitioners and researchers. We identified more than 200 articles (over two decade) and classified them by year of publication, functional discipline, publication source, research methodology and application for the purpose of comprehensive literature review. Study identifies relationship between analytical tools and IT in supply chain decision making and supply chain performances. It explores research trends and patterns across disciplines and suggestions of potential areas for future research in BA, IT and supply chain decision making and performances.

Keywords: business analytics; supply chain management; SCM; information technology; operational performances.

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1 Introduction

Business enterprises have increasing use of data and advanced analytics for various types of decision making problems (Delen and Demirkan, 2013; Turban, 2011). Data analysis is heart of all decision making in business function and in supply chain management (SCM) function too (Hult et al., 2004). Business analytics (BA) has been shown number 1 priority of chief information officers (COI) in annual Gartner survey of information technology (IT) in 2011 among top ten priorities (Thibodeau, 2012). Researchers have good interest in BA in manufacturing (and supply chain), where it is expected to make significant contributions (Brown et al., 2013; Davenport and O'Dwyer, 2011). The area of BA in SCM becomes important since enhancing the effectiveness and efficiency of supply chain analytics is a critical component of a SCs ability to achieve its competitive advantage (Sahay and Ranjan, 2008). Souza (2014) highlights importance of analytics which has historically played a significant role in SCM as a well-planned and executed decisions contribute directly to the bottom line by lowering sourcing, transportation, storage, stock out and disposal costs. The emergence of a number of forces is accelerating the development of the possibilities for BA in supply chains. which are, growing supply chain data, cheaper data storage, faster and ever-increasing processing power, anywhere, anytime connectivity, better tools, making analysis simpler and advanced visualisation with tools and techniques to show and present huge volumes of data visually (Anon, 2014). IT has potential to boost SCM (Huo et al., 2015). The performances of SC can be improved as competitive advantage by application of efficient SCM practices with integration of high quality of information sharing (Li et al., 2006). It is factual that, most of the decision areas in SCM have scope of integrating with IT for better results through prompt and accurate decision making. Advance digital technologies are helping in improving SCs performances with modest cost (Gezgin et al., 2017). Recent studies in area of operations management have given more importance to SCM area (Mirtalaie et al., 2017). Analytical tools, artificial intelligence are getting practical nowadays (Viel et al., 2018). The consulting sector highlighted how analytics is playing pivotal role in digital transformations of SCs (Mahajan et al., 2018). Prior works done in the area builds up theoretical background on this research area and list it important topic of study (Swanson et al., 2018) but there is gap of overview with respect to the results in SCM performances. This research provided an overview by doing a systematic literature review of earlier works done in the area of BA and SCM. Further different classifications were done on the basis of category and functional disciplines, year of publication, publication, research methodology and application.

2 Problem statement and formulation of research questions

The area of BA in SCM function is area in OM where is need of finding out the differences and gaps in literature on BA and IT in SCM research. As the most of the previous review studies, has limited their analysis to five to ten-year time spans, we provided a comprehensive picture of the scholarly development and trajectory of research of more than 20 years and are thus able to identify important trends in BA and IT integration, SCM and supply chain performances.

2.1 Research questions

On the basis of problem statement we constructed following research questions:

1 What are relationship between analytical tools and IT in supply chain decision making and supply chain performances?

2 Find out research trends and patterns across disciplines.

3 What are potential areas for future research in BA, IT and supply chain performances?

3 Research method

The research method used for answering the research questions was designed on the bases of previous proven methods. For the purpose of answering the research questions and validate the findings, a systematic literature review was performed. Method described by Webster and Watson (2002) was used. The rationale behind this method is to increase the scientific value of study. Review has been done with inclusion of all the relevant literature on this subject [as per in method by Webster and Watson (2002)]. In order to keep the quality of the research as high as possible our literature search was limited to only those databases, journals and conferences that have a good academic reputation. Literature was searched in the leading databases providing good coverage of the relevant sources. Based on the research questions, research quarries were formulated. The research query was formulated in several steps of improvement, to make sure we did not miss or exclude any relevant papers. To increase the likeliness of the results being relevant, it was insured that the keywords in the research query have to occur in the titles, abstracts or keywords of the articles. Research approach for systematic literature review used is represented in Figure 1.

3.1 Data source

The research used secondary data. But primary focus was online resources. A pre stage scanning of literature showed enough application of BA in supply chain decision making. Data has been included from all different categories, by comprehensive search of online database like Emerald full text, Science Direct, JSTOR, tandfonline and Springer. Our emphasis was on including more and more peer-reviewed journals which tend to be the best outlets for disseminating new knowledge (Donohue and Fox, 2000; Nord and Nord, 1995). Data sources included different categories of methodologies like: case study, literature, content analysis, field experiments, field study, mathematical model and qualitative research. Data source included 87 journals (edited volumes and proceedings also included) of repute published by Emerald, Science Direct, Springer, Taylor & Francis, JSTOR, data also included publications from Palgrave McMillan, Informs, British Academy of Management, Council of Supply Chain Management Professionals, Management Information Systems Research Centre, University of Minnesota and Penn University Press. The details of data collected are given in Table 1 and shown in Figure 2.

Figure 1 The research approach (see online version for colours)

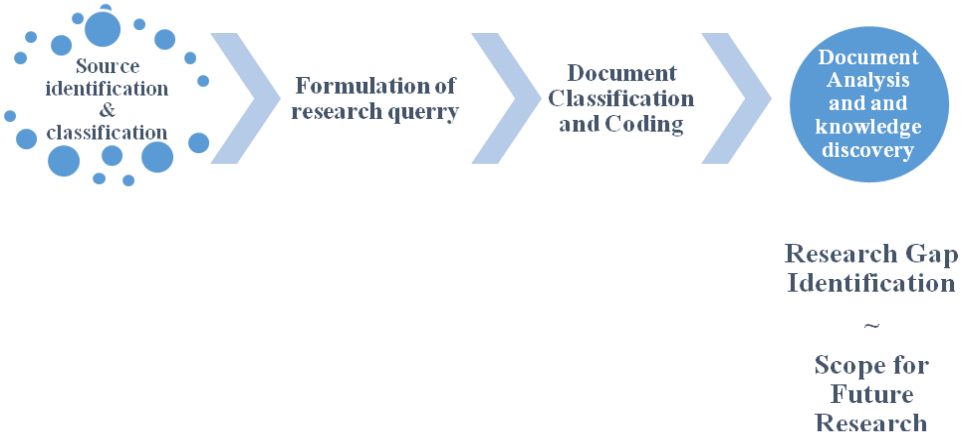
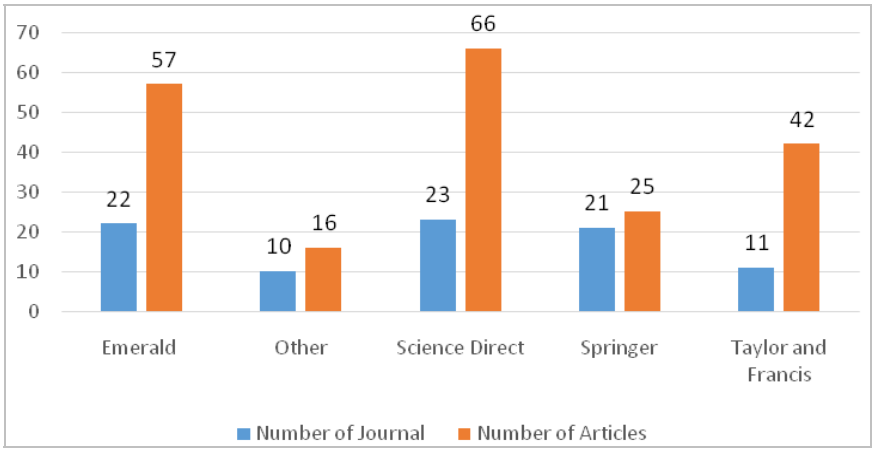


Table 1 Journal's sources and article numbers

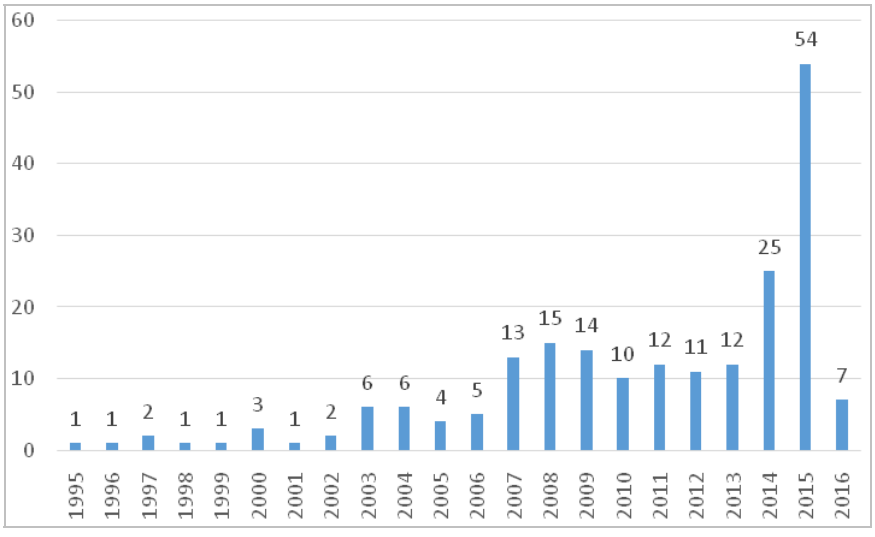
Publisher/source	*Number of journal*	*Number of articles/chapter*
Emerald	22	57
Other	10	16
Science Direct	23	66
Springer	21	25
Taylor & Francis	11	42
Total	87	206

Figure 2 Journal's sources and article numbers



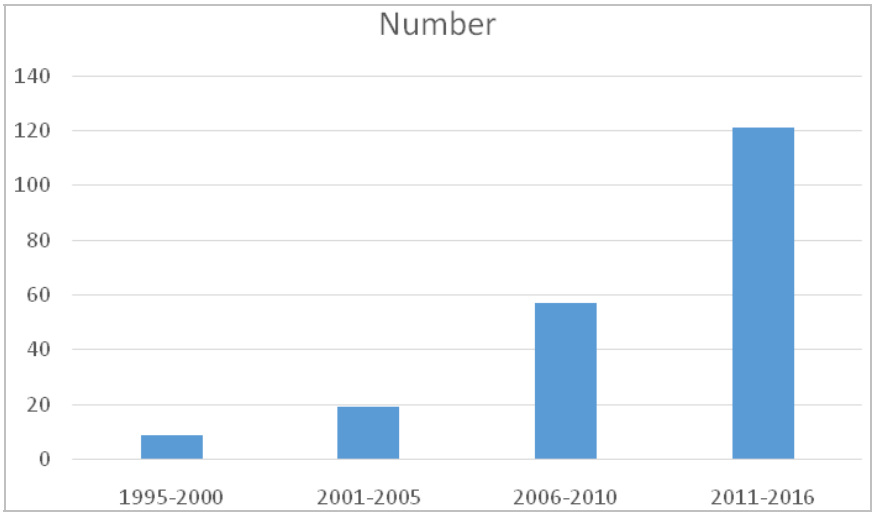
The inclusion was done from varied kind of sources for ensuring all kind of literature. Highest number of articles was included form Science Direct which included 23 journals and 66 articles and second highest was from Emerald with 22 journals and 57 articles. The statistical references drawn are represented in Figure 3.

Figure 3 Year to year publications (see online version for colours)



Year to year publication shown increase in number of publications with alterations in one after year. Highest articles was taken from year 2015 (study included articles published up to 2017). It is easy to refer Figure 4 to understand trend in publication of concerned studies the first block (1995–2000) is having less publication, and in fourth block, we have more than 50% of articles.

Figure 4 Year (block) vise publications (see online version for colours)



The present study included publications from all concerned disciplines of topic (objective). Figures 5, 6 and 7 show three field of studies.

Data was taken in such way it should cover all three relevant disciplines of study. The three major disciplines of publication included were adopted from Basole et al. (2013):

1 information systems and computers science, system, application (IC, CS)

2 decision sciences (decision theory, OR, operations management, production management) (DS OM OR)

3 management and organisation (business, strategy, marketing, finance, organisational behaviour (BZ OB M).

Figure 8 depicts the percentage of these publications in different three disciplines of study

Figure 5 Field of study – information systems and computers science (see online version for colours)

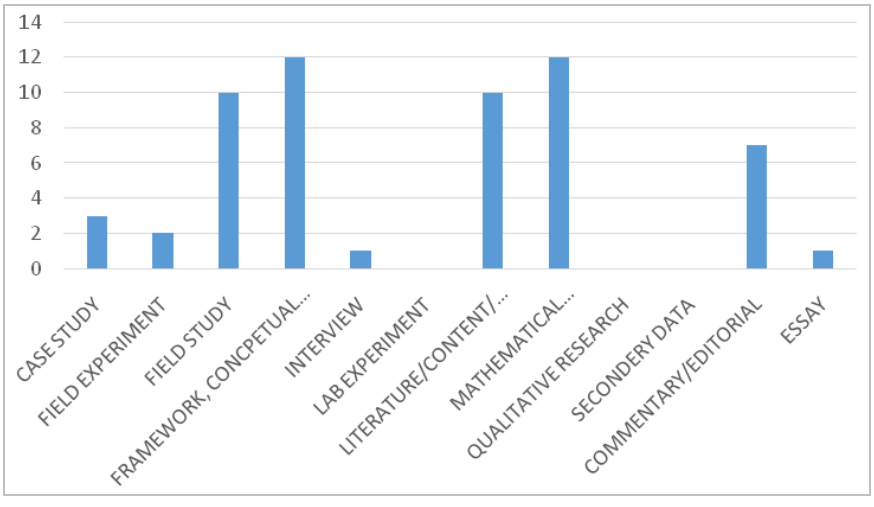


Figure 6 Field of study – decision sciences and operations research (OR)/management (see online version for colours)

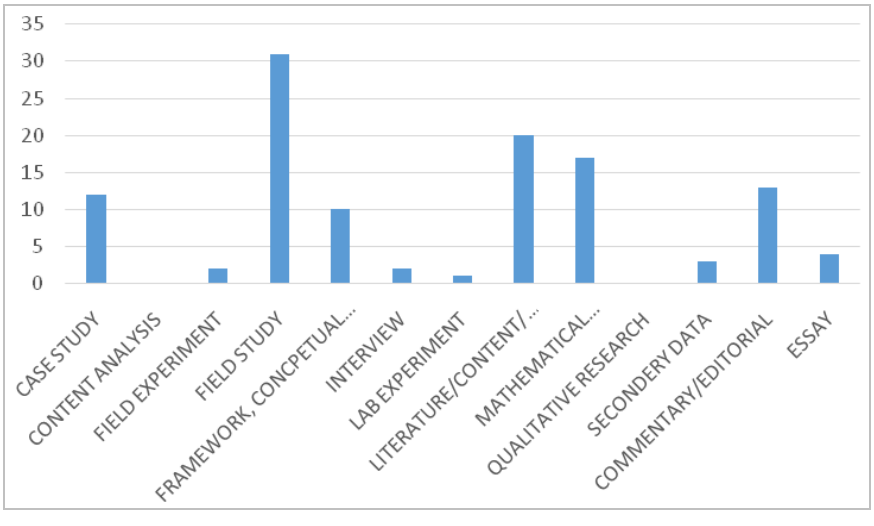


Figure 7 Field of study – business, OB and management (see online version for colours)

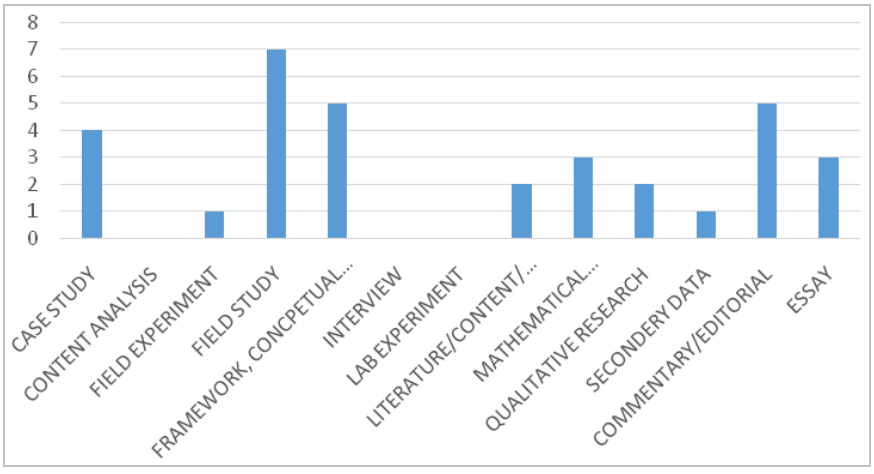
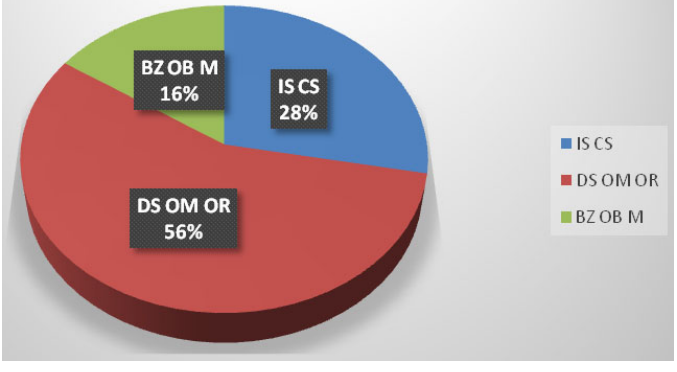


Figure 8 Disciplines of study and articles percentage (see online version for colours)



3.2 Literature inclusion criterion

Different articles, reports and publication in form of books, book chapters, editorial essays and periodicals were included as per defined criterion. Time frame for inclusion is of last two decades. The articles published since 1995 to 2016 was included. The review of articles was done which were solely based on SCM, include BA in different manners. Articles with IT integration and BA in SCM were included.

3.3 Literature classification

Articles were classified basically on year of publication, source or publisher, functional discipline of publication, application area in SCM and research methodology. Classification in study was based on several taxonomies.

The classification and coding system used in the study was kept simple for the purpose of easy review and analysis. Alpha numeric system of coding was utilised for

providing every article a unique and comprehensive code. Alpha numeric (one item with alphabets and next item by numbers depending upon characters) is shown in Table 2.

Table 2 Literature classification

Item		*Description*	*Coding pattern*	*Example*
1	Sr. no.	Simple serial of article/publication	1, 2, 3, ……, 200	1
2	Publisher	Source of article/publisher	Two alphabets	EM
3	Year	Year of publication	Four numeric	2008
4	Journal	Name of journal/book/series	Four alphabets	EJOR
5	Discipline	Functional discipline of journal publication	One numeric	2
6	RM	Research methodology	Two alphabets	CS
7	Area	Application area/coverage of paper to functional area	One numeric	3
8	Author code	Coding first author (for identity purpose)	Three alphabets	DAV

A coding for classification of a research article looked like is shown in Table 3.

Table 3 A coding for classification of a research article looked like

144	*SD*	*2015*	*JOPM*	*2*	*FS*	*3*	*DAV*
Serial number	Science Direct is source of publication	Year of publication	*Journal of Operations Management*	Discipline is operations management, operations research	Research methodology is field study	Application area is performance management	Author(s) Gligor et al.

4 Systematic literature analysis on BA and IT in SCM

In field of operations management SCM is now more studied area. Earlier works done in area of SCM and BA contributed theoretical background. BA is defined as an application of different advanced analytical techniques to data and provides solutions related with SCM (or relevant area). BA in SC involves combination of technology with human effort to identify trends, perform and highlight potential in supply chain performances area in case of large amount of data involved. With respect to competition today, we have to look well beyond basic statistics. BA and linked concepts that are related with analysis of business data for decision making purposes are given weight age in both the academic and business communities (Chen et al., 2012; Acito and Khatri, 2014; Holsapple et al., 2014; Mortenson et al., 2015). Competitive organisations use predictive modelling to identify the most profitable or potential areas. It has previously been well established that the adoption of SCM systems can lead to better financial performance through an improvement in inventory turnover and reduction of sales expenditure on day to day SC operations.

Application of statistical and mathematical tools is well established in every field of management. SCM also involves a lot of decision making. Analytics competitors make expert use of statistics and modelling to improve a wide variety of functions (Davenport, 2006). Researchers are continuously working on how the information system may be used as intelligent system. Lavalle et al. (2010) finds the combination of increasing

complex world, vast usage of data and competition has led to focus on analytics. High quality, real time or near real time, BA, making appropriate use of 'big data', may be utilised for better decision making and optimisation at different levels (Capgemini, 2009). BA may be an important tool to improve organisations performance and an important area of BA is used in SCM and can deliver the high performance (Trkman et al., 2011). Simple understanding of BA can be had from meaning of analytics. Analytics is defined as science (Turban, 2011) of analysis. Analysis of data is done by tools, software and applications. BA is applications and techniques for gathering, storing, analysing and providing access to data to help users make better and strategic decisions. BA is also known as analytical processing, business intelligence (BI) tools or BI applications. BI and BA are being used together by researcher in academics and industry. Researchers tried to compile a comprehensive definition as the technologies, systems, practices and applications that analyse critical business data to help an enterprise better understand its business and market (Lim et al., 2013). It is very common tradition to use BI as an umbrella term to describe concepts and methods to improve business decision making by using fact-based support systems (Lim et al., 2013). BI is heavily dependent over various advanced data collection, extraction and analysis technologies (Turban, 2011). These techniques are collectively known as BA and data warehousing is often considered as foundation. Computer-based technologies and BA is useful in demand integration, supply chain integration, improved customer knowledge and increases processing power (Ramanathan et al., 2012). Advance use of analytics is referred as supply chain analytics, in other way, supply chain analytics focuses on the use of information and analytical tools to make better decisions regarding flows in supply chain (Souza, 2014). Five benefits of BA like – improving the decision making process, speeding up the decision making process, better alignment of resources and strategies, realising cost efficiencies and responding to user needs for availability of data on timely basis. The usage of right capability, privacy and security (important in SCM), use of AI and behavioural economics is to be taken care of (Viel et al., 2018).

4.1 Review of studies with literature review and basic concepts (framework and conceptual models)

The comprehensive literature survey reveals out the conceptual frame work on the BA, IT, SCM and their operational performances. In present literature survey, we had 28 articles on conceptual model and framework. Similarly, studies with literature review and content analysis are 31. These articles provide enough evidences of works in the area of SCM and BA.

Stewart (1995) emphasised very early the importance of SC integration. He argued on SC integration because of the two sided characteristics of SC. He said supply chain are consisted of logistical and informational elements which are constrained by the aggregate demands of the marketplace at side and by specific product/service delivery at the customer site, at the other side of SC (Stewart, 1995). In an initial study by Fulkerson (1997) introduced the genetic algorithm for managing the order in dynamic changing situation. Researchers in a study (Motwani et al., 2000) done a literature analysis for studying IT related implications in global SCM. Kleijnen and Smits (2003) done literature survey and concluded that optimisation is a major methodological and practical challenge, may be studied further. Literature review done by Gunasekaran and Ngai (2004) on IT in SCM and suggested that IT is essestial for survival and competiveness of

SCM. Sellitto et al. (2007) reviewed RFID-based benefits found to be associated with the distribution and transportation sectors of the supply chain. The initial literature survey on IT, BA and intelligence was done Jourdan et al. (2008). Van Donk (2008) done literature review on IT in SCM and tried to establish research agenda for integration of ICT in SCM. Jain et al. (2009) in their literature review on IT in SCM for issues relating to integration of core processes across organisational boundaries through improved communication, partnerships, alliances and cooperation and IT opinioned over importance of IT and process integration. Basole et al. (2013) review literature in area of IT in SCM and suggested few IT adoption determinants and their relationships and research patterns across disciplines. The literature review done by Elgendy and Elragal (2014) on BA methods and tools which can be applied to big data, as well as the opportunities provided by the application of big data analytics in various decision domains is useful in developing concepts in area. Donovan et al. (2015) work as literature (mapping) study on IT in SCM highlighted data technologies, internet of things (IoT) smart manufacturing and analytics. Good conceptual framework has been developed by Dubey et al. (2015) on operational strategies and techniques to achieve competitive advantage by big data analytics (BDA) and data analytics in sustainable manufacturing. Bayrak (2015) work on BA provided working definition, background and a review of BA, BI, BD theory and practices. The flexibility in SC functions and its impact on performance was conceptualised by Kumar and Mishra (2017) and a framework was presented. The above papers provide enough framework for studying BA application in SCM.

4.2 Review of studies on secondary data, qualitative, interviews, essays and commentaries

BA and IT are applied for supply chain decision making and performance management. Still researcher found latest literature reviews which are demanding more emphasised works for conceptual framework building. At the same time, a lot of studies have been done with secondary data, qualitative methods and interview and in form of essays also.

IT has been accepted background of analytical tool application. Singh (1996), in his commentary on application of IT in SCM emphasised on flow of operational and financial information, communication and transfer of data, highlighted importance of data accuracy and timeliness. Larson and Rogers (1998) categorised SCM functions in technological functions, relational functions and the decision related functions were kept under category of analytical functions. Again, in his editorial, Gunasekaran (2004) mentioned SCM as core and technocentric function. Importance of using internet and EDI was focused. Technology and IT as competiveness with focus on SCM decisions was advocated by Johnson (2006). Power of data and data analytics in managerial decision making was agenda for discussion in editorial by Bock (2008). Sahay and Ranjan (2008) advocate essence of BI for SC analytics. In situations of extensive data application of BI which eases accessibility of information's in organisations. The sophisticated flow of data and SC analytics improves the performance. Stenger (2011) commented on technology usage in planning and operation areas of business and said that technology may bring new opportunities in decisional areas. Challenges and methods in data analytics were discussed by Kambatla et al. (2014). They insisted advances in hardware will be proved more useful for new developments in area of analytics. The

commentary-based article by Souza (2014) gives wider platform for researchers to work on different types of analytics (predictive, descriptive and prescriptive analytics) in SCM. Article was emphasising on emergence of SC analytics. Hazen et al. (2014) further added that SC decisions are highly based on data and data analytics. It is over to the quality of data and its analytics that up to which extent of decision making it may be used. Conceptual development in area was well supported in invited review done by Mortenson et al. (2015), where they review grooving field of analytics. They termed the current years as analytics period in OR research. Precision and in decision making is highly reliant on data source and power is dependent on human judgement (Simpson et al., 2015). Even simple factor rating method was used well in organisations for vendor evaluation (Singh, 2015). Now, in advance stage of analytics research article by Schoenherr and Speier-Pero (2015) discussed about importance of predictive analytics in SCM, provided different challenges and avenues in area of SCM and BA. Further, the research agenda in area of SC performance was given a more deliberate way in a recent work (Maharaja et al., 2018). These studies provide future indicators for research in area of BA in SCM.

Table 4 Classification scheme of research methodology

Methodology	*Definition*
Case study	Concentrated study of a single happening, phenomenon, organisation or system application.
Field experiment	Research in organisational setting that manipulates and controls the various experimental variables and subjects of study.
Field study	Study of single or multiple and related processes/phenomena in single or multiple organisations.
Framework, conceptual model	Research which is intended for developing conceptual framework or model for further studies.
Interview	Research based on information gathered by asking questions to the respondents directly.
Lab experiment	Study in a simulated laboratory environment that manipulates and controls the various experimental variables and subjects.
Literature/content/analysis/review	Research that critiques analyses and extends the existing literature and attempts to build new ground for future research, content analysis text are systematically examined.
Mathematical model/simulation	An analytical or descriptive model (simulation) is developed for the problem under study.
Qualitative research	Help to understand social and cultural contexts within which subjects fall these include ethnography, action research and interpretative studies.
Secondary data	Study that utilises existing data of organisation or sources.
Commentary/editorial	Derives from thinly supported arguments or opinions with little empirical results.
Essay	In depth critiques and analysis of existing information within a frame or topic.

Source: Adopted from Palvia et al. (2007)

4.3 Review of studies on field study and field experiment

A good number of field studies in different areas of SCM have been reviewed. Evidences of emerging and exciting research areas are shown in these studies. Most of researchers had established conceptual framework on the basis of earlier works and tried to support with results of field studies. Few studies had used very good sample sizes (up to or more than 900 also). It seems interesting that application of BA, big data, BI, IT and ISS are still burning issues in SCM. The question of how, when and what extent of performance is being affected is still left. Study by Treleven et al. (2000) on IT in SCM discussed about perceived investments in IT and try to make difference in need of IT in small, medium and large manufactures. Investments in IT have been again proved significant by field study by Subramani (2004). Technology implemented has been directly linked to SC performance (Kincade et al., 2001). IT is key enabler for SC efficiencies and worldwide application and solutions are being tested and recommended for others too (Sahay et al., 2003). Inter-organisational relationships are more dependent on IT implementation (Li and Lin, 2006). SCM management functions of different type of industries are different and are in requirement of varied practices (Jharkharia and Shankar, 2006). The importance of analytical data availability is important like forecast information may act as key enablers for various decisions in SCM and have impact on SC performance (Won Lee et al., 2007). Data collection methods like EDI and RFID are useful in information sharing and decision making too. Thus, SCs have wide scope for technology adoption (Childerhouse et al., 2009). RFID and SC performances are interlinked (Wamba et al., 2015). The area of supplier management and collaboration in area for improving SC performances is one area where technological intervention has scope (Il et al., 2009). Kamaruddin and Udin (2009), in their survey of automotive suppliers found that technology adoption in SC functional area indicates improvements in efficiency and performance. Importance of inventory measures with respect to performance management was studied in survey by Martin and Patterson (2009) and found financial performance measurement was affected by inventory management. Butner (2010), in a survey of SCM executives found that visibility, flexibility are areas through which supply chain risk may be minimised. Visibility (transparency) and flexibility in SC function may be enhanced with analytical tools. In important field survey done by Trkman et al. (2010), it was found that BA and IT have impact on SC performances with moderating effect of process orientation and ISS. Klatt et al. (2011) done a survey of automotive manufacturing and mechanical companies targeting to study BA and IT in general functions and found that BA supports managers in understanding complexities of business decisions and leveraging efficiencies in such functions. Mechanism through which IT affects SC outcomes was explained in case-based research done by Fawcett et al. (2011). Another important and foreseeing study done by Trkman et al. (2010) on BA in SCM was focussed on relationship between analytical capabilities and SCOR, with view to also cover business process maturity and suggested to explore more on IS areas to understand the influence in better way. This study was supported by filed study done by de Oliveira et al. (2012) and suggested that investment in BA are beneficial at all maturity level. The importance of information sharing is still being a challenge in SCM, the problem was studies that how information sharing is done on cloud computing in e-SCM and suggested to explore more in area (Cegielski et al., 2012). While talking about e-SCM, implementation of enterprise resource planning (ERP) also becomes crucial. The status of ERP implementation has impact on operational

performances (Madapusi and Souza 2012). Liu et al. (2013), in a field study found that SC operational performances are mediated by IT capabilities and SC agility. Bronzo et al. (2013) established in their field study direct effects of analytics. Setia and Patel (2013) proposed a hierarchical relationship between IS and operation as management capabilities. Chae et al. (2014b) conducted a field study and found that data accuracy in manufacturing planning and advance analytics have effect on organisational performance. Jothimani and Sarmah (2014) integrated approach of SCOR, fuzzy analytic hierarchy process (FAHP) and technique for order preference by similarity to ideal solution (TOPSIS) for measuring the SC performance and suggested SC performance measures. A comprehensive architecture of SC analytics, IT enabled resources, data management resources and PMS resources in SCM was suggested (Chae et al., 2014a). IT tools, information systems and information security are important in SCM (Nikabadi, 2014). SCOR are the key areas of performance measurement and may act as key indicators of analytical and IT applications effectiveness. Bukhori et al. (2015) used SCOR model for performance indicators after applying AHP. Integration of ICT capabilities of suppliers and other partners helps to boost effects of IT in business performance (Gonzálvez-Gallego et al., 2015). In advance manufacturing setups like automotive industry BI helps in managing SC agility. In area of transportation management predictive analytics application was studied by van der Spoel et al. (2015) and found big data have role in estimation in such functions. In analytical capabilities role of information and information sharing increases and it acts as link between different partners (Marinagi et al., 2015). Top management vision, devotion towards implementation of advance techniques are important factors to be considered while applying tools like BA. Information at supplier level and inventory status are some points of data emergence and variability (Kumar et al., 2015).

4.4 Review of studies including case studies, lab experiments, mathematical modelling and simulation

Application of IT in business decision making is well proven. Bunsiness analytics have also been much studied in last three-four years. But we found than roots of studies on IT and analytical methods in area of SCM. Lau and Lee (2000) modelled IT infrastructure as framework for liking cross platform data exchange in SCM. Kohli et al. (2001) done a case study on dissemination of quality and cost information among channel partners in e-business scenario and resulted in to improved efficiency. In distribution system of a case organisation, IT has emerges as competitive advantage (McLaughlin et al., 2003). While developing model for e-SCM, Kubat (2014) commented consideration of huge amount data and information sharing as concern. Huge data concern was further handled by Hsu and Wallace (2007) in their model for digitalisation and advocated real time data from digitalisation. Chatfield et al. (2006) developed a simulator (model) software based on SCOR functions in SCM and specified integration SC operations. The leverage of information sharing in collective customer collaboration (C3) system and demand information was simulated in as study done by Elofson and Robinson (2007). In a model for digitalisation, Hsu and Wallace (2007) found that digitalisation provides real time data and helps in customer services. Alan (2008) done a cross-case analysis to understand key issues in IT systems of SCs, where problem of SCs integration was faced. In such situation, intelligent application of IT may prove helpful. Use of RFID as data input source was studied by Jayaraman et al. (2008) who found that accuracy of information is

key element SC decision making. For studying performances of SCs, a model (software) was developed and simulated by Stefanovic and Stefanovic (2008) was based on SCOR and concept of SC network modelling was used. Here, e-SCOR framework discussed on usage of IT in SCM. In series of modelling, Chatfield et al. (2009) proposed supply chain modelling languages as model platform for extensible model language (XML) for storage of information. Ren et al. (2010) embedded analytical tools within performance management software (for a IBM customer) for more accurate results. Importance of data mining, OR tools and geographic information system (GIS)-based analytics in a case study of blood SCM. Timely and accuracy of data collection has been highlighted in study (Delen et al., 2011). A case study done on SYSCO by O'Leary (2011) discussed use of data warehousing and BI in customer integration. ERP driven systems eases data collection and supports for analytical decisions. In a simulation series done by Datta and Christopher (2011) managing SCs information sharing and coordination reduces uncertainty. In situation centralised information distribution structure coordination becomes ineffective. Sidola et al. (2012) experimented with a model for IT in SCM where IT capabilities in performance have role, market share increases with increase in IT capabilities. Khalili-Damghani and Tavana (2013) proposed a model and performed a case study in area of performance management. Model involved network data envelopment analysis (NDEA) for assessing the efficiency of decision making units (SCs) (Khalili-Damghani and Tavana, 2013). The issue of increased variability a model development was done using AHP in SCOR areas for decision making and suggested for more exploration in area of demand management (Ponis et al., 2014). The structural modelling in SC decision making was studied by Chand et al. (2014). The importance of information in enterprise system was well studied by Peiris et al. (2015) in case of 100 enterprises and suggested to study the developed enterprise system evaluating tool (ESET) in more organisations. The issue of data collection technologies is key issue in big data age in case study by Li and Zhang (2015) was discussed and concluded importance of information sharing. BA in demand forecasting was studied in a case highlighting application of SC analytics. Predictive analytics explores external environment and translates it in to information for decision making (Blackburn et al., 2015). Computer-based simulation was used in reducing process waste in a case (Nikakhtar et al., 2015). The use of meta-heuristic approach in scheduling in SC delivery and inventory functions was discussed in study by Abedi and Seidgar (2016) and suggested use of analytical and computational methods in SCM functions. IT has been pivotal in attaining efficiency in SCM functions of an automobile company in a case study (Singh, 2016). The usage of quantitative techniques for decision making, forecasting and reporting are in well use in SCM.

5 Discussion

The literature of scholarly developments in area of data analysis, IT and SCM functions provides strong evidences of rapid growth in research area. In late years of last decade of 20th century itself, initial studies have been found. The initial works had discussed about IT, its usage in decision making. ERP has been buzz word used in those days. Data collection, storage its analysis and interpretations has been always challenges and provided scope for new innovations. For data collection, IT is proven technology. Stewart

(1995) said that supply chains are consisted of logistical and informational elements which have constraints of aggregate demands and market's volatile characteristics. In very early days, Fulkerson (1997) introduced genetic algorithm for managing the order in dynamic situation. Different literature analysis/review done in that period was targeted towards finding scope for new research in field of SCM. The issue of IT in SCM, performance management was discussed. As time preceded more studies on IT was done for establishing IT as competitive advantage. The different studies based on literature review and conceptual framework supported field studies, case works and modelling in first decade of 21st century. More studies with emphasis on IT adoption in SCM have been done in last early phase of current decade.

6 Research implications

The study provided a comprehensive multidisciplinary classification and analysis of scholarly developments in BA and IT for efficient supply chain decision making and performances. The major outcomes of the literature review are discussed below.

6.1 Emergence of BA tools in SC decision making and performance areas

Recent trends in publications of studies in area of BA shows the emergence of BA tools in management, within last three years (2014, 2015 and 2016), we got highest number of publications in areas of BA. Davenport (2006) reported that BA is considered to be an important tool to improve efficiency, competitiveness and profitability of business. As of the competitive advantages in supply chain areas are also driven by improving efficiency, competiveness and profitability in current scenario. Huge data requires advance analytics (Elgendy and Elragal, 2014). Cadez and Guilding (2008) argued on data analysis and said it is necessary for all the applications of business. Data is base for information in decision making. Application of data and its transformation was supported by study done by Sahay and Ranjan (2008). They reported that understanding the data, transforming and shaping the data into networked market places is a key strategy for any organisation to achieve competitive advantage. The success of firms now lies on ways of data gathering and their flow for the key decision among the units. Demand forecasting, market research, varied pricing, customer value calculation and prediction, marketing plan effectiveness measurement, evaluating competitors, supply-chain analytics are examples of application of BA. Souza (2014) highlighted importance of analytics which has historically played a significant role in SCM as a well-planned and executed decisions contribute directly to the bottom line by lowering sourcing, transportation, storage, stock out and disposal costs. Emergence of a number of forces is accelerating the development of the possibilities for BA in supply chains, which are growing supply chain data, cheaper data storage, faster and ever-increasing processing power, anywhere, anytime connectivity, better tools, making analysis simpler and advanced visualisation with tools and techniques to show and present huge volumes of data visually. Recent studies in area of decision science supported emergence of BA in area of SCM. The issue of volume, variety and velocity of data in consumer related functions is usual. Organisations had used analytics in structured or unstructured way in form of collecting the past data and preparing reports, taking decisions and future directions (Ranjit, 2009).

6.2 Integration of BA with IT

IT has been always a help to business enterprise. The case of IT usage in decision making got prominence with emergence of advances in ICT area. SCM area is having similar usage of IT in key functional areas. Studies done over IT and SCM reveal major challenges and opportunities in area of BA and IT in SCM functions. The importance of IT in SCM has been first highlighted by Davis (1993) in his article titled 'Effective supply chain management' in *Sloan Management Review* in very early. He considered information as an integral part of a supply chain network and argued that such information systems should also be regarded as an essential ingredient to provide the customer and supply chain partners with the ability to see, know, anticipate, model, link and trade off available resources. All these decisions have direct impact on supply chain operations.

In earlier years, there were research activities regarding information system in SCM. Works done by Desbarats (1999), Ellam and Cooper (1990) and Harland (1996), these studies concerned with detailed infrastructure of information system which have role of monitoring and coordinating data interchange among suppliers, business partners and other links of supply chain. Themistocleous et al. (2004) proposed a framework based on enterprise application integration for inter-organisation and intra-organisation integration typical of a supply chain network. The framework used multiple permutations of internal and external integration. Such framework supports application of IT in SCM. Mitra and Valante (2007) found BA tools had effectively integrated with IT support system (IS), which is essential part, for organisational processes of the business. Study shown integration of BA and IT in different organisational processes. Gunasekaran and Ngai (2008) classified IT applications into five categories those are strategic planning, virtual enterprise, e-commerce, infrastructure for IT and knowledge and IT management. This classification supports application of IT across supply chain functions. These classifications indicate application of IT in improving supply chain operational performances. The emphasis has been made on how IT plays important role in business functions. IT has all around application in day to day functions. Ye and Wang (2013) studied impact of IT and information sharing on operational characteristics of Chinese manufacturers and reported that alignment is more useful for responsiveness and IT is useful for efficiency. Here, application of analytical tools becomes effective with usage of IT. Singh and Garg (2015) done a study on IT and decision making in supply chain network and cites that fluctuations are inherent characteristics of supply chain networks. It may happen that at a certain point of time there will be high demand and low inventory like condition. They further said that combined effect of such fluctuations are more divesting and efficient decision making done with intelligent application of IT is one kind of solution. They further add decision making in supply chain must take in consideration the system-wide approach and it should focus on supply chain life cycle. Analytical tools are helpful in such condition with background of IT. Usage of comprehensive framework for IT is preferred during IT integration in decision making. While developing conceptual framework in SCM and BA and IT, Basole et al. (2013), in their review of literature highlighted the IT adoption determinants and their relationship and current research patterns in area of SCM (Wamba et al., 2008). Challenges of IT design and integration of RFID technologies in logistics operations have been explained in literature review by Musa et al. (2014). The literature review done by Jede and Teuteberg (2015) explained the cloud computing implementations in supply chain processes. The further researches

on IT and BA highlighted data technologies like IoT, smart manufacturing and analytics as emerging areas in SCM research areas (Wamba et al., 2008).

6.3 BA and IT in operational performances of SCs

SC performances are core of organisational performances. The performance of SC is dependent over several factors. The framework of SCM, its structure, IT build up and the way decisions are taken. Large number of studies had been performed to understand the key factors in SC optimisation for efficiency. Optimisation of SCs has been always concern for achieving all over better efficiency in operations. The key areas plan, make, source and deliver and return (SCOR model for SC performances). Efficiency of SCs is considered to improve if we can insure higher utilisation of SC resources. Optimisation is proven method of improving operational performances. The way to track or measure performances are measurement with help of different data capturing, collecting tools and techniques. The detailed reporting of such evaluations is being done with help of descriptive analytics tools. Technology implantation and directly related with SC performances and IT may be used for dramatic improvements in efficiency (Kincade et al., 2001). It has been found that integral integration is crucial for cost involvement, electronic systems and data control positively affect performances (Won Lee et al., 2007). Small IT-based interventions have large impact on SC performance as found in case of RFID adoption in study done by Lin and Ho (2009). Schläfke et al. (2012) provided detailed framework of BA in performance measurement. The study provided multilayer analytics framework consisting of capture, couple and control and communicate. Challenges in performance measurement with respect to data and its analysis can be addressed with such framework. IT and decision making are seen together as competitive tools in case of SCM. The performance optimisation is possible with help of integrating IT with analytical tool. In previous studies, it has been highlighted that SCOR model is suitable to measure the performances of SCs. Studies in area of performance management also advocated challenges of partner relationships, information sharing and SC integration. In field study done by Trkman et al. (2012), it has been found that BA in critical SC areas can affect SCs performance. Organisations which are able to use BA tools with good IS support have better chances of performing.

7 Conclusions

BA in area of SCM decision making had been well studied. The cross domain review of literature provided enough evidences that application of BA have given positive results. The review helped in building proper theoretical framework for studying BA in SCM functions. Studies in core and related areas of SCM had been done in last two decades. Enough number of conceptual framework, literature review and editorial essays field studies, case studies, etc. is available in area of BA, IT and SCM. Researcher found good number of researches in all cross domain fields of SCM, i.e., information systems and computers science, systems, applications, decision sciences (decision theory, OR, operations management, production management and management and organisation sciences (business, strategy, marketing, finance and organisational behaviour).

Detailed analysis of these studies provided scope for future study. This paper identified relationship between analytical tools and IT in supply chain decision making

and supply chain performances. Further, we discovered research trends and patterns across disciplines and suggested potential areas for future research in BA, IT and supply chain performances.

The earlier works done were lacking few important concerns like what, where and how to use analytics in SCM functions more precisely. In present study, inclusion of more specific cases highlighting the results was needed to be studied. Sector or industry specific studies were lacking in our inclusion which is a big limitation of our study. On the bases of above discussion, we concluded with following research gaps for future research. There is need of research to find out areas in SCM functions in which BA is used (Huang and Handfield, 2015). The extent of availability of BA and IT in industries needs to be studied (Blackburn et al., 2015). Further, it was found the advantages (Chae et al., 2014a) and results of using analytics in SC functions and its impact on SC performances. We found that there is need of exploring BA application in SC as advance technology and its impacts on SC performances and overall organisational performances.

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