Guest editorial

Big data analytics and business process innovation

Big data analytics (BDA), which is defined a "holistic process to manage, process and analyze 5 Vs (i.e., volume, variety, velocity, veracity and value) in order to create actionable insights for sustained competitive advantages" (Fosso Wamba *et al.*, 2015), is now considered as a hot topic for both practitioners and scholars. BDA has a huge potential in transforming various organizations and industries seeking sustained competitive advantage (Davenport and Harris, 2007). While much has been written about the high operational and strategic potential of BDA, the literature dedicated to the empirical evidence of the real business value of BDA at the firm and supply chain levels on the one hand, and to the relationship between BDA and process innovation on the other hand, remains thin and even poor. The main objective of this special issue was to fill this knowledge gap in the relevant literature. Specifically, a good number of scholars and practitioners have been invited to explore the ways and means to identify and capture business value from BDA in terms of innovative business models, improved decision making, improved intra- and inter-organizational performance, and competitive advantage.

All articles included in this special issue went through a double-blind review process. The review of the introductory article was handled by the editor-in-chief of the journal.

Synopsis of articles

Here below, a synopsis of the articles included in this special issue is set out.

In the paper entitled "Big data integration with business processes: a literature review", by Samuel Fosso Wamba and Deepa Mishra, the authors make a synthesis of studies published between 2006 and 2016 on the integration of business process management (BPM), business process re-engineering (BPR) and business process innovation (BPI) with big data. A total of 49 papers on big data, BPM, BPR and BPI from top journals in the retained period are profoundly reviewed. The most influential works were identified and retrieved based on the citations and PageRank methods. Through the network analysis, four major clusters providing potential opportunities for future investigation were identified. This paper ends up with the implications for both practitioners and scholars, and future research directions.

In the paper "Business intelligence serious game participatory development: lessons from ERPsim for big data", by Elise Labonte-LeMoyne, Pierre-Majorique Leger, Jacques Robert, Gilbert Babin, Patrick Charland and Jean-François Michon, the authors present a serious business intelligence's game participatory development by focusing on lessons from ERPsim for big data. They discuss educational methods to prepare business students to use business analytics tools when they reach the workplace. The authors introduce a new serious game and discuss how it was developed through collaborative efforts, together with a testing of an enactive approach to teach business intelligence

concepts and provide hands-on experience to students in an authentic and dynamic business environment.

The paper titled "Examining the adoption of big data and analytics curriculum", by Alexander J. McLeod, Michael Bliemel and Nancy Jones, examines the demand for big data and analytics curriculum. Such demand seems to be increasing as organizations are more and more eager for a highly skilled and data-savvy workforce. Connecting business processes and analytics is important to facilitate decision making, and yet, today, this means dealing with big data. Thus, it is crucial to examine and share how faculties come to adopt curriculums on evolving big data and analytics. To support the dissemination of such curricula, large software companies such as SAP, Oracle and Microsoft fund programs that provide "hands-on" curricula to be adopted by academic institutions. One such program, SAP University Alliances, supports the development of faculty curricula, subsidizes targeted curriculum development based on its products and provides community-based support for courses such as big data and analytics. This landscape continues to change as technological improvements make their way into businesses and academia. In this work, the authors explore the SAP University Alliances program to review the academic utilization of curricula on big data and analytics, and then consider academic usage trends and suggest a research agenda to support new curriculum development. The results show that there is a sizable shift toward business process curriculum in general and a larger demand for newer big data and analytics curriculum. Recommendations from business leaders in this area encourage the identification of business processes in the production of big data and analytics, so as to enable better organizational decision making. A faculty interested in creating or furthering their business process programs to include big data and analytics will find in this study a number of practical information, materials, suggestions, as well as a resourceful agenda on research and curriculum development.

The paper entitled "A big data framework for facilitating product innovation processes" is coauthored by Yuanzhu Zhan, Kim Hua Tan, Guojun Ji, Leanne Chung and Minglang Tseng; it seeks to explore how firms could use big data to facilitate product innovation processes, notably by shortening the time to market, improving customers' product adoption and reducing costs. The research is based on a two-step approach. First, this research identifies four potential key success factors for organizations to integrate big data with a view to accelerating their product innovation processes. The proposed factors are further examined and developed by conducting interviews with different organization experts and academic researchers. Then, a framework is proposed based on the interview outputs. This framework sets out the key success factors involved in leveraging big data to reduce lead times and costs in product innovation processes. The findings show that the three determined key success factors are: accelerated process, customer connection, and a fast launch-and-improve ecosystem. We believe that the developed framework based on big data represents a paradigm shift. It can help firms to make new product development faster and less costly.

In the paper "A theoretical model of jump diffusion-mean reversion – constant proportion portfolio insurance strategy under the presence of transaction cost and stochastic floor", by Anindya Chakrabarty, Zongwei Luo, Rameshwar Dubey and Shan Jiang, the authors develop a theoretical model for the jump diffusion-mean reversion – constant proportion portfolio insurance (JD-MR-CPPI) strategy with transaction cost and stochastic floor. From the existing literature on CPPI strategy, a common assumption has been that the investment in the risk-free assets grows at a constant rate in spite of frequent trading. Empirical evidence buttresses the fact that the interest rate follows a stochastic mean reverting behavior, and thus the frequent reshuffling of portfolio between risky and risk-free assets makes it impractical to assume that the investment in the money market account will grow at a constant rate along the entire investment horizon. Considering this gap, this paper modifies the CPPI algorithm by

redefining the floor of the algorithm in order to turn it into a stochastic mean reverting process which is guided by the movement of the short-term interest rate in the economy. This development is more relevant for two reasons. First, the short-term interest rate changes with time and, therefore, the constant yield during each rebalancing step is not practically feasible. Second, historical literatures have revealed that the short-term interest rate tends to move opposite that of the equity market. So, during the bear run, the floor will increase at a higher rate whereas the growth of the floor will stagnate at the bull phase which helps the model to capitalize on the upward potential at the growth phase and to cut down on the exposure at the crisis phase. In the theoretic model of the JD-MR-CPPI strategy in the presence of transaction cost and stochastic floor as opposed to the deterministic floor, the paper adopts the Merton's jump diffusion (JD) model to simulate the price path followed by risky assets, but also the CIR MR model to simulate the path followed by the short-term interest rate. The floor of the CPPI strategy is linked to the stochastic process driving the value of a fixed income instrument whose yield follows the CIR mean reversion model. The developed model is benchmarked against CNXNIFTY 50 and is back tested using the Monte-Carlo simulation across the crisis and recovery phases of the 2008 recession regime, and this revealed that the portfolio performs better not only than the risky markets during the crisis by hedging effectively the downside risk, but also than the fixed income instruments during the growth phase by leveraging on the upside potential. This makes it a value than can enhance a proposal for the risk adverse investors.

In the paper "A bibliographic study on big data: concepts, trends and challenges", the authors Deepa Mishra, Zongwei Luo, Shan Jiang, Thanos Papadopoulos and Rameshwar Dubey conduct a review of the literature on big data by using citation and co-citation analysis. Citation analysis enables researchers to understand when the major articles in a field were published and how their popularity has evolved over time, and to see whether an article is still useful for current research (Pilkington and Meredith, 2009). Co-citation analysis, on its part, can reveal the major research clusters within a particular field and show how they evolve and vary across different journals over time. The article has a two-pronged objective: providing a consolidated overview of the existing literature on "big data"; and describing the current trends and opening up various future directions that may be explored by researchers as further research inputs in this rapidly evolving field. This analysis involved an assessment of 57 articles published over a period of five years (2011-2015) in ten selected journals. The findings reveal that the number of articles devoted to the study of "big data" has increased rapidly in recent years. Moreover, the study identifies some of the most influential articles of this area. The findings of research can help researchers to understand the evolution of research trends in the field, and those articles that have been influential in shaping research in these years; and to reveal the intellectual structure of the field. It is important for companies to adopt BDA so as to better comprehend the trends in customer behaviors and provide them improved and customized services.

The paper entitled "Past, present and future of contact centers: a literature review", by Morteza Saberi, Omar Khadeer Hussain and Elizabeth Chang, deals with intelligent contact centers in CRM. While contact centers play a pivotal role in organizations and form an important part of CRM operations with the changes in technology, their operation and structure have to evolve in order to meet the ongoing challenges. In this paper, the authors made a review of the state-of-the-art literature and described the challenges while identifying the gaps to be filled through intelligent contact centers. The current literature on contact centers is essentially made up of analytical and managerial studies. It has been found that current contact centers suffer from two main defects, namely the lack of interactive contact centers and the high amounts of unstructured data. Given the production of massive amounts of data in contact centers, especially unstructured data, the authors opted for discussing the benefit of using big data processing techniques in contact centers and presenting it as a new research agenda for

CCs. Based on the critical literature review that are being made on contact centers, these structures have the potential to receive more attention from data scientists in the next decade.

In the paper "Let's stop trying to be 'sexy' – preparing managers for the (big) data-driven business era" by Kevin Daniel André Carillo, the author critically investigates the inadequacies of current business education in the tackling of the educational challenges inherent to big data and to the overall advent of a data-driven business era. Through a review of the literature and of secondary data, it analyzes the implications of digitization and BDA on organizations, with a special emphasis on decision-making processes and the function of managers. The paper argues that business schools and other educational institutions have well responded to the need to train future data scientists but have rather disregarded how the function of managers and decision makers shall evolve in data-driven organizations. In short, the development of analytics skills and mindset shall not pertain to data scientists only; it must rather become an organizational cultural component shared among all employees and, more specifically, among managers. In the data-driven business era, managers turn into manager-scientists who shall possess skills at the crossroads of data management, analytical/modeling techniques and tools, and business. The multidisciplinary nature of BDA and data science seems to collide with the dominant "functional silo design" that characterizes business schools which have been criticized for years for their lack of multidisciplinary integration and experiential components. The specificities of analytics and data science necessitate revisiting pedagogical models by developing approaches such as experiential learning or spiral-shaped pedagogy. The attention of scholars is needed as there is an array of unexplored research territories in which investigation will help bridge the gap between education and the industry. The results and recommendations of this paper will help practitioners and business education to develop effective trainings and programs that are suited to address the challenges faced by data-driven organizations.

The paper "Does big data analytics influence frontline employees in services marketing?" by Saradhi Motamarri, Shahriar Akter and Venkat Yanamandram, argues that frontline employees (FLEs) play a dual role as "voice of the firm" to the customer and "voice of the customer" to the firm. The FLEs need to adapt their service to suit the individual customer needs and thereby enhance the customer's service experience. In high contact services, like financial, healthcare and airlines, FLEs need to deal with every other customer differently as the interactions are highly personal and variable in nature. Detailed information about customers and their path to service facilitate FLEs to adapt the service in an optimal fashion. BDA may provide insights about the customers' preferences and market conditions, which facilitate service adaptation. For a financial consultant, a prior idea about a customer is invaluable in structuring an effective solution; as for a retailer, he can offer better discount to a loyal customer, while an airline may propose an optimal itinerary for a frequent traveler. Aptly, Ostrom *et al.* (2015) have identified big data as one of the 12 key research priorities for services marketing. The motivation for this research is to answer the question: "How does big data analytics enable frontline employees in effective service delivery?" In doing so, while synthesizing the extant literature, the paper explores the challenges of FLEs to: enhance service delivery, support informed customers, achieve mass-customization, and build deeper relationships with customers. From the perspective of FLEs, the role and necessity of BDA differ from one service type to another. For example, delivering a financial consultation is resource- and time-intensive in comparison to processing a withdrawal request at a teller counter. In recognition of this, the research develops a service typology to explore the research questions. Similar to variations in customers and service types, there exist variations among FLEs and it is vital to recognize their typology as well. In addition to these variations, firms also vary according to their maturity in deploying BDA across their business functions. One of the findings of this research is that all these typologies

intricately interact and influence BDA and impact the service delivery capabilities of frontlines. Our analysis also conveys that in knowledge-intensive, customizable and high contact service contexts with innovators, the type of FLEs in highly matured BDA firm settings (metamorphosis or Level 5) results in higher co-creation potential for both firms and customers. However, the review has identified significant knowledge gap in enabling the FLEs with BDA tools. Reconciling such shortcomings from the service-dominant logic perspective, it implies that managers ought to enhance the skill asymmetry between their frontlines and customers so that providers sustain their service portfolio. It also suggests that managers need to devise training programs to enable frontlines. Frontlines are to be oriented with customer linking and market-sensing capabilities and empower them to make adaptive decisions in real time. Ultimately, the better the frontlines deliver service, the better organizations sustain in the competitive markets. Last but not least, both firms and customers also need to be aware of the privacy and ethical concerns of big data.

In the paper "Big data in the Danish Industry: application and value creation" by Sune Dueholm Müller and Preben Jensen, the authors argue that companies are increasingly realizing the value creating potential in big data. This article focuses on how SMEs use big data to create value. The study compares the findings from an online survey among 457 Danish companies with the extant literature, in an effort to address the following research question: To what extent does the application of big data create value for small and medium-sized companies? The findings show that the application of big data correlates with value creation, but that it is highly dependent on the organizational context and managerial action. Companies should not focus on capturing, storing, and analyzing data through application of technology in isolation. Strong leadership is needed in terms of establishing and communicating clear business goals. IT capabilities, business processes, and analytical skills need to be aligned with and adapted to those goals. Thus, a holistic perspective on big data is advocated and implications are offered with an emphasis on how the application of big data creates value for SMEs.

In the paper "Employees' reactions to IT-enabled process innovations in the age of data analytics in healthcare" by Hillol Bala and Viswanath Venkatesh, the authors claim that inter-organizational business process standards (IBPS) are IT-enabled process specifications that standardize, streamline and improve business processes related to inter-organizational relationships. There has been much interest in IBPS as organizations from different industries implement these process innovations that lead to successful organizational outcomes when they are integrated into and standardized with intra- and inter-organizational business processes. These process innovations enable BDA capabilities by facilitating new sources of inter-organizational process data. The purpose of this study is to unearth employees' reactions to a new type of supply chain process innovations that involved an implementation of a new IBPS and supply chain management (SCM) system and associated analytical capabilities. The researchers gathered and analyzed qualitative data for a year from the employees of a healthcare supplier, a high-tech manufacturing organization, during the implementation of a SCM system and RosettaNet-based IBPS. In what they termed the initiation stage, there was quite a bit of confusion and unrest among employees regarding the relevance of the new process standards and associated analytical capabilities. With the passage of time, in the institutionalization stage, although the situation improved slightly, employees found workarounds that allowed them to appropriate just part of specific processes and the analytical capabilities. Finally, once routinized, employees felt comfortable in the situation but still did not appropriate the new supply chain processes faithfully. Overall, employees' reactions toward the SCM system and associated analytical capabilities were different from their reactions toward the new business processes. Significant contribution to the literature is hereby made by the authors, as they offer novel insights on how employees react to and appropriate process innovations that change their work processes.

In the paper "Big data analytics: transforming data to action" by Daniel Bumblauskas, Herb Nold, Paul Bumblauskas and Amy Igou, the authors provide a conceptual model for the transformation of big data sets into actionable knowledge. The model introduces a framework for converting data to actionable knowledge and potential impediments for the organization. Case examples and the use of dashboards provide a practical application for analysis of big data. The authors developed the model and used industry experience and network resources to gain valuable insights into an effective BPM related to BDA in research and practice. Examples and cases have been provided to highlight the use of dashboards as a visual tool within the conceptual framework. They argue that the transitions required reaching the actionable knowledge state; virus identification process and dashboard visualization tools can all be deployed by practitioners in industry. Furthermore, information assurance, security, and the risk of large-scale data breaches are a contemporary problem in the society today. These topics have been addressed within the model framework.

In the paper "Digital competences of the workforce – a research topic?" by Matthias Murawski and Markus Bick, the authors deal with digital competences of the workforce. They discuss whether this field is a research topic or not. Their paper presents both pros and cons regarding this issue based on the experiences and findings gathered from literature analysis as well as practical projects. The authors argue that digital competences of the workforce are indeed a research topic. They conclude by providing a first proposal of a research agenda for the topic at hand. Although a comprehensive list of related literature is provided, this paper is a personal viewpoint and does not report on the outcomes of a structured research project. This paper is one of the very few contributions that are being made in the area of digital competences of the workforce; besides, it considers various perspectives like different IT generations, occupations, roles, and curricula design.

In the paper "Automated competitor analysis using big data analytics: evidence from the fitness mobile app business", by Liang Guo, Ruchi Sharma, Lei Yin, Ruodan Lu and Ke Rong, the authors argue that competitor analysis is a key component in operations management. Most business decisions are rooted in the analysis of rival products inferred from the market structure. Relative to more traditional competitor-analysis methods, they provide operation managers with an innovative tool to monitor a firm's market position and competitors in real time at higher resolution and lower cost, all of which more traditional competitor-analysis methods cannot enable. They combine the techniques of Web Crawler, Natural Language Processing and Machine Learning algorithms with data visualization to develop a big data competitor-analysis system that informs operations managers about competitors and meaningful relationships among them. The authors illustrate their approach by using the fitness mobile app business. Their study shows that the proposed system supports operational decision making both descriptively and prescriptively. In particular, their innovative probabilistic topic modeling algorithm combined with conventional multidimensional scaling, product feature comparison and market structure analyses reveal an app's position in relation to its peers. The authors also develop a user segment overlapping index based on user's social-media data. They combine this new index with the product functionality similarity index to map indirect and direct competitors with and without user lock-in. Their approach improves on previous approaches by fully automating information extraction from multiple online sources. The authors believe this is the first system of its kind. With limited human intervention, their proposed methodology can easily be adapted to different settings, giving quicker, more reliable real-time results. Their approach is also cost-effective for market analysis projects covering different data sources.

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