The Opportunities of Big Data Analytics in Supply Market Intelligence

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Abstract. Firms need comprehensive knowledge and understanding of the opportunities available in the market by creating supply market intelligence (SMI). SMI can facilitate in finding the best partners and combination of capabilities within collaborative networks (CN). However, despite of its evident managerial relevance, SMI is still little researched topic. Simultaneously, big data analytics (BDA) has developed rapidly, becoming vital for businesses across industries. The objective of this paper is recognizing the importance of SMI and opportunities of BDA through qualitative research. The data derives from two focus group discussions of 75 purchasing professionals and six qualitative interviews of BDA experts. This research contributes to our understanding of the opportunities of BDA in creating systematic SMI to reinforce strategic collaboration, and to the understanding of knowledge as a strategic resource for forming strategic CN. Collaborative big data intelligence creates value through, for instance, creating transparency in business processes and discovering market changes.

Keywords: Supply Market Intelligence, Big Data Analytics, Strategic Collaboration, Data-Rich Systems, Collaborative Big Data Intelligence

1 Introduction

Many firms have developed both horizontal and vertical collaboration networks to respond to the increasing global competition. Particularly in technology based industries, firms' competitiveness depends much on the complementary services and on the entire business ecosystem they are embedded in. Fast developing technology and often very short business opportunity windows create need for fast adaptation to changes in dynamic networked markets, and thus, there is a need for continuous exploration of information about the advancement of technologies and changes in the business environment. Companies need comprehensive knowledge and understanding of the opportunities available in the market to find the best partners and combination of resources to the collaborative networks (CN) [1].

Dynamic sourcing strategies require intelligent actions through collaborative activities, thus supply management has a vital role in understanding the supply environment [2]. In purchasing and supply management (PSM) literature, the concept

of supply market intelligence (SMI) has been introduced to answer this call. SMI is defined as "the ability to develop deep insights into key supplier market characteristics, including emerging technologies, price and cost trends, mergers and acquisitions (M&A), capacity requirements, quality and delivery performance, and other key supplier capabilities that form the basis for sound strategic sourcing" [3]. SMI facilitates in selecting partners, making good contracts and developing collaborative business models [4]. Data about potential partners and supply markets are available in many forms and sources, but the challenge is to identify, extract, analyze, present and use the data in processes [5]. Collaborative approach is needed for utilizing the opportunities of big data analytics (BDA) in SMI.

Recently, development of data management technologies and analytics enables leveraging big data in innovative ways [6]. Big data refers to the capability to process and utilize data that has features of volume, variety, velocity (3Vs) and other granular and complex properties that distinguish big data from data in relational databases [7]. BDA consists of processes for identifying new insights that have potential to provide economic value. Fast development of BDA has left little time for maturing discourse and research. Conversely, previous approaches to CN were embarrassed by scarcity of data, and thus they need to be revisited. Therefore, in order to harness the potential of BDA in SMI, the main research question is: What are the opportunities of BDA in creating systematic SMI to reinforce strategic collaboration? Questions that help in answering the main research question are: What is the importance of SMI in creating competitive advantage across collaboration networks?, and How can BDA be utilized for SMI? This paper represents empirical results of two focus group discussions with totally 75 company managers and interviews of six big data experts. The focus group discussions provide broad viewpoints from purchasing professionals, whereas the big data experts bring valuable knowledge of the opportunities of BDA.

This paper is organized as follows. In the second section, we shortly discuss on literature of CN and then review the current literature base on SMI and BDA, in order to understand the current academic and managerial knowledge. In the third section, we describe the research methods of focus groups and qualitative interviews as our empirical research approach. The fifth section describes results from the conducted qualitative research. Discussion and conclusions recapitulate this paper.

2 Literature Review of SMI and BDA

2.1 Collaborative Networks

A digital, hyperconnected economy creates a specific and unique form of value creation wherein the firm and its partners generate value for various users in the networked market [8]. Therefore, organizations frequently form various types of partnerships, such as CN and virtual organization (VO), in order to share knowledge, skills and resources to seize market opportunities, create innovative products, and provide value-added services together with partners. [9] For effective collaboration, new models are required in the era of data-rich world and for instance the concept of collaborative business ecosystem (CBE) has been highlighted [10]. Depending on the

type of required support and objectives, these CN with different configurations and purposes are often divided to [11]: 1) Long Term-Strategic Network (i.e. Virtual breeding environments) and 2) Goal-Oriented Network (i.e. VO). In this paper, we focus on supply networks and markets as long-term strategic networks (supply base). Thus, we aim to complement the view by deepening understanding on development of new strategic collaboration networks (supply markets). The full potential of data-rich world can be captured in collaboration with external actors, i.e. CN, as access to and integration of third-party big data sources is required to explore changes in networked business environment.

2.2 SMI in Present Research

SMI includes recognizing and understanding supply market competition, dependencies and dynamics in global supplier corporate hierarchies, networks and linkages. SMI as a concept is often mentioned in PSM research. It is suggested to be an enabler for developing sourcing strategies [12], interpreting supplier behavior and making supply management decisions [13], as well as selecting and committing to suppliers [14]. SMI has an important role in securing availability from risky supply markets, in developing (new) strategic collaboration networks and in supply management and category strategy development as well as other strategic business decisions [15]. Interestingly, 'breakthrough scanning' of the environment for innovations results in higher technical proficiency of the customer company and in increased knowledge sharing with suppliers [16]. SMI is linked with higher levels of internal integration, as the resulting 'valuable information increases the inclusion and integration of supply management in the organization's activities' [2].

Although the importance of SMI is generally accepted in the literature [15], the research is scattered, and our understanding of capturing the potential of SMI in creating strategic networks and competitive edge is still limited. Data are worthless without context and understanding, thus an intelligence hierarchy is applied (Fig. 1).

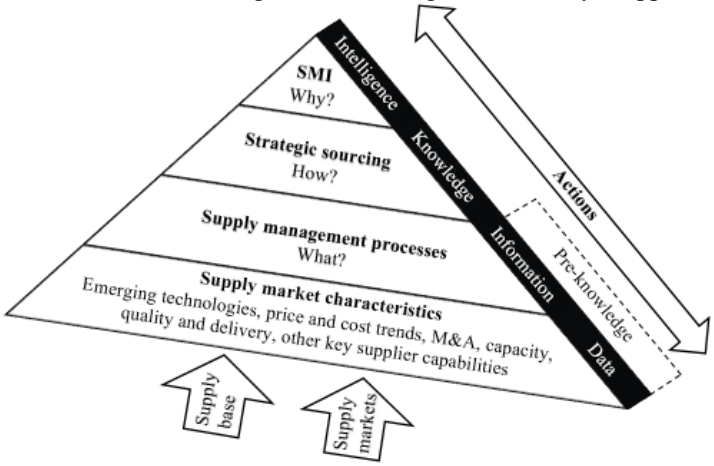

Fig. 1. Data, information, knowledge and intelligence in SMI (Source: [3]; [17])

Intelligence as the highest level refers to the capacity to acquire knowledge to facilitate actions [18]. Data and information can be called pre-knowledge that are needed for knowledge creation [19]. Intelligence from the supply base and supply markets is generated when pre-knowledge is collected and analyzed to form actionable conclusions that affect a company's ability to strategically locate, secure, and manage sources of supply [20]. Active collaboration is needed during the process of transforming data into intelligence on a timely and precise manner [21].

2.3 SMI and BDA

Data exist in every sector, economy, organization and user of digital technology [22], and the amount of generated data continues to grow rapidly. As per existing literature, data can be categorized based on the form, and ownership or access to the data (as per Fig. 2). The formation of unstructured data to structured data is a continuum, including semi-structured data that does not follow a conventional database system [23]. Structured data are stored in fixed fields, such as relational databases and data spreadsheets, whereas unstructured data resides in various sources and formats, such as free-form text, image, video or untagged audio. [22] Notably, the line between structured and unstructured, relative to internal and external data is indistinct since external data can also be structured or semi-structured.

Business data are often proprietary containing non-disclosure agreements, but firms are realizing the strategic importance of investing in insight based decision-making and value co-creation [24]. As data can be a competitive asset, companies need to understand data, which they hold or have access to by inventorying proprietary data and cataloging external data [22]. Internal data should be organized before acquiring external data [25].

Big data definitions have evolved rapidly, resulting to fragmented classifications [6]. Using the 3Vs characteristics big data is commonly defined as: "high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision-making, and process automation" [7]. Besides, concepts like veracity, variability and visibility [26], value and virtual [27] are used subject to sector, size and location of the company [6].

Generating insights from the marketplace to support intelligent decisions requires new analytical tools. Often two categories of analytics are identified as descriptive and predictive. Predictive analytics is a significant aspect of BDA, creating radical new insights and opportunities with third parties via automated algorithms and real-time data analysis [25]. The key in creating value via BDA is collaboration between analytics professionals mining and preparing data, conducting statistical operations, building models and programming business applications, and the businesspeople capable to utilize analyses in processes [28].

BDA applications are increasingly important in strategic sourcing and collaboration. The ability to capture, store, aggregate and analyze data for extracting intelligence is vital for strategic decisions. [25] Big data applications in SMI consist of the areas, which provide insights into key supply market characteristics, consisting of emerging technologies, price and cost trends, M&A, capacity requirements and

quality and delivery performance. Patents are an important knowledge resource in identifying technology development trends and opportunities, specifically emerging technologies [29]. Through descriptive statistics, such as the frequency table, retrieved patent documents can be summarized, using representative variables in order to discover novel data for technology forecasting and analysis [30]. Interest and exchange rates analysis is an important part of price and cost trends prediction and financial risk management in the global and unstable economic environment. Exchange rate movements can be forecasted, for instance, from time series of social media channels, such as Tweet counts [31]. M&A actions are influenced by competition policies, which can be analyzed and reveal insights from the retail sites as well as the social side via social media analytics solutions [32]. Furthermore, user demographics can be utilized to find patterns and create insights into usage clusters in order to create multidimensional segmentations and evaluate capacity requirements [33]. Finally, geographic information systems facilitate delivery performance monitoring and optimizing by integrating spatial data into regressions or simulations [22].

Reaching the full potential of BDA in SMI requires accessing third-party data sources that may be public, through collaboration or purchased, and involve several data types [22]. Access to external market and internal enterprise data supports supply management by integrating software between enterprises and supply chain partners.

Research framework

In studying the research questions, the importance of integrating external data to the company's context and internal data is recognized. Therefore, a data categorization / integration -based research framework is applied (Fig. 2), as a baseline for the research and a tool for analysis of the empirical data.

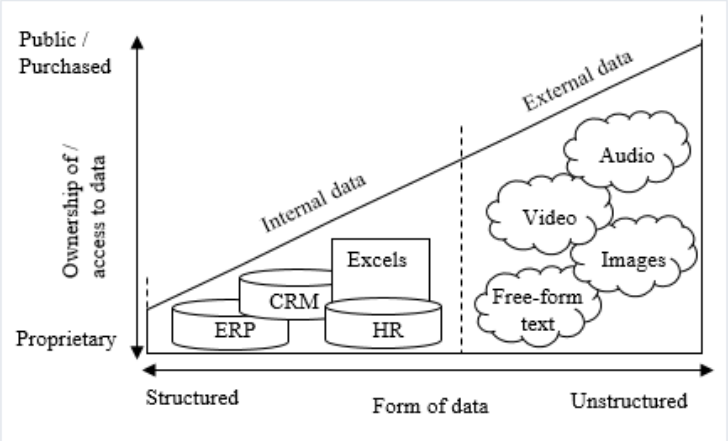

Fig. 2. Data categorization / integration -based research framework (Source: modified from [24]; [23]; [22])

3 Research Methods

Data collection methods in this paper consist of two focus group discussions with purchasing professionals and six qualitative interviews of big data experts (Table 1). Qualitative research is particularly relevant when there are minor previous insights about a phenomenon under study, which indicates that qualitative research is exploratory and flexible due to unstructured questions [34]. The choice of method was based on the types of research questions [35]. The practical orientation of big data enabled SMI coupled with a lack of academic research proposes a research approach that includes a strong collaboration between academics and practitioners. We consider focus groups an appropriate method for collecting empirical data, as we can benefit from the participants' practical experience related to SMI and need for SMI. In addition, the approach was chosen because focus groups allow idea generation and strong interaction between members of focus groups, which generates new perspectives and in-depth answers [36]. Focus groups can be defined as 'a research methodology in which a small group of participants gathers to discuss a specified issue under the guidance of a moderator' [37]. Focus group participants produce qualitative data during a focused discussion to explore particular areas of interest.

The focus groups allowed us to gather empirically relevant data from large number of purchasing professionals. However, as the application of big data was still limited, we added interviews of big data expert to get an understanding of the potential of technology. The selected BDA experts have expertise from a wide range of data engineering and analytics solutions, thus enabling to receive insights into the opportunities of BDA in creating SMI.

Table 1. Overview of the data collection

Method	Objective	Number of informants	Role of informants
Focus group discussion 1	To get an understanding of the need for SMI in companies and how companies are performing today	35	Purchasing professionals
Focus group discussion 2	To examine what are the fundamentals, pre-knowledge, methods and use cases of systematic SMI by utilizing BDA	40	Purchasing professionals and BDA experts
Semi-structured interviews	To answer how can big data be categorized and what are the most suitable BDA methods, and what opportunities there are in creating SMI and providing value	6	BDA experts

Two focus group sessions were organized, in which 35 participants were invited to the first, and 40 to the second one. The participants were purchasing professionals from different companies, representing various industries and positions in the value chain, providing views of both customers and suppliers. Their shared professional background and identity thus enabled discussion in a shared language and facilitated knowledge sharing [36]. In the first focus groups the participants were divided into three groups which discussed three questions in three rounds lasting 25 minutes each:

(1) Why and when SMI is important? (2) How SMI is conducted in your company? By whom? Please tell examples from practice. (3) How SMI capabilities should be developed?

In the second focus group, the participants were mostly purchasing professionals, in addition to a few BDA experts. The participants were divided into six groups, in which 1-2 mediators guided the discussions and made notes of the participants' answers. All of the groups discussed two questions lasting 20 minutes each: (1) Describe an ideal situation of what data from the supply market would you need to reinforce supply management in your company? (2) Which changes in the supply market are most relevant in supply management? How can intelligence be used to prepare for changes in the supply market? Furthermore, two of the groups discussed third question for 10 minutes: (3) Who creates SMI in your company? Who should do it?, and finally one group discussed last question for 10 minutes: (4) Which supply management processes can benefit from descriptive analytics? Which processes require and can benefit from predictive analytics?

In addition, we conducted BDA expert interviews to receive valuable insights to creating SMI using BDA. The discussions concentrated mainly on the potential and benefits BDA can create for business through supply management, enabling strategic collaboration with particular partners. Qualitative interviews enable tailoring for the purposes of the research objectives and questions of the study. Three of the interviewees represent BDA solution providers to study analytics solutions and customers' needs for SMI. Furthermore, three interviewees of BDA experts were selected from the academic field to study the current research and knowledge regarding the subject. The interviews were recorded and transcribed for further analysis.

Data coding and analysis was conducted through coding, using a qualitative data analysis software NVivo. The first focus group discussions were analysed by use of coding; identifying the needs and methods for SMI. The analyses of second focus group discussion strongly utilized the framework derived from related literature (Fig. 2). The BDA experts' interviews were analysed in order to discover opportunities for creating SMI using BDA, and analysis use cases to reinforce strategic collaboration.

Data triangulation was ensured through different data collection methods as well as analysis from different perspectives. Data was analysed by two researchers from the perspective of strategic sourcing and one of the researchers brought the point of view of knowledge management into the analysis.

4 Findings

Based on the empirical research, it was discovered that collaboration should be threefold in order to harness the opportunities of BDA in SMI. According to focus group discussions SMI enables (long-term) strategic collaboration with suppliers and other external partners for joint development opportunities and innovative solutions. Secondly, internal collaboration between business units is required for information sharing and strategic alignment. Thirdly, the interviews of BDA experts revealed that collaboration between supply management professionals and big data analysts is a

prerequisite for harnessing the full potential of big data solutions to support informed decision-making in networked business environment. This requires analytical mindset and receptive attitude from the supply management professionals and business understanding from the big data analysts. Supply management professionals perceived strategic alignment between business units and suppliers, as well as actions such as joint development opportunities with suppliers as fundamentals for innovation and strategic collaboration.

The company representatives in the focus groups considered SMI to be critical in predicting and identifying changes in the supply base and supply markets among existing and new partners. SMI can be used to find and select new suppliers, and evaluate current suppliers as well as make choices such as when to change partners. SMI is important for reacting to changes in the supplier base, and for anticipating risks, for example connected to raw material availability. Supply risk management, comprising of for example country and image risks, was considered important in all of the second focus groups. Ecosystems may change much faster than the focal company, thus frequently producing new valuable business opportunities by finding new partners. In specific, the ability to scan new supply / partner markets was considered important in new business development, requiring becoming familiar with new supplier bases connected to for instance new geographical areas. Furthermore, SMI allows rapid identification of new opportunities. Up-to-date knowledge about new technologies and capabilities may be important in contributing to innovation and business development.

Moreover, the BDA experts emphasized the importance of going further than just monitoring changes in the markets. One of the interviewees stated: "It is not enough that the system gives an alert, but it needs to justify why it was distributed and what should be done." The system should recommend further actions, or in some cases even automatically solve the issue. Value from BDA derives from applying the analyzed information to decision-making and actions. In supply management, the value from BDA can be divided into backward and forward oriented as well as reactive and proactive processes. Due to the dynamic and complex business environment and supply markets, management of change and staying ahead of market fluctuations is crucial. Forecasting the future and being aware of current market conditions and potential risks via SMI enables proactive actions and fast reactions to unprecedented events. However, as per one of the BDA experts: "In a very critical part is that the one who is using the information understands what it is, and that is the biggest challenge." If the extracted insights are not converted into intelligence across business units, value from the analysis will be unexploited. Hence, collaboration between business people and analysts is important, in collaboration with external partners and across business units for acquiring knowledge and identifying development opportunities.

As today, SMI in the sample companies was still immature and not systematic. The use of BDA was very limited and minor. Internal data in relational databases was mostly not sufficiently organized, and knowledge sharing between business units was infrequent. Segregation of "traditional data" in relational databases and big data was indistinct, even though as per the BDA experts, one of the most important aspects is integrating data from diverse legacy systems and external market data. The research framework (Fig. 2) is utilized to analyze the BDA expert interviewees to present a

more precise framework for pre-knowledge categorization in the context of SMI (Fig. 3).

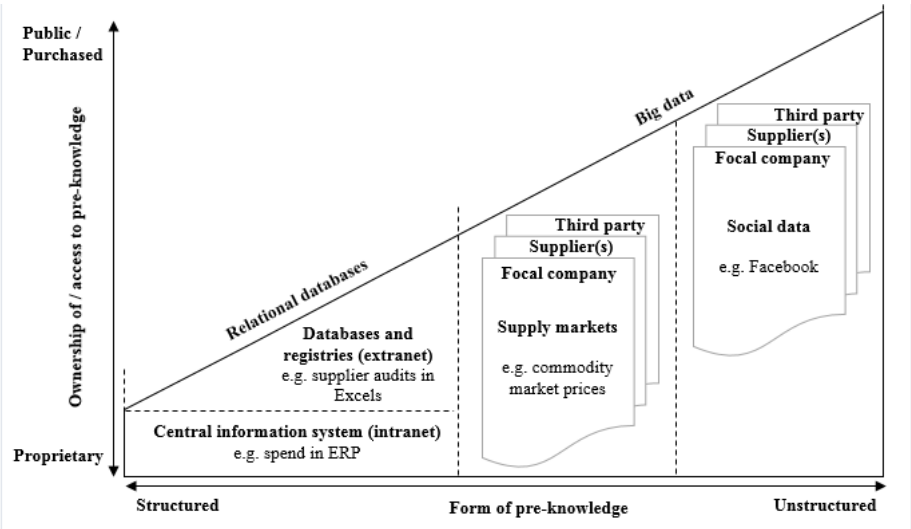

Fig. 3. Pre-knowledge categorization in the context of SMI

Pre-knowledge for creating SMI consist of data and information before refining them into knowledge. Below in table 2, some examples of pre-knowledge according to the supply management professionals and BDA experts are presented.

Table 2. Examples of pre-knowledge in different categories based on empirical research

Intranet	Extranet	Supply markets	Social data
Supplier spend (per category, supplier)	Total cost of ownership	Global price levels	Attractiveness of the company / importance of other customers
Contracts (purchase prices, terms of payment)	Fast-moving consumer goods	Commodity MI	Suppliers' reputation / experiences perceived by others
Working capital / savings	Proprietary indices	Quality and delivery performance	Corporate hierarchies / networks and linkages
	Suppliers' impact on business	Future market (mega)trends	My Data
	Suppliers' value proposal and compliance	Product and service availability / capacity	Social media
	Financial performance	Innovations and technological development	
		Business environment drivers / key players	
		Existing suppliers' abilities and new suppliers and solutions	
		Suppliers' alignment / accountability	
		Suppliers' personnel turnover	
		Demand and supply	
		M&A and personnel turnover	
		Rules and regulations	

According to the research findings, the supply markets consist of a wide range of data and information, so before acquiring the data it is important to define what data are needed, why they are needed and how they are utilized to support supply management processes. Hence, as per the big data experts "Asking the right questions is vitally important". One of the most appeared pre-knowledge was recognizing future market trends and megatrends, but also their influence on suppliers' strategy and value proposal. Access to this type of data and information requires collaboration across networks.

5 Discussion and Conclusions

As per recognized in the literature ([4]; [15]; [20]) and verified by the purchasing professionals, SMI is an important capability for the firm, as firms need comprehensive knowledge and understanding of the opportunities available in the market to find the best partners and combination of capabilities within the CN. However, despite of its evident managerial relevance, SMI is still little researched topic. This research contributes to our understanding of the opportunities of BDA in creating systematic SMI to reinforce strategic collaboration, and to the understanding of knowledge as a strategic resource for the forming of strategic CN. Therefore, the term collaborative big data intelligence is utilized in order to highlight the need for involvement of multiple parties. The radical new source of value and competitive advantage in supply management originates in the intersection of different sources of data, for instance, comparing negotiated prices to market prices and the causal connections of price fluctuations to a company's profitability. With the expertise of a BDA solution provider, and businesses capability to absorb analyses, it is possible to reach more mature BDA and receive comprehensive results.

The results of this paper suggest that decision-making support is one of the most critical benefits that can be achieved through collaborative big data intelligence. Threefold collaboration is needed for reaching the full potential of BDA in SMI for acquiring knowledge and recognizing collaboration opportunities with suppliers. Collaboration between analysts and business people is supported by literature [28], but this research contributes to recognizing collaboration opportunities with external partners. Once an opportunity is recognized, SMI can be used to indicate the win-win situations to external partners. By utilizing big data technologies, multidimensional segmentations based on defined criteria enable, for instance, evaluating capacity requirements, user demographics, and supplier suitability for a particular company.

According to the big data experts, some of the biggest advantages of BDA are advanced algorithms that can automate routine tasks, leaving more time for strategic decisions that require human input. In addition, collaborative big data intelligence provides visibility and openness to processes, allowing perceiving defects and initiating improvements. Also previous literature has proved that there is great potential to benefit from BDA by collecting and analyzing the data, and utilizing them to detect risks [31]. Correspondingly, supply risk management, linked to recognizing needs and opportunities, was perceived as one of the most important aspects according to the purchasing management professionals. Implemented by analysts,

BDA makes it possible to receive automatic alerts of threats and changes, or correspondingly opportunities that require actions. However, simply alerts are not enough, but reasons and understanding of the alerts is required for intelligent actions. BDA can provide suggestions for action plans, but at present human intervention is still required for most critical decisions and processes. BDA can be used to analyze the past via historical data, describe the present in real time and forecast the future. Instead of focusing only on the figures of spend and savings, more forward oriented approach of supply pipeline management should be applied. Utilizing BDA enables to detect risks and opportunities, and proactively develop the pipeline and networks. Ability to accomplish backward focused cost-follow up is needed for moving to forward oriented forecasting.

As in any empirical research, the results of the present study cannot be interpreted without taking into account its limitations. Thus, this study provides many interesting avenues for further research. It may, for instance, take place in the form of multiple case studies of leading firms and their CN in order to more fully understand the potential of SMI.

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