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An integrated concept for supply chain analytics in Small-medium sized enterprises

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ABSTRACT

Recent developments such as the Internet-of-Things generate data and foster the exchange of it among nodes in various fields such as the supply chain management. This allows firms to improve their supply chain performance by analyzing the data. However, many firms struggle to store the data, analyze the data, and interpret the data. Therefore, we propose a concept that integrates existing IS solutions helping firms to identify and realize a higher (supply chain) performance. The concept covers supply chain analytics, big data (storage), and IT architecture. More importantly, the concept can be realized with a low-budget solution allowing even small-medium sized enterprises to apply it and realize performance gains. We contribute to theory by proposing an integrated big data and analytics concept, and a supply chain analytics solution. Future research can use our concept, e.g. to develop low budget supply chain analytic scenarios or compare performance gains between our solution and cost-intensive solutions.

Keywords (Required)

Supply Chain Analytics, Big Data, IT Architecture, Integrated Concept.

INTRODUCTION

The storage and collection of big data allows firms to develop new business processes and thereby create value, especially in the field of supply chain management (Vogt 2011; Waller and Fawcett 2013). For example, supply chain analytics allows firms to use data to improve their forecasts and predict customer orders by integrating real-time data and data from various sources such as social networks (Alias et al. 2016; Waller and Fawcett 2013). In specific, using data from retailers in combination with data from social networks enables firms to improve the forecast accuracy creating the opportunity to define the optimum between reduction of stored goods vs. availability of goods (Bensinger 2014; Waller and Fawcett 2013). Therefore, firms collected as much data as possible (big data) to realize performance gains (Manyika et al. May 2011; Sadovskyi et al. 2014; Schermann et al. 2014), while most of the firms focus on optimizing only internal production processes (Sadovskyi et al. 2014).

Firms have to combine data from different departments such as sales, production, and enrich the data with additional information such as GPS data or general traffic data enhancing firms to recognize relations in order to take better decisions by considering cause and effect. First concepts within distribution logistics use customer data, GPS positions, delivery address, availability, and “live” location of customers to improve their delivery processes (Sadovskyi et al. 2014). Despite that, firms are starting to understand possibilities for supply chain performance improvements (Kiron et al. 2014).

The examples visualize the relation between supply chain processes, IT systems, and analytics and how they contribute to performance gains. However, firms are nowadays not able to analyze data in a structured and target oriented manner using (predictive) analytics (Debortoli et al. 2014; Long and Brindley 2013; Waller and Fawcett 2013) Hence, firms need an integrated solution covering the fields of supply chain management, analytics, and IT systems to realize a higher performance (Schoenherr and Speier-Pero 2015) vs. using use ad-hoc solutions or have stand-alone solutions (Simchi-Levi et al. 2015).

This paper is structured as follows: The next section proposes the general concept of big data and its relation to analytics, being followed by the description of our integrated supply chain analytics solution including a first scenario to evaluate the concept and the supply chain analytics solution. Finally, we discuss our proposed concept and elaborate next steps for future research.

GENERAL CONCEPT OF BIG DATA AND ANALYTICS

Big data is characterized by 6V´s within the literature: volume, velocity, variety (Batra 2014; Chaudhary et al. 2015; McAfee et al. 2012; Russom 2011), value (Watson 2014), veracity (Baesens et al. 2014; Gillon et al. 2012), and variability (Demirkan and Dal 2014). The volume of data is either created by internal sources, integrated sources, or internal processes such as on the Shopfloor. Velocity describes the data generation and processing, e.g. by transferring data from sensors being attached to an Internet-of-Things (IoT) device into a database. Variety reflects various forms of data that can be analyzed, while variability describes different perspectives that lead to an altered understanding. In addition, veracity defines the level of trustworthiness of data, being complemented by value that explains the transformation from data towards performance.

Figure 1 depicts our big data and analytics concept that is build on the 6V´s. Within our concept, the central part allows firms to integrate, store, and process data using a database and data warehouse, supplemented by a cluster of distributed file systems. Thereby, data can be integrated from various sources such as ERP-systems or unstructured data; further, data can be integrated from machines, IoT-devices, or interactive data generators representing a physical flow of products being tracked. Finally, we add a business intelligence (BI) and analytics perspective, enabling firms to develop models, analyze data, and build reports or dashboard for taking appropriate decisions and create value. Hence, our concept presents an integrated approach from integrating data from various sources, over processing the data, towards analyzing the data and visualizing the data in order to prepare decisions.

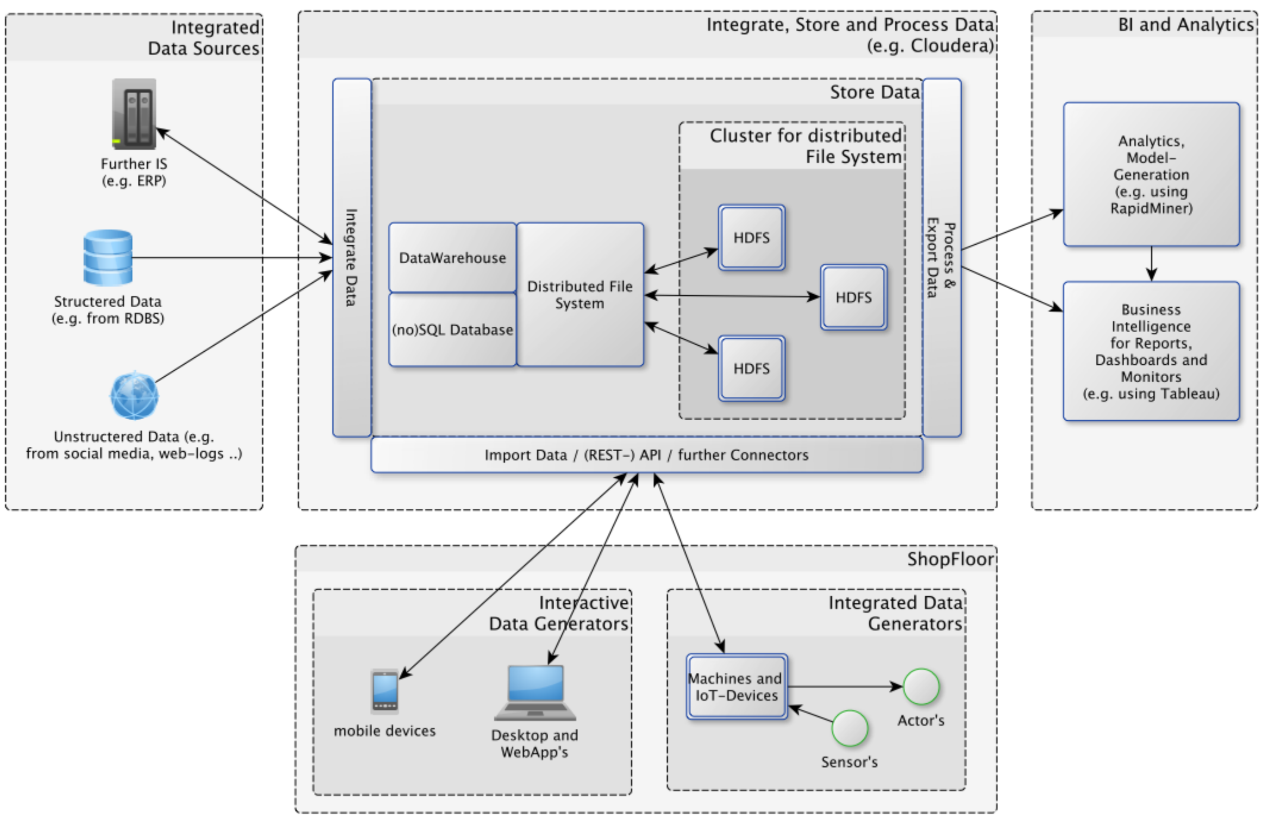

Figure 1. Big Data and Analytics Infrastructure

SUPPLY CHAIN ANALYTICS CONCEPT

We use the general concept to develop our integrated supply chain analytics concept. We integrate, store, and process the data by using a Cloudera Virtual Machine (VM). For this purpose, the Cloudera VM offers a set of IS solutions such as Hive, Sqoop, Impala, or Flume. In specific, Flume allows firms to integrate data from the internet such as social data form facebook, Twitter, or Google Trends. This, e.g., provides firms with the opportunity to improve their forecast process. Next, to integrate and store data from mobile devices, web-applications, or IoT-devices, we use a REST-API that enables firms to implement various supply chain scenarios and integrate data from physical flows by gathering data from sensors such as RFID tags, temperature, or movements. Thereby, we provide firms with the opportunity to consider future development such as the IoT or mobility. In addition, the computer cluster for distributed file systems enhance firms to gather data from things or machines (e.g. reflecting production sites or autonomous vehicles) and/or improve the velocity by storing data. Moreover, firms can setup a distributed file system solution by using low-cost single board computers such as Raspberry Pi´s (RaspPi). Further, gathering data from various machines provides firms with a chance to improve supply chain operations such as down-time, quality, or utilization time. Additionally, the data have to be analyzed using an analytics tool such as RapidMiner, followed by a visualization of optimization opportunities within a BI-Tool like Tableau; being an integrated supply chain analytics solution. Figure 2 depicts our integrated supply chain analytics concept.

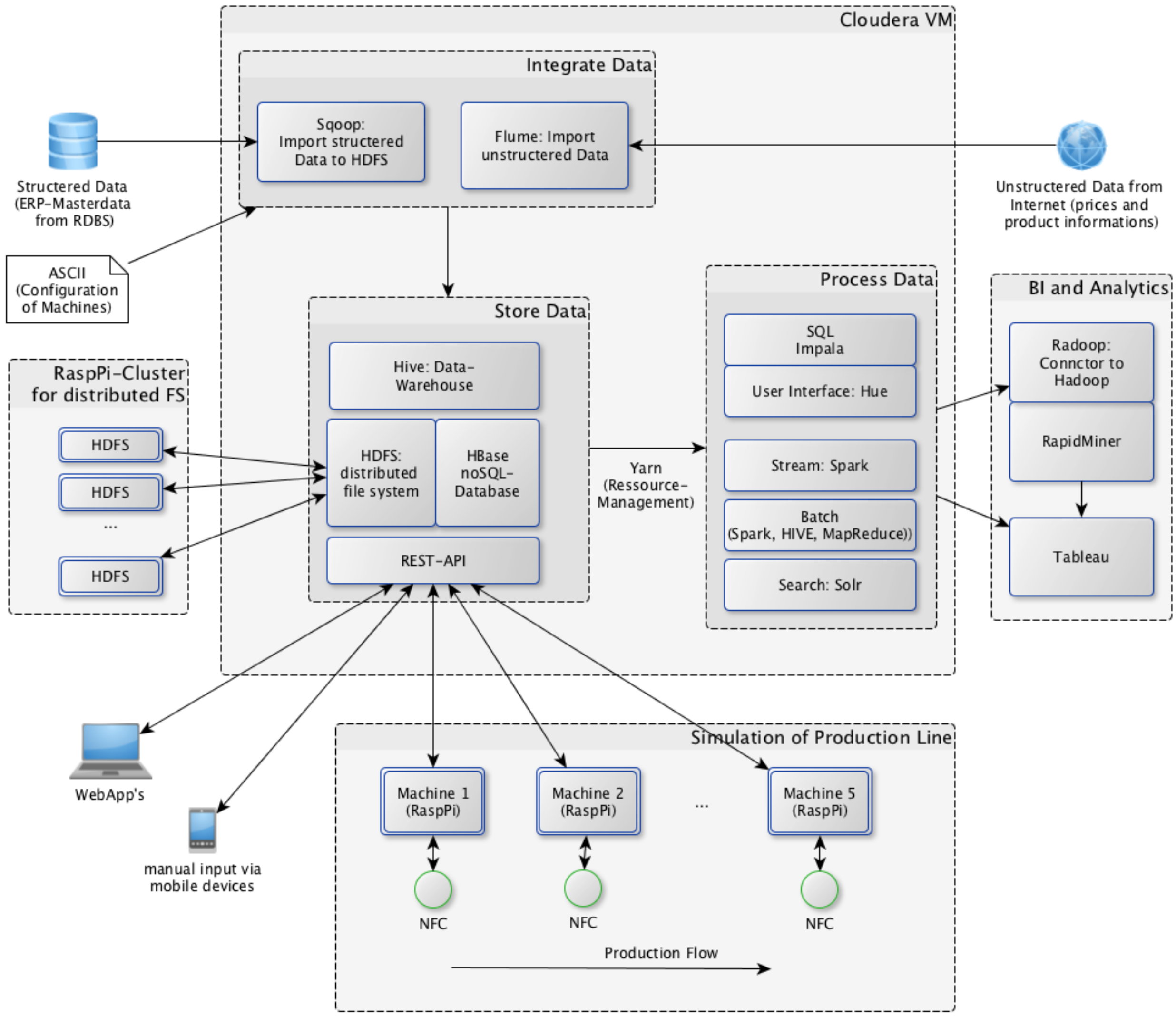

Figure 2. Integrated Concept for Supply Chain Analytics

Based on the integrated supply chain analytics concept, we developed a low-cost supply chain analytics solution to evaluate our approach. The solution reflects a production line that consists of five machines. Thereby, each machine is being represented by a Raspberry Pi (RaspPi) being connected with the distributed file system within the Cloudera VM by using the REST-API. Further, we attached a NFC (RFID) solution to the RaspPi´s that allow us to read and write data onto NFC tags. Therefore, the RaspPi is equipped with a NFC reader to exchange data with the tag. The NFC tags represent the products. In addition, the exchanged data is stored within the distributed file system allowing firms to process, analyze and visualize the data for analytics.

To evaluate our solution, we created fictional orders for four products requiring a specific production sequence. For example, product A is needed fourteen time – which equals 14 NFC tags – that require machine 1, 3, and 5, while the demand for product B is twelve and its production sequence is machine 1, 2, 4, and 5. In addition, the production time for each product on each machine varies according to our fictional production scenario. Further, we ensured that each tag can only be processes once (representing quality checks).

Applying this scenario allows us to read data from NFC tags, apply the dependent production program on the machine related to the tag, write production data on the tag (after the production step is finished), and integrate and store data from machines within the Cloudera VM (e.g. an ERP system). As a next step, the data can be processed and exchanged with the RapidMiner and Tableau application for analysis and visualization.

DISCUSSION, LIMITATIONS, AND FUTURE RESEARCH

Our concept is a first attempt to generate an integrated concept for big data analytics being applied in the field of supply chain analytics covering actual fields of interest such as big data, Internet-of-Things, or predictive analytics. The concept enables firms to integrate data from various sources, process the data, and analyze the data in combination with existing data using an exemplary analytical tools plus a visualization solution. For example, the concept will help firms to improve their supply chain performance by applying it to given scenarios such as optimization of distribution logistics within cities or improve inventory turns and forecast (Engel et al. 2014; Waller and Fawcett 2013).

Our first supply chain analytic solution allows firms to create transparency by collecting data from products and machines. In addition, firms can add necessary information to products and enrich their data for analysis. Based on the analysis, firms can improve their internal processes and thereby ensure sustainability of supply chain processes. Further, our solution offers small and medium sized (SME) firms an opportunity to establish a low-cost supply chain analytics solution that covers all relevant aspects of big data and supply chain analytics to ensure competitiveness within the market.

In addition, the concept and solution allow us to educate people with the basics of big data, analytics, IT infrastructure, logistics, applications within various fields such as supply chain analytics. For example, necessary skills and fields for supply chain analytics such as decentral vs. central production strategies or push and pull strategy (produce on-demand vs. produce-to-stock) can be taught. Further scenarios can cover aspects such as integration of mobile devices, e.g. to interact with machines in case of quality issues or integrating data from external sources such as Google Trends. This enhances us to create a supply chain scenario to show the relation between forecasting and social analytics, and how firms have to handle these challenges. These scenarios have to be developed, evaluated with practitioners, and tested for applicability within the different industries.

We contribute to theory by proposing an integrated low-cost solution for supply chain analytics allowing firms to establish more sustainable supply chain processes, educate their employees (Schoenherr and Speier-Pero 2015), and implement a structured and target oriented process for predictive analytics (Debortoli et al. 2014; Long and Brindley 2013).

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