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The influence of Big Data on Production and Logistics

A theoretical discussion

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Abstract. Information is a crucial factor for companies in all lines of business. Within the years the requirements to do business have changed and got more complex. Due to recent developments and trends such as Industry 4.0, Cyber-Physical-System, data and/or information is omnipresent. In this context Information logistics is a relevant discipline to deliver the right information element. To attain this goal, it is essential to manage and supply efficient data and information. Therefore, this paper deals with trends and models behind Big Data and the influence on production and logistics.

Keywords: Big Data, Smart Data, Production, Big Data Patterns, Information Logistics

1 Introduction

Big Data, Smart Data, Data Analytics are common words today which even concern business matters. Under the theme Industry 4.0 the manufacturing industry elaborates on the creation of increasingly intelligent, autonomous and decentralized subsystems that should lead to more competitive production and logistics processes. However, it is not only the access to new technologies and new methods of technical integration, information is an essential asset for this approach. No service, no production can be understood without the fundamental perception of information to implement logistics scientific approaches through optimized supply chain [9]. Therefore, the effective and economic integration of information and decision-making bodies is relevant. [2]
Due to recent developments and trends - such as Industry 4.0, Big Data, Smart Data and Data Analytics - data and/or information is omnipresent. This apparent advantage can be quickly turned into a drawback: an oversupply of data that are not beneficial information to their environment also includes more disadvantages than potential for a company. In this context Information logistics is a relevant discipline: In short the goal of information logistics is to deliver the right information element, in the right format, at the right place at the right time [12].To attain this goal it is important to manage and supply efficient information. This is then of essential importance for the production. Therefore, this paper deals with the cornerstones of information management, the importance and principles of big data for logistics and production in particular.

Data science requires both domain knowledge and a broad set of quantitative skills, but there is a lack of literature on the topic and open questions. Therefore, this paper focuses on the gap between data management and logistics and elaborates on the individual models and methods. A recently mentioned research project is also presented in this area.
The remainder is structured as follows: First the focus is put on terms and definitions to define the research background. Then the gap to production and logistics is bridged. Finally, the paper concludes with an outlook and a future industrial use-case.

2 Terms and Definition

As the discipline of information management is a wide area and no clear definitions exist, this paper gives a rough overview of the most important terms for the research that underlies this paper.

2.1 Data and Information

Talking about the quality of information in general and for logistics in particular, it is important at this point to define the terms data and information to connect information and logistics in a more appropriate way.

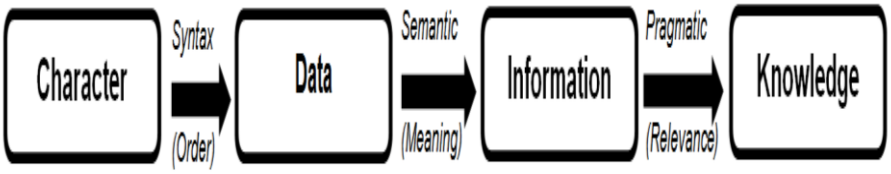

Fig. 1. Interconnection between data, information and knowledge [4]

- Character: a letter, number, or other symbol used in writing, especially in printed text or on a computer [6].
- Data: data is raw. It simply exists and has no significance beyond its existence (in and of itself). It can exist in any form, usable or not [1]. Today organizations generate large amounts of multi-spectral data. In view of its discrete form, data in itself may not be very useful, so it is often referred to as the original knowledge asset. When data is processed into a context, it becomes information.[5]
- Information: For this paper the relevant definition of information is defined as something that is conveyed or represented by a particular arrangement or sequence. Bali et al. mentioned that information is data that has been arranged into a meaningful pattern and thus has an identifiable shape [5].
- Knowledge: knowledge is the appropriate collection of information, such that it's intent is to be useful. [1] Knowledge is a deterministic process and a mix of framed

experience, values, contextual information, expert insight and grounded intuition that provides an environment and framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers [1].

When talking about data and information it is also interesting to have look on IBM's "Business Information Maturity Model" which defines five levels of data management, shown in fig. 2. The focus of data at the lowest level is an operational perspective. At the next level, Information is used to manage the company. Information becomes a strategic asset at the next level. At the forth level Information becomes to some kind of special expertise. Finally, at the top level, Information is a competitive advantage and therefore often need to be protected against external actors. Here we finally talk about the creation of real business value [3].

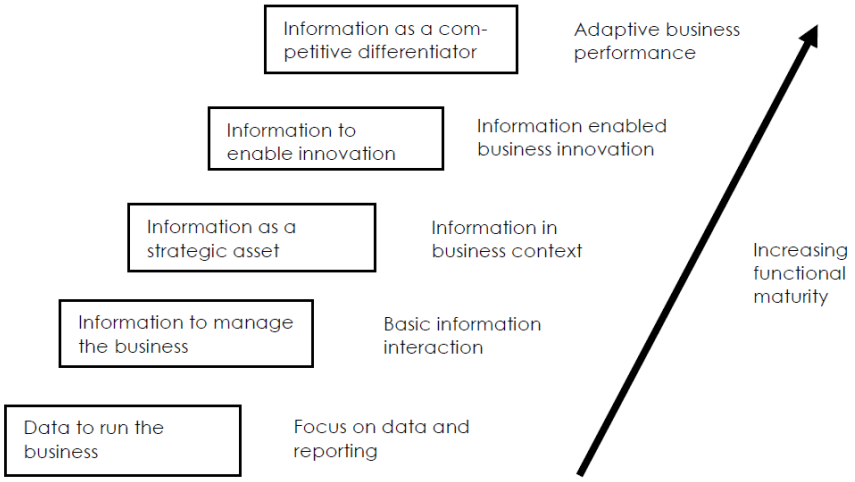

Fig.2. Business Information Maturity Model [3]

It, however, is not that easy to reach the fifth level of the maturity model, as nowadays the data flood is so huge in companies that it gets always more difficult to distinguish between data and meaningful information. Therefore, in the context of logistics and especially information logistics the classical "6Rs" have to be adopted to the "8Rs of Logistics"

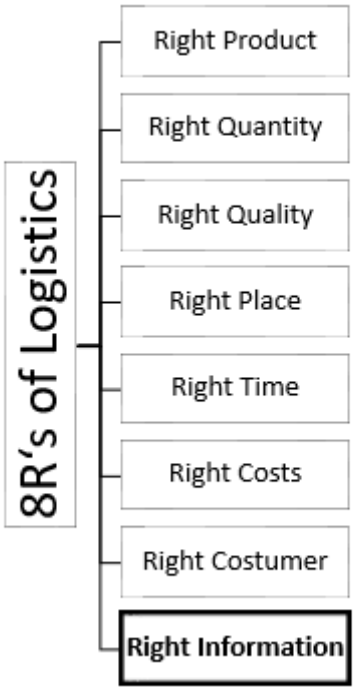

Fig. 3. The 8R's of Logistics in the information age [9]

In this context it is important to have a look on Big and Smart Data and then concentrate on the impact on logistics and production. Here Production logistics will be defined as all operational purchasing, in-house material flow, in-house material handling, operational distribution and information flow processes which do need to be organized, controlled, executed and optimized in order to supply necessary raw-materials, perform manufacturing operations and physically distribute finished goods to customers [8]. Thus it is relevant to know both sides – the production logistics as well as the information logistics aspects – to make use of the advantages of data management for the production.

2.2 Big Data and Smart Data

Big data is a comprehensive term for generally any collection of data set – structured or unstructured – that are so large and multifarious that processing them with conventional data processing systems is almost impossible. Therefore Provost and Fawcett define "Big Data as 'datasets that are too large for traditional data-processing systems and that therefore require new technologies" [11]. Big data is mainly produced by machines and thus often represented as machine data, too. According to Cooper and Mell

‘Big data is where the data volume, acquisition velocity, or data representation limits the ability to perform effective analysis using traditional relational approaches or requires the use of significant horizontal scaling for efficient processing.” [7] Concerning the scalability IBM describes Big Data in terms of four dimensions: (1) volume, (2) velocity, (3) variety and (4) veracity as shown in Fig. 4.

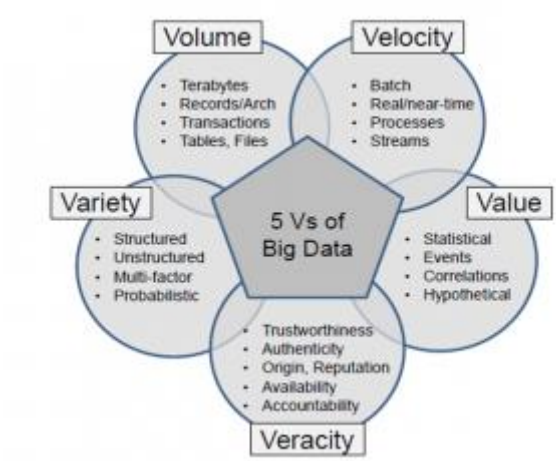

Fig. 4. 5V’s of Big Data

These information assets demand cost-effective, innovative forms of information processing for enhanced insight and decision-making. And this is the direct connection to production planning and supply chain issues nowadays. Here methods and approaches have to be found and implemented to get the most out of the big data and make smart data for the corresponding context. Data Analytics and Data Algorithms are here the keys. Thus making smart data out of big data, as Fig.5 schematically illustrates. “Smart Data” means information that actually makes sense. Algorithms turn meaningless numbers into actionable insights. Smart data is data from which signals and patterns have been extracted by intelligent algorithms. Collecting large amounts of statistics and numbers bring little benefit if there is no layer of added intelligence.

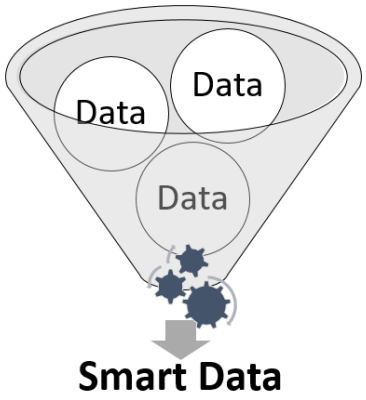

Fig. 5. Turning Big Data into Smart Data

3 Impact on production and logistics

Coyle et al. stated that information flow has become an extremely important factor for success in supply chain management. Traditionally information was viewed as flowing in the opposite direction of products, it means, from the market or customer back to the wholesalers, manufacturers, and vendors. The information was primarily demand on sales data, which were the trigger for replenishment and the basis for forecasting. If there were long time intervals between orders, the members of the supply chain were faced with much uncertainty about the level and pattern of the demand, which usually resulted in higher inventory or stock-out costs, a phenome-non known as the bullwhip effect [8].

All above mentioned aspects of data and information management mainly focus on the data domain and are therefore insufficient to cover all topics faced in managing production logistics processes, as for example complexity or analyzing the data gathered is not covered in the definitions above. In order to connect the different characteristics of Big Data to Production logistics the mentioned aspects need to be expanded further creating an integrated view of the topic, which includes dependencies of characteristics, Business intelligence, statistics and characteristics clustering [13].

Due to all these aspects the focus has to combine production, information technology and internet in order to be beneficial for classical industrial processes – in production and logistics. In the whole production life cycle, the mechanism and approaches of data management, big data and smart data are merged inseparably throughout, which will lead to advantages for all involved parties. More functionalities and customization options are gained for the client and more flexibility, transparency and accuracy for the whole production. Using information more effectively is one of the most important sources of competitive advantage for business firms today. The key to business success is information: accurate information, delivered at the right time, to the people who need

it and can quickly make the best use of it. Nevertheless, this means the industry to introduce new types of production strategies.
Here a research programme is currently starting to investigate on the benefits on production in details: different logistic production processes – and in the long run supply chain processes - will be analysed and in a next step it will be researched on finding combinations for approaches from information logistics including data management and production management. Thus the logistic processes in production and also for the supply chain can be improved by means of big data analytics.

4 Future Work and Conclusion

If information is not well managed, it may lead to disruptions in the supply chain, thus endangering the overall performance of the supply network. However, when information is managed appropriate, accurate, timely, and complete, the companies will be able to make good decisions for their own operation, and also maximize the profitability of the entire supply chain. In the research project it is the main goal to develop a roadmap for data science in the logistics area and to develop a big data analytics architecture for logistics, comparable to the research of [13]. With this architecture it should be possible for companies to gain business value out of using big and smart data.
Therefore, this paper gives a rough overview of information management and addresses big data and smart data aspects. A currently starting research project is investigating on the process benefits due to big data and smart data. (It is estimated that first findings can be presented at the conference and can be mentioned in the final paper version!)

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