Supply Chain Management: The Value of Logistics

João Zambujal-Oliveira (Editor)
University of Madeira, Portugal

Volume nr. 2019/3
Operations Management and Research and Decision Sciences Book Series

2019

Published in Portugal by
University of Madeira
Department of Management Science and Economics
Campus of Penteada
9020-105 Funchal - Portugal
Tel: (+351) 291 705 000
Email: info@mail.uma.pt
Web site: http://www.uma.pt

DigitUMa Cataloging-in-Publication Data
For electronic access to this publication, please access: https://digituma.uma.pt/.

Supply Chain Management: The Value of Logistics / João Zambujal-Oliveira, Editor

Includes bibliographical references and index.

Summary: "Supply chains are critical and their stability depend on the agents behavior. A supply chain ensures its high value, being effectively organized on logistic terms."– Provided by editor.

ISBN 978-989-8805-56-0 (ebook) 1. Logistics and Supply Chain Management. 2. Logistics Analysis Tools and Supplier Qualification. 3. Inventory management. 4. Transportation and Logistics Management. I. Zambujal-Oliveira, João.

This book is published in the DGE book series Operations Management and Research and Decision Sciences (OMRDS)

Contents

Chapter 1

Article/Case Study of Wang, B., Master Thesis "Sustainable organization capabilities in supply chain management"[1]

Gouveia, Catarina

Abstract

This paper aims do study a related theme under the subject of supply chain management, a curricular unit of the postgraduate degree in business administration for non-management graduates. The author chose the master's thesis of Wang (2016), because of personal interest on environmental issues and curiosity on how it is managed within the supply chain management, a component of business management that appears to be affected by the environmental values of sustainability of a product or service nowadays. In the study Wang (2016) wanted to focus on a matter on growing interest among academics, practitioners and consumers – sustainability. She proposed to revise the information existed on theme, gathering the concepts of sustainability and how business try to integrate it into its operations, developing sustainable organization capabilities, all accounted in the perspective of the supply chain management. Activity which greening adds public recognition and value to a company. For this she used literature reading on the topic and systematic review. As insights for future research, Wang (2016) sharpened the value of exploring organizational operations – material and warehousing management, as well as for practitioners she made suggestions for supply chain managers and top-level managers in business operations.

[1]This paper is based on Wang, B. (2016). Sustainable organization capabilities in supply chain management (Master's Thesis). Aalto University.

1. Introduction

The purpose of Wang's (2016) thesis is to define sustainable organizational capabilities (with focus on environmental effects) through existent literature and to explore its application on the supply chain management field (broken down in sub categories), providing insight for academics and practitioners. Her study took place between the years 2015-2016. Discussion on this research area needs to happen because little result exists on the topic of sustainable organization capabilities in the supply chain management setting.

Living the era of globalization, Wang (2016) referred that advanced infrastructure and internet bring businesses close together in competition. To strive in this global context companies, need to develop their competences and, in competing with rivals', organizational capabilities (OC) stand as the core of competences. Being competitive isn't enough and sustainability has been gaining position among corporates as the social and economic demands of the countries get more precise (e.g. Kyoto protocol and "environmental trade barriers"). Data has shown a growing trend and the environmental reports of businesses suggest looking carefully at the companies' supply chain activities. As important is the demonstrated positive link between an organizational environmental initiatives and customer satisfaction, and that this helps gaining market value, said Luo & Bhattacharya, 2006 (Wang, 2016).

In the academic perspective this research area has been evolving showing that there is a need for organization and categorization of current research on the topic. Wang (2016) starts by making a review of the literature by identifying sub components in sustainable organizational capabilities in the supply chain context. Afterwards empirically she uses systematic literature review method (SLR) to narrow relevant literature. Category for current information and areas that are still missing are provided by Wang (2016).

A five-part article. An introduction, a review on the existing literature on the matter, the methodology process, the analysis of the results, conclusions, limitations and implications are presented at the end.

2. Literature review

This part is made up essentially by reading previous literature on the topic gathering guidelines for the research. In 2016, Wang managed to approach in a literature review several concepts and aspects related to the sustainable organization capabilities in supply chain management.

The author was able to understand, first separately, the concepts of organization capabilities and sustainability, and then jointly in the context of supply chain management. Thus Wang (2016) provided a composed background literature to guide her thesis. Sustainable OC are "organizational capabilities that are both environmentally friendly and profiting generating", and yes literature points out (according to the resource based view (RBV) and other

methodologies) a positive link between environmental and financial performances (Wang, 2016).

Sustainable supply chain management involves thinking about a complex activity that acts globally (bringing impacts to supply chain) and has been seen as the most important component in corporate strategy that determines organization's competitiveness. Sustainable supply chain as a set of activities that aim to generate minimal environmental harm, and the goal of such supply chain operations is to reduce all resource waste. Environmental impacts are most discussed nowadays and with the rising emphasis on fulfilling with environmental regulations the matter in consideration is of very practical implications.

According to Srivastara (2007), cited by Wang in 2016, green supply chain management (GSCM) breaks the supply chain in different operational perspectives: green transportation, procurement, supplier management, IT innovation, warehousing management and material management, which will be addressed.

3. Methodology

In 2016 Wang's thesis a quantitative research method to conduct a qualitative research was used. Empirical part was made through the method of systematic review, where Wang (2016) goes by the ideas of Tranfield, et all, Kitchenham and Hiroharu (2003, 2004 e 2016). Combination of this SLR and previous section of literature review makes possible the insights for further research.

The SLR process consists on Planning the review (identifying the needs), Conduct the review (formulate the protocol) and Review the results (implementing it). The first step starts with the discussion on the need for adopting this method and with the formulation and review of the protocol. Next there is the definition of the research scope and what the investigator wants to find in order to answer the research questions. A search strategy is defined as well as the selection of studies, the way quality of the studies are assessed and how data will be extracted (by more than one person) and synthetized (Wang, 2016). The last part is the discussion and comprises two segments: an overview of the article's relevant characteristics and a descriptive analysis of them. Thus, the investigator can summarize the data by answering the research questions or by providing enlightenment for further research.

In Wang's thesis SLR was chosen to avoid the disadvantages of traditional research methods, although may be more time consuming. She wanted "to find answers to the research questions by performing comprehensive unbiased search among existing literature, according to her citation of Tranfield, et al, 2003. The review of the SLR protocol defined for Wangs work was developed following the steps that characterize that phase.

Besides the SLR in the development of the search concept, triple bottom line and Porter's value chain model were also taken for guidelines of Wangs study (2016). This is because according to Grant (2010), by Wang (2016), there are two ways to identify one organization's capabilities. One is to categorize by the organization functions, the other is to integrate the

organization capabilities with the Porter's value chain model – that mainly categorizes organizations by their operations, Wang (2016) according to Porter (1985) and Grant (2010).

4. Data

Implementation used 226 defined search strings, to cover 5006 search hits, 2264 articles were identified, out of which 24 raging from 1997-2015 stood as the selection for the final discussion. This narrowing was possible because the research scope defined consisted of only journal articles in top tier journals, excluding any other types of formats, facilitating comparison between the 24.

Search strategy was defined by choosing the type of database, in the case scientific Direct, in time range that started from 1990. Search strings were expressed clearly after some preparation and included "sustainability", "capability" and for the context of supply chain management Wang (2016) decided to create the search string based on the value chain model (excluding technology development and human resource management). Before all testing the settings, a pilot trial was made to test and reduce repetitive results.

The selection of the final data met the inclusion criteria and not the exclusion ones, proposed by Wang in 2016. The quality of the review was guaranteed by the effort to formulate inclusion criteria and the by the publishing journal, whereas the quality of the results was evaluated by the publishing journal and the article's content.

Study happened from 2015 to 2016, when at the beginning two assessors were involved to guarantee the quality of the results. The 24 articles cover different types of research: peer review, empirical, case studies, hypothesis testing, etc. Excel sheet was the format where final data was extracted according to already established information aspects.

5. Results analysis

The results show a comprehensive overview of the current literature in sustainable organizational capabilities in supply chain management. The results are presented in two ways: 1. quantitative presentation showing the overall features of the 24 articles and 2. a descriptive presentation of the selected studies categorized based on their functionalities (Supply chain management capabilities, Procurement capabilities, IT capabilities, Supplier capabilities and Innovation capabilities). These functionalities were then defined by Wang (2016) as the units of analysis of her research.

When publication year is considered the 90's were the starter decade on supply chain management papers, however most relevant ones are from after de 20th century, especially from 2015. When the publication journal is concerned the supply chains management focused journals provided the most comprehensive results. In the study's scope nine different research methodologies were referred, with being hypothesis testing and proposition development the most common ones. Wang (2016) deducted that the articles have formulated certain frameworks or generated new results for this research area.

On sustainable organization capabilities in supply chain management the thesis in study author's found some articles pointed out the future important research areas and theories used in green supply chain management. On sustainable supply chain management capabilities and practices each and one of them were discussed and compared by Wang (2016). Enumerated were adoption of environmental management system; quality management and its relation to sustainable capabilities; value chain thinking; food and service industry. According to Wang (2016) practices don't transfer into capabilities on their own and research shown that successful disposition of such practices for organizations is what creates competitive advantage thereby constituting organization capabilities. The adequate methods for choosing the right practices for an organization and for it then to adopt and maybe turn it into organization capabilities are discussed by Wang (2016) following Govindan's (2015) and Wang X (2015) perspectives. Practice implications are seen on food and service industry, followed by the manufacture one.

About sustainable procurement capabilities, according to Wang (2016) citations of other authors, we can say that in the public sector it is worth to study it alone; purchase of renewable resources can save more energy as well as buying the right thing. Walker et al (2012) cited by Wang (2016) emphasis the combination of triple bottom line and different perspectives to a larger guideline and research possibilities of sustainable purchasing. Other author expanded the purchasing into the supply chain network context with the focus on supplier management. Results were also presented about the straight impact from both supplier assessment and purchasing on environmental performance. Repercussions on practice are that product life cycle from end to end must be taken in consideration by companies.

Living under a safe veil supplier management was seen to be easily overlooked, but recent studies have showed the importance of supplier management from a supply chain network perspective. Wang (2016) found on the analysis that supplier greenness intensity influences the whole supply chain activities, so suppliers must be encouraged do improve. Government support is the best way to overcome barriers (lack of manpower and IT skills) in greening.

About information and innovation capabilities, one can say that IT environmental integration system is a very usual one. It increases energy efficiency within organizations. IT influences environmental performances and its stronger when the company is proactively developing its own capabilities to attain sustainability. These capabilities can be seen as a whole, and investigation results show that IT capabilities are linked with innovation. Innovating products tend to reflect greener conceptions and the use of minimum resources. Wang (2016) decided that these last capabilities should be approached together and highlighted the fact that the RBV, as one fundamental constitute for organizations competitive advantage, can be joint with environmental focus.

6. Conclusions

The purpose of Wang's thesis, using a systematic literature review, is to define sustainable organizational capabilities (with focus on environmental effects) and to explore its application on the supply chain management field (broken down in sub categories), providing insight for

academics and practitioners. By developing her own SLR protocol, Wang (2016) analysed 24 articles and presented the results in two ways. First presented was a quantitative overview and secondly through qualitative and comparatives analysis, combined with tables and descriptions, research questions were answered.

Data showed five main recent research areas concerning sustainable capabilities. They are supply chain, procurement, supplier assessment, IT and innovation, and together they can work as guideline for an organization check its current operations. It was found that in all areas organizations tend to use sustainable capabilities, and the most studied appear to be the non-industry and manufacture industry. No categorization between practices and types of industries was found by Wang (2016). As more focus exists on manufacture industries, she pointed out worthy exploring organization operations such as material and warehouse management.

Wang's 2016 thesis stands out three main contributions to the practical context of management. First and most important commitment of supply chain managers and top-level managers in business operations is required in shaping organizational sustainable capabilities. Secondly the resource based view can be used by organizations while mangers evaluate sustainable investments in the organizations. Most articles analysed advocated that resource based view can provide grounds for sustainable supply chain management as well as in helping companies to gain competitive advantage. Finally implementing the set of R's can significantly increase firm's performance while minimize environmental dangers.

The thesis analysed not only served a great deal of information and learning for the author personally, as responded to Wang's pretention to give insights for practitioners and researchers.

References

Wang. B. (2016). Sustainable organization capabilities in supply chain management (Master thesis non published). Department of Information and Service Economy, Aalto University, school of Business, Finland.

Chapter 2

Advantages of compliant mechanisms: a review on product characteristics and manufacturing costs[2]

Pinto, Wilson

Abstract

Reducing costs is one of the primary objectives of an organization. Manufacturing a single product that can satisfy quality demand and be cost efficient, can be very stressful and challenging. Through compliant mechanisms (CM) manufactures can create products at a lower cost and with a quality certification. These products are addictively manufactured (AM), or, in other words, 3D-printed. This paper presents an overview of some of the particularities behind CM - it's advantages, challenges, requirements and specifications – and an economic analysis of an AM process. Finally, practical applications of CM are demonstrated.

Keywords: Compliant mechanisms, space mechanisms, robotics, mechanics, cost reduction, addictive manufacturing.

[2]This paper is based on Merriam, E. G. (2013). Fully Compliant Mechanisms for Bearing Subtraction in Robotics and Space Applications (Master's thesis). Brigham Young University.

1. Introduction

CM are a one-part structure with one or more flexible segments that bend in order to accomplish a useful purpose. Larry Howell (2013), a pioneer in the research of CM, shows us how movement in nature can be achieved through flexible parts (e.g., beating heart, spines, elephant trunk, bee wings) instead of rigid or stiff parts connected by hinges and sliding joints (Howell, Magleby, Olsen, & Wiley, 2013). Even though it is easier to rely on rigidity given that designing for flexibility requires a more complex understanding and prediction of limited deformation and life fatigue, many fields of engineering have developed a plethora of methods, models, and tools for CM development, design, and manufacture (Chen, Mueller, & Shea, 2017; Homer et al., 2014; Howell, Magleby, Olsen, & Wiley, 2013; Megaro, Zehnder, Bächer, Coros, Gross, & Thomaszewski, 2017; Mutlu, Alici, in het Panhuis, & Spinks, 2016; Zhou et al., 2015).

Conventional mechanisms are known for its hinges and bearings that cause friction, which in turn can suffer backlash and wear over time. CM in the other hand are portrayed by hingeless structures and require no bearings, eliminating/reducing all the problems previously presented. Plus, they require no assembly and minimize manufacturing costs, since they can rely on the idea of a building block synthesis technique, using 3D printing (Homer et al., 2014; Howell, Magleby, Olsen, & Wiley, 2013; Zhou et al., 2015).

In this study, we demonstrate how a CM approach can give a valuable advantage in minimizing costs in manufacture and maintenance through a collection of scientific research material, gathered by the author – the methodology for this study is furtherly discussed. Additionally, a brief analysis on the economic impact of AM – present and future - will be presented.

2. Literature review

The concept of CM isn't new (Sigmund, 1997). In fact, due to recent increased attention by the scientific community it has gained new ramifications given its unique increased performance and cost reduction (Megaro, Zehnder, Bächer, Coros, Gross, & Thomaszewski, 2017; Merriam, 2013). In reducing costs, we can find advantages such as: (1) severe reduction in the number of parts required, can be seen in microelectromechanical system (MEMS) manufacture methods; (2) no assembly required; (3) fewer components to stock; and (4) simplified manufacturing, can produce a mechanism from one mold. And can increase performance by: (1) high precision; (2) low weight; (3) no lubrication needed, due to friction-free and wear-free motion; and (4) high reliability, especially relevant at the micro/nanoscale (Howell, Magleby, Olsen, & Wiley, 2013; Kota, Joo, Li, Rodgers, & Sniegowski, 2001; Megaro, Zehnder, Bächer, Coros, Gross, & Thomaszewski, 2017; ten Kate, Smit, & Breedveld, 2017).

According to Howell (2016), there are a particular set of challenges: (1) the need to integrate several functions into a single part mechanism, they have limited rotation and segments may collide if one isn't careful; (2) material(s) of choice, the desirable behavior usually is dependent on the material properties; and (4) nonlinear motion, simplified linear equations are not sufficient to analyze their motion. So, in a way, designing appears to be the major challenge. Multiple approaches have been developed over the recent years, to help define the CM topology (Howell, Magleby, Olsen, & Wiley, 2013; Howell, 2016). Some of them are: the *finite element analysis*, to quantify and model the bending potential of flexible segments; the *pseudo-rigid-body model*, allows the modeling of flexible parts as rigid links connected at appropriately placed pins; and the *topology optimization*, has the advantage of eliminating any of the designer's biases and no major amount of knowledge of the desired CM is mandatory (Gouker, Gupta, Bruck, & Holzschuh, 2006; Howell, Magleby, Olsen, & Wiley, 2013; Howell, 2016; Kota, Joo, Li, Rodgers, & Sniegowski, 2001; Megaro, Zehnder, Bächer, Coros, Gross, & Thomaszewski, 2017; Merriam, 2013; Yu, Zhu, Xu, & Zhou, 2016).

AM (or 3D-printing) is a process of joining materials to make objects from 3D model data, layer upon layer, and has many advantages over conventional manufacturing processes (Huang, Leu, Mazumder, & Donmez, 2015). The technology involved in this process is the key to some of its advantages. Since the input information is digital, no tools, molds, or cutting implements are required (Baumers, Dickens, Tuck, & Hague, 2015; Weller, Kleer, & Piller, 2015). Accordingly, Baumers, Dickens, Tuck, & Hague (2015) argue that "technology observers and the media speculate that AM will have a profound economic impact on the manufacturing sector and indeed on wider society" (pp. 193-194). In the *2013 Wohlers Report*, compound annual growth rate of worldwide revenues of AM products/and services, over the previous 25 years, was 25,4%, with a growth rate of 27,4% in the 2010/12 period and reached $2.2 billion (usd) in 2012. Still in 2012, 7771 AM industrial units were sold (19.3% increase), while 35.508 3D personal printers were sold (46.3% increase) (Huang, Leu, Mazumder, & Donmez, 2015).

3. Methods

This paper is part of an assignment proposed in the *Logistics and Operations Management* subject, that is part of the *Business Administration for non-management graduates* course. A dissertation about CM was selected by the author and submitted for approval. Once it got approved, the main task was to establish a link between CM and cost reduction on manufacture related operations.

Two databases were selected to gather the information needed for this review, the BYU (Brigham Young University) Compliant Mechanisms Research Group (CMR) and google scholar. The first one has a big collection of theses and dissertations, and publications about CM. And one of CMR's top researchers is Larry Howell, who is the top cited author on CM, according to google scholar authors profiles. On the second one,

a search was conducted based on specific key words like “compliant mechanisms”, “space mechanisms”, “robotics”, “mechanics”, “cost reduction”, and “addictive manufacture”.

4. Results

As previously stated, material selection is very important. Some fundamental concepts should be taken into consideration: stiffness-strength; and strength-flexibility (meaning, its properties, geometry, and loading and boundary conditions). The yield strength to Young’s modulus ratio and resilience for several materials, according to Howell, Magleby, Olsen, & Wiley (2013), are: (a) steel (1010 hot rolled), *E (GPa)*=207, *Sy(MPa)*=179, *(Sy/E)*x*1000*=0.87, and *(0.5*x*S²y/E)*x*0.001*=77; (b) titanium (Ti-35A annealed), *E (GPa)*=114, *Sy(MPa)*=207, *(Sy/E)*x*1000*=1.8, and *(0.5*x*S²y/E)*x*0.001*=190; and (c) nylon (type 66), *E (GPa)*=2.8, *Sy(MPa)*=55, *(Sy/E)*x*1000*=20, and *(0.5*x*S²y/E)*x*0.001*=540 (for more materials, see Howell, Magleby, Olsen, & Wiley, 2013, p. 12).

In the medical field, in a review by ten Kate, Smit & Breedveld (2017) about 3D-printing technology used to print upper limb prostheses, 46 devices are printed using *fused deposition modelling* (FDM), 6 use *selective laser sintering* (SLS), 1 uses *selective stereolithography apparatus* (SLA), 1 uses *polyjet printing*, and 4 don’t specify the implemented technology. The authors state that the two most commonly used materials for prostheses print, with FDM technology, are *acrylonitrile butadiene styrene* (ABS) and *polylatic acid* (PLA). Their findings suggest that the cost of 20 prostheses ranges, in us dollars, between 5$ (in this end, only materials costs for 3D printing are specified) and 500$ (in this end, all materials costs for prostheses manufacture are included) (see Kate, Smit & Breedveld (2017), p.308, for more product specifications, including fabrication method, material, material cost, and design availability).

According to Huang, Leu, Mazumder & Donmez (2015), AM applications are very well diversified across a diverse array of industries: automotive, aerospace, energy, and many more. And innovation in the technological world appears to have a great impact on companies and market structure, since AM technology seems to influence flexibility, capital and marginal production costs, and individualization (Huang, Leu, Mazumder & Donmez, 2015; Weller, Kleer & Piller, 2015). Weller, Kleer & Piller (2015) argue that in a monopoly, AM technology, would allow a company to increase profits by capturing consumer surplus when flexibly producing customized products. In contrast, in competitive markets, this technology has the potential to lower barriers to market entry given its capacity to play in multiple markets at the same time, hence lowering consumer prices.

In the Baumers, Dickens, Tuck & Hague (2016) paper, a comparison is made between two AM commercially used systems: *electron beam melting* (EBM) and *direct metal laser sintering* (DMLS). The authors aimed to build an AM cost model [$C_{Build} = (C_{Indirect} \times T_{Build}) + (m \times Price_{Raw\ material}) + (E_{Build} \times Price_{Energy})$] to determine the total

production cost (£): manufacturing (raw material and energy consumption) and total indirect costs (time-dependent). Their results state that, for the EBM and DMLS respectively, the total build time was 25.65h and 107.79h, the energy consumed was 200.80 Mj and 917.10Mj, the build rate was 15.63cm³/h and 4.83cm³, and the mass-material deposition was 69.24g/h and 37.58g/h. An estimation for the mean cost was presented for EBM and DMLS, of 2.39£/cm³ and 6.18£/cm³ respectively. The research concludes that AM, in most cases, just cannot compete with traditional manufacturing – machining and injection molding process rates can reach over 100kg/h - to support high-volume production (Baumers, Dickens, Tuck, & Hague, 2016).

5. Conclusion

In this research, it appears that CM have some very promising applications. Although, when it comes economies of scale AM still have a long way ahead. This means that companies may still prefer the traditional methods, because they are able to fulfill demand much faster. But AM may have found a loophole when it comes to define business strategy.

According to Gibson et al. (2010), Berman (2012) and Lipson & Kurman (2013), AM has a major advantage in market environment (customized products, flexible products, complexity in design, and transportation costs) (Baumers, Dickens, Tuck, & Hague, 2016). Then, decisions about where manufacturing should be located may take a different turn. With more affordable AM machines and setup, combined with the ability to customize products – changes in designs are fast and inexpensive, plus it increases customers' perceived product value and the willingness to purchase a premium product - and lower or none transportation costs, manufacturing location may shift to the point of use (Baumers, Dickens, Tuck, & Hague, 2016; Huang, Leu, Mazumder & Donmez, 2015; Weller, Kleer & Piller, 2015). Thus, setting up production in low-wage countries may no longer come as an advantage.

References

Baumers, M., Dickens, P., Tuck, C., & Hague, R. (2016). The cost of additive manufacturing: machine productivity, economies of scale and technology-push. *Technological forecasting and social change*, *102*, 193-201. doi: 10.1016/j.techfore.2015.02.015.

Chen, T., Mueller, J., & Shea, K. (2017). Integrated design and simulation of tunable, multi-state structures fabricated monolithically with multi-material 3D printing. *Scientific reports*, *7*, 45671. doi: 10.1038/srep45671.

Gouker, R. M., Gupta, S. K., Bruck, H. A., & Holzschuh, T. (2006). Manufacturing of multi-material compliant mechanisms using multi-material molding. *The international*

journal of advanced manufacturing technology, *30*(11-12), 1049-1075. doi: 10.1007/s00170-005-0152-4.

Homer, E. R., Harris, M. B., Zirbel, S. A., Kolodziejska, J. A., Kozachkov, H., Trease, B. P., Borgonia, J. P. C., Agnes, G. S., Howell, L. L., & Hofman, D. C. (2014). New methods for developing and manufacturing compliant mechanisms utilizing bulk metallic glass. *Advanced Engineering Materials,* 16(7), 850-856. doi: 10.1002/adem.201300566.

Howell, L. L., Magleby, S. P., Olsen, B. M., & Wiley, J. (Eds.). (2013). *Handbook of Compliant Mechanisms*. John Wiley & Sons, Incorporated.

Howell, L. L. (2016). Compliant Mechanisms. *Encyclopedia of Nanotechnology,* 604–611. doi: 10.1007/978-94-017-9780-1_302.

Huang, Y., Leu, M. C., Mazumder, J., & Donmez, A. (2015). Additive manufacturing: current state, future potential, gaps and needs, and recommendations. *Journal of Manufacturing Science and Engineering*, *137*(1), 014001. doi: 10.1115/1.4028725.

Kota, S., Joo, J., Li, Z., Rodgers, S. M., & Sniegowski, J. (2001). Design of compliant mechanisms: applications to MEMS. *Analog integrated circuits and signal processing*, *29*(1-2), 7-15.

Megaro, V., Zehnder, J., Bächer, M., Coros, S., Gross, M. H., & Thomaszewski, B. (2017). A computational design tool for compliant mechanisms. *ACM Trans. Graph.*, *36*(4), 82-1. doi: 10.1145/3072959.3073636.

Merriam, E. G. (2013). Fully Compliant Mechanisms for Bearing Subtraction in Robotics and Space Applications (Master's thesis). Retrieved from https://scholarsarchive.byu.edu/do/search/?q=Fully%20Compliant%20Mechanisms%20for%20Bearing%20Subtraction%20in%20Robotics%20and%20Space%20Applications&start=0&context=1&facet=#.

Mutlu, R., Alici, G., in het Panhuis, M., & Spinks, G. M. (2016). 3D printed flexure hinges for soft monolithic prosthetic fingers. *Soft Robotics*, *3*(3), 120-133. doi: 10.1089/soro.2016.0026.

Sigmund, O. (1997). On the design of compliant mechanisms using topology optimization. *Journal of Structural Mechanics*, *25*(4), 493-524.

Su, H. J., Dorozhkin, D. V., & Vance, J. M. (2009). A screw theory approach for the conceptual design of flexible joints for compliant mechanisms. *Journal of Mechanisms and Robotics*, *1*(4), 041009. doi: 10.1115/1.3211024.

Kate, J., Smit, G., & Breedveld, P. (2017). 3D-printed upper limb prostheses: a review. *Disability and Rehabilitation: Assistive Technology*, *12*(3), 300-314. doi: 10.1080/17483107.2016.1253117.

Weller, C., Kleer, R., & Piller, F. T. (2015). Economic implications of 3D printing: Market structure models in light of additive manufacturing revisited. *International Journal of Production Economics*, *164*, 43-56. doi: 10.1016/j.ijpe.2015.02.020.

Yu, Y. Q., Zhu, S. K., Xu, Q. P., & Zhou, P. (2016). A novel model of large deflection beams with combined end loads in compliant mechanisms. *Precision Engineering*, *43*, 395-405. doi: 10.1016/j.precisioneng.2015.09.003.

Zhou, Y., Huang, W. M., Kang, S. F., Wu, X. F., Lu, H. B., Fu, J., & Cui, H. (2015). From 3D to 4D printing: approaches and typical applications. *Journal of Mechanical Science and Technology,* 29(10), 4281-4288. doi: 10.1007/s12206-015-0925-0.

Chapter 3

Influence of big data and analytics on management control[3]

Bento, Sofia

Abstract

This article is based on a study, and the purpose to complement the investigation essentially with the evolution of the big data paradigm and the IT solutions available. The investigation is based on the pros and cons of the use of big data and analytics on management control, the challenges it embraces and the potential for improvement. Generally the literature on big data is rather theoretical exploring mainly the benefits and disregarding the influence it could have in the organizations and its management control. To get a more profound knowledge of what it is happening the investigation conduct a series of interviews in organizations with data aware organizations and especially involved employees. As a result of the study it is demonstrated that the five organizations obtained no significant changes so far but have identified the need for progressive development in the area of data, giving data a more prominent role in the organizations. The benefits of big data implementation in organizations are difficult to obtain, with the results of the study demonstrating that the impact in not significant in the management control but an indirect effect is recognized with the organizations shifting to a more enabling form of control. Due to these limitations this article is completed with more recent studies and information's that give a different perspective on the situation, greatly due to significant evolutions of information technologies (IT) in the big data storage and analyses.

[3]This paper is based on Vloet, L. (2016). Influence of big data and analytics on management control. Why changes in management control by means of big data and analytics are not achieved yet (Master's thesis). Radboud University.

1. Introduction

The developments in IT have been very significant in the last decades as well as its use in the day to day life. This evolution has provided a new range of possibilities for the organizations, in which big data and analytics play a great role (McAfee & Brynjolfsson, 2012; Shao & Lin, 2016). This leads to higher volumes, variety, velocity and veracity of information (Assunção, Calheiros, Bianchi, Netto, & Buyya, 2015; McAfee & Brynjolfsson, 2012; Zhou, Fu, & Yang, 2016) with an expected change in the thinking.

It is expected that big data and analytics lead to more supported decisions and better performance (Chang, Kauffman, & Kwon, 2014; Frizzo-Barker et al., 2016; Zhou et al., 2016). Also, according to Frizzo-Barker et al. (2016), by using big data and analytics it is possible to enable organizations to optimize the processes of the organization.

In the forms of control there are four design principles repair, internal transparency, global transparency and flexibility that make it possible to distinguish the enabling from the coercive form of control.

However, McAfee and Brynjolfsson (2012) note that there are several challenges for organizations to become a big data enabled organization such as technological and managerial. This makes it difficult for every organization to became big data oriented.

This article and preceding study aim to examine influences and effects of big data on management control, and how organizations are dealing with the challenges of this transition.

As so the goal is to obtain more insights on the management control of organizations oriented to bid data and analytics. Therefore, a literature study is conducted and interviews to the organizations are carried out to have the parallel insight.

Furthermore, it provides scientific insights into how organizations deal with the benefits and challenges of big data and analytics and what impact this has on management control.

In a practical side this study can provide new insides into the possibilities and expectations of big data for their organization either if they have started its implementation and are struggling with it or if they are considering to embrace it.

2. Literature review

This literature review aims to describe the existing literature in the area of management control and big data, in order to provide understanding and insights into relevant existing studies. As so this made it possible to identify gaps in existing literature.

Management control can have various definitions based on the distinction between a coercive and an enabling form of control (Adler & Borys, 1996; Ahrens & Chapman, 2004). Coercive control emphasizes centralization and pre-planning and it provides employees only limited options for actions. On the other hand, gives enabling control employees more power, hence employees are enabled to deal on more effectively ways with the inevitable contingencies in their work and work processes (Jorgensen & Messner, 2009). Although the

organizations are neither totally coercive nor totally enabling it is possible to discern the differences between them by the four design principles of the system, repair, internal transparency, global transparency and flexibility.

The rise of IT applications created challenges to organizations and its employees because of the large amounts of data that they have to deal with to obtain benefits, which can improve decision making and therefore the performance of the organization (McAfee & Brynjolfsson, 2012). This big data causes a new wave of innovation (Tambe, 2014) focused on the (IT) infrastructure, security and privacy, and the collection, integration, processing and analysis of data.

The technological changes caused by big data are distinguishes in four aspects in literature - 4V's: volume, velocity, variety and veracity (Frizzo-Barker et al., 2016; Goes, 2014; Porche et al., 2014; Salehan & Kim, 2016) with some literature adding a fifth aspect value. Also, the big data has several characteristics as the several formats of data (structured, unstructured and semi-structured data), the differences in the processing of data and the different forms of obtaining (internet, social media and sensors).

But the investment goes beyond technological development requiring a social and cultural shift in organizations (Chow-White & Green, 2013) especially focused on leadership, skills of employees, decision making and organizational culture. Literature argues that a more enabling form of control can contribute to achieve the potential of big data better.

3. Methodology

This study is based on a qualitative research methodology collecting specific information from a small group by means of an interview study, in which the benefits and challenges of big data and the form of control in organizations are examined in different organizations. The proposes is to make a parallel relation between big data / analytics and the management control which seems to be complex in reality due to the benefits and challenges of big data. This adds difficulty when determining to which extent organizations are able to successfully implement big data.

The five employees from five different organizations where closely involved with data implementation and the developments of data in their organization.

All organizations are located in The Netherlands with a wide range of organizations, differing in terms of the area of industry, technological development and size, both manufacturing firms and service firms. Some organizations use advanced systems such as ERP (enterprise resource planning), but also some which do not use advanced systems, being in different stadium in the field of the use of big data in their organization.

Although the differences all organizations where treated equally to gain more insights into big data and the impact it has on management control, and the organization in general. The interviews where carried out personally in order to obtain opinions and perceptions from the employees with the advantage it can go into detail as it is chosen to do a semi-structured interview type.

The interviews focused on general questions about big data, the form of control in organizations, the benefits of using data and the challenges of using data. These guidelines included the basis during all the interviews. The interview questions are divided into four dimensions, which are subdivided into various indicators (Bleijenbergh, 2013).

Reliability and validity where an import aspect of the study. The reliability is reduced due to the interviews reflecting a very specific time and reality to the organization and the open questions having the possibility of wrong interpretation by the employees. On the positive side the fact that five different organizations were studied resulting that there are less based on coincidence in one organization. Also, reliability is increased with the anonymity of the employees, which is empathized before the interview starts. Lastly reliability is increased by the operationalization with dimensions and indicators.

Validity focuses on the question whether the interviewer can get access to the knowledge and experience of the employees. This is increased by the fact that questions have been set up in advance, and also the open questions despite this reducing reliability the overall benefit is considered more relevant. One additional increase in validation is the fact that the questionnaire is mailed to the employees before the interview what gives more time to consider the relevant topics.

Additionally, a brother and more recent research is carried out with the purpose to obtain more recent updates on the use of big data since 2016, as well as to get a better perception on what is new in the IT solutions in the areas of storage, security and analytics.

A wider research was carried out in other areas where big data can have influence in order to make it possible to do the parallel to the management control area.

4. Result analysis

The results of the interviews show that all the five organizations and its employees make increasingly more use of data and analytics, being engaged with the developments.

Company A has concluded that the current ERP system is failing in the processing, so the purpose is to get a new ERP system, that insures more possibilities to store data, which allows them to obtain more from the system in the future. Company B has an inadequate structure of their system, they have decided to renovate and later they are also going to optimize the design of the processes in the organization. Company C, started with the rollout of a global ERP system for the entire organization one year ago and simultaneously implementing CRM across the entire organization. Company D has implemented a new CRM system in their organization and they are working to one central database, which brings together and combines data from different systems that the organization has used in the past. Company E has observed that their ERP is limited for the use of more data so they have performed a complete re-implementation in which they connect all entities into one system.

Although all organization have realized the importance of these changes, in many of them it means critical changes within the organization. According to them, it is a progression

of developments and that means that there are changes observed in the market and organizations simply have to respond to this.

The organizations they have realised what is available and what is possible with data getting great opportunities in the use of data. But this is not an easy and quick process. The data alone is of no relevance and the processing is crucial to achieve a particular purpose. Organizations emphasise that data is only a mean to achieve the goals.

As an improvement the organizations foresee is more uniformity, what should lead to higher reliability of reports and faster collection of data, giving more time to the employees to dedicate to the next phase of data the processing and analytics. All this together results that executives can draw conclusions faster and can take actions more quickly.

Organizations also see possible improvements for processes of the organization like improvement in communication between various entities of the organization, better communication within the organization and better communication with customers and suppliers is possible. Furthermore, standardization of processes can arise, as well as compare the way one unit is performing in contrast to another unit, learning from each other.

The use of data can lead to better opportunities towards customers by understanding the customer, keeping customers more satisfied and preserving them. This understanding can also lead to prejudge on customer needs in the future.

On the negative side the organizations describe several adversities to accomplish a data enabled organization. In this was identified: ERP systems of the organizations, issues based on managerial level and issues based on other disadvantages of features of big data.

The first aspect was already predictable when identifying the stat of the systems in the organizations because the majority of them were facing a change. May occur that old systems in the organization make the compatibility difficult or that the system is not what is need or even not flexible enough to adjust to the changes and needs of employees.

The security and privacy issues may occur, especially with the recent Data Protection Regulation in the European Union. The value of data is also a great concern so that employees have valid and reliable information.

In the managerial level becomes clear the importance of stimulation from the management, as it can be differences in alignment from older employees for example, or different departments. There is also the perception that some level intuition should be maintained, as well as experience and insights, that all together will improve analytics.

The organizations have to take in consideration that the work does not became too complex, keeping it clear to the organization and employees of what is wanted to analyse and what is not. Big data is impossible to analyse in it’s all.

Overall organizations notice the importance of big data and analytics on management control in the organizations that also feel the need to shift to more enabling forms of control, with the employees having a better perception of the systems and processes. Also the results suggest that the organizations gave greater importance to the repair possibilities of procedures, processes and systems.

In addition to these results further research demonstrates that in other fields the big data is getting great changes in the mindset that was establish but sometimes a step back has to be done as seen in the google flu trend of 2009, or the political tendencies obtained in twitter when it's users are a specific range of the population.

Additional researches are going in the direction of data processing but mostly in analytics, being given a great relevance to the skills of the employees carrying them out or the articulation between the IT developers and the analytics.

Furthermore, thought the years organizations are appearing largely interested in supplying the services of secure data storage and integrated data analytics. As a result, costs have been decreasing.

5. Conclusions

The study proposed to obtain more insights on the big data and analytics on management control, with the especial regard of going beyond the positive aspects of the existing literature

As a result, it can be concluded that the expected impact of big data and analytics on management control is not attained in the different organizations considered in this study, due to the fact that they still haven't got a big data system implemented. All of them realized that they have to accompany the developments in this field of the big data and analytics.

Although the difficulties in the implementation all recognize the advantages of the use of data, as are the improvements in decision making, processes and customers.

In many organizations the systems where not enough to respond to the increase in data. Also the technological issues can cause difficulties for organizations in implementation.

The changes in management leaders can also be challenging with the recognized need for them to support the change with employees and shift to a data-driven decision.

Due to all the above benefits of big data and analytics are not that easy to obtain as mentioned in literature, with the result of the study indicating that the big data does not have a significant effect on management control. But an indirect effect exists, such as employees awareness of the processes, becoming more adjustable and the transparency shifting the organization towards enabling control and an increase in flexibility.

In the context of the more recent developments it becomes clear the relevance of an accurate processing of data and analytics done with the skills and precision needed to obtain the relevant data to the management request. Without the right request employees will be lost in processing and analysing the data not being able to provide organized and clear results to the management. The goal is to formulate the right answer so that the system and employees provide the analysed data in the most clear and appealing way.

Another conclusion is that with the increase in interest more organizations are emerging for this type of service, what consequently tends to reduce cost as has been indicate.

References

Adler, P. S., & Borys, B. (1996). Two Types of Bureaucracy: Enabling and Coercive. *Administrative Science Quarterly, 41*(1), 61-89.

Ahrens, T., & Chapman, C. S. (2004). Accounting for Flexibility and Efficiency: A Field Study of Management Control Systems in a Restaurant Chain*. *Contemporary Accounting Research, 21*(2), 271-301.

Assunção, M. D., Calheiros, R. N., Bianchi, S., Netto, M. A. S., & Buyya, R. (2015). Big Data computing and clouds: Trends and future directions. *Journal of Parallel and Distributed Computing, 79–80*, 3-15.

Bleijenbergh, I. (2013). *Kwalitatief onderzoek in organisaties*. Den Haag: Boom Lemma.

Chang, R. M., Kauffman, R. J., & Kwon, Y. (2014). Understanding the paradigm shift to computational social science in the presence of big data. *Decision Support Systems, 63*, 67-80.

Chow-White, P. A., & Green, S. E. J. (2013). Data Mining Difference in the Age of Big Data: Communication and the Social Shaping of Genome Technologies from 1998 to 2007. *International Journal of Communication, 7*, 556-583.

Côrte-Real, Nadine & Ruivo, Pedro & Oliveira, Tiago & Popovič,Aleš. (2019). Unlocking the drivers of big data analytics value in firms. *Journal of Business Research*, 97, 160-173.

Davenport, Thomas H. & Bean, Randy. (2017). Big Data Business Impact: Achieving Business Results through Innovation and Disruption *Big Data Executive Survey*.

Frizzo-Barker, J., Chow-White, P. A., Mozafari, M., & Ha, D. (2016). An empirical study of the rise of big data in business scholarship. *International Journal of Information Management, 36*(3), 403-413.

Goes, P. B. (2014). Big Data and IS Research. *MIS Quarterly, 38*(3), 3-8.

Harford, Tim. (2014). Big data: are we making a big mistake?. *The Financial Times Ltd.*

Jorgensen, B., & Messner, M. (2009). Management control in new product development: The dynamics of managing flexibility and efficiency. *Journal of Management Accounting Research, 21*(1), 99-124.

McAfee, A., & Brynjolfsson, E. (2012). Big Data: The Management Revolution. *Harvard Business Review, 90*(10), 60-68.

Porche, I. R., Wilson, B., Johnson, E.-E., Tierney, S., & Saltzman, E. (2014). *Data_flood: helping the Navy address the rising tide of sensor information*. Santa Monica, CA: RAND/National Defense Research Institue.

Richards, Gregory, & Yeoh, William, & Chong, Alain & Popovič, Aleš (2019). Business Intelligence Effectiveness and Corporate Performance Management: An Empirical Analysis. *Journal of Computer Information Systems* 59:188-196.

Salehan, M., & Kim, D. J. (2016). Predicting the performance of online consumer reviews: A sentiment mining approach to big data analytics. *Decision Support Systems, 81*, 30-40.

Shao, B. B. M., & Lin, W. T. (2016). Assessing output performance of information technology service industries: Productivity, innovation and catch-up. *International Journal of Production Economics, 172*, 43-53.

Tambe, P. (2014). Big Data Investment, Skills, and Firm Value. *Management Science, 60*(6), 1452-1469.

Zhou, K., Fu, C., & Yang, S. (2016). Big data driven smart energy management: From big data to big insights. *Renewable and Sustainable Energy Reviews, 56*, 215-225.

https://www.stayclassyinternet.com/articles/investigating-AWS-pricing-over-time.

Chapter 4

The Role Of Design Management In Increase Of The Productivity[4]

Santos, João and Marques, Pamela

Abstract

Design management is really important in business development. These days, with things changing so quickly, greatly leveraged by the development of technology, it is critical that companies be able to respond quickly to the needs of the market and design management can contribute very positively. With the present work, we intend to analyze succinctly the function of the design management and the impacts that can have on the productivity of the organizations. Since this is a leadership-related role, the various leadership styles will also be addressed

Keywords: Design Management, Management styles, Productivity.

[4]This paper is based on Hantsuk, N. (2018). The role of design management methods and styles in increase of the productivity (Master's thesis). European University of Lisbon.

1. The Role of Design Management in Increase of the Productivity

The main objective of this work is to validate the role of design management in companies and to verify the influence that design has on the various industries. On the other hand, it is also intended to perceive the impacts that the choices of the leadership styles of design management can have on the productivity of the companies.

According to Design Management Institute (2010), "Simply put, design management is the business side of design.", that is, design management uses project management, design strategy and supply chain to control the creative process of companies in order to achieve the strategic and mission goals intended by the organization.

2. Why Design Management is important

Design is more than just a tool, it is also a strategy and in this regard it needs to be managed. This way design becomes powerful. (Cocoonfxmedia. 2019)

Peter Gorb (2001) says:

"Design management is the effective deployment by line managers of the design resources available to an organization in the pursuance of its corporate objectives. It is therefore directly concerned with the organizational place of design, with the identification with specific design disciplines which are relevant to the resolution of key management issues, and with the training of managers to use design effectively."

The objective of design management is to develop and maintain an efficient business environment in which an organization can achieve its strategic and mission goals through design. Design management is a comprehensive activity at all levels of business (operational to strategic), from the discovery phase to the execution phase. No company can do without design but the vast majority of small businesses do not have this feature:

- Adds value to brands of products and services
- It allows the company to adopt a way of thinking and facing problems focused on empathy, collaboration and experimentation
- Creates packaging models that value the presentation of products on the shelves of stores and supermarkets
- Develops visual identity of product lines, establishing links with consumers
- It promotes sustainable buildings, not only in the construction phase, but also in the use (ex: natural lighting, solar energy, water reuse, etc.)
- Develops projects that reduce waste of materials (solid waste)
- It uses innovative technology and equipment aimed at the market of residential and building automation with solutions of sustainability to the environment
- Create business web sites for the promotion of furniture and furniture.
- Develops graphic and editorial materials for the promotion of Innovation products

3. Areas of Design Management

Design falls into a large number of disciplines and thus so too does design management (Interaction Design Foundation, 2019). Some of the more common areas in which design management can be found include:

- **Product design.** A very broad coefficient and effective generation and development of ideas through a process that leads to new products.(Morris, 2009)
- **Brand design.** The analysis and planning on how a brand is perceived in the market. A brand manager would oversee all aspects of the consumer's brand association as well as relationships with members of the supply chain. (Understanding the Power of a Brand Name, 2015).
- **Service design.** Establish best practices for designing services according to both the needs of customers and the competencies and capabilities of service providers.
- **Business design.** Business design is an emerging concept – it's the understanding that businesses can be designed from within to operate more efficiently and at higher levels of effectiveness (Interaction Design Foundation, 2019).
- **Engineering design.** Engineering design is more concerned with technological outputs than other disciplines of design. Engineering design is the method that engineers use to identify and solve problems

Some management practices can be facilitate in the process of innovation in a company. The environment must foster innovation. If the priority is to innovate in your market, the company environment needs to be in favor of this process. And we are not just talking about giving space to creative ideas and their execution - after all, this is already a necessary condition for design professionals.

For innovation to happen, it needs investments and managers must foresee this in their budget discussions. The team must be committed to innovation. Innovation is generated by people. And good ideas are of no use when the whole team that participates in the project is not well oriented. Innovation management needs to be focused on bringing the team together so that ideas become tangible.

It is necessary to understand that before the hit, there is the error

The error is natural and without it, innovation can not exist. It is important to get around the failed attempts, but it is even more fundamental for management to learn to accept mistakes and to encourage its practitioners to keep trying - thus avoiding any barriers to project evolution.

4. Leadership Styles

Each company has a unique culture and its employees have different experiences and stages of maturity, so the leadership should use different management styles in order to adapt to the circumstances and raise the levels of productivity of the organization (situational leadership).

They use two dimensions:

- Task behavior - set objectives, organize, set deadlines, direct and control.
- Relationship behavior - support, communicate, facilitate interactions, listen carefully and give feedback.

According to Hersey, P. and Blanchard, K. H. (1969), this mode of leadership can be divided into four styles, which are related to the levels of maturity of the subordinates:

- **Telling** - Leadership occurs when the employee needs to learn the task to be performed, being the task supervisor to the end, directing the collaborator to elaborate it until gaining confidence.
- **Selling** - This style of leadership occurs when the employee needs to know the task and gain a stimulus to execute it. The leader contributes by helping to get new ideas and disseminating knowledge when the employee needs help.
- **Participating** - the leader is in charge of stimulating the employee to acquire safety and seek learning, increasing their skills and knowledge, giving more support to the employee to perform their tasks. The leader provides support, but oversees little.
- **Delegating** - it occurs when the employees have greater autonomy and freedom, having knowledge and security with the tasks. The leader maintains contact with little supervision and little support. Often the employee also has authority for environmental change decisions at the hierarchical level.

5. Measurement of Productivity

Productivity describes various measures of the efficiency of production. Often (yet not always), a productivity measure is expressed as the ratio of an aggregate output to a single input or an aggregate input used in a production process, i.e. output per unit of input (Sickles, R., & Zelenyuk, V., 2019).

Many external factors can affect your organization's productivity -- the national economy, a recession, inflation, competition, etc. Although you can't control everything, you can control and measure employee performance. Employee productivity has a huge impact on profits, and with a simple equation, you can track productivity per individual, team, or even department.

You can measure employee productivity with the labor productivity equation: total output / total input.

The level of productivity is the ratio of output to inputs. (For labor productivity, the input is only labor, for other measures of productivity, the input is an index of combined inputs). The percent change in a ratio is approximately equal to the percent change in the numerator minus the percent change in the denominator.

Productivity growth is frequently lauded by the business community, media commentators and politicians as the solution to improving living standards, yet there is little agreement on what productivity actually is.

To economists, productivity is the efficiency with which firms, organisations, industry, and the economy as a whole, convert inputs (labour, capital, and raw materials) into output.

Productivity grows when output grows faster than inputs, which makes the existing inputs more productively efficient. Productivity does not reflect how much we value the outputs — it only measures how efficiently we use our resources to produce them.

The government's industrial strategy, published in November 2017, made clear that raising productivity was one of its key priorities. The strategy focused on five foundations of productivity: ideas, people, infrastructure, business environment and place. As part of the strategy, the government has looked in-depth at the actions that are required to improve the productivity and growth of small and medium sized businesses.

Information on labor productivity presented enables the designer to solve strategic economic problem. The formula of labor productivity enables engineers to calculate the production rate to increase labor productivity and to consider each component of economic issue and its influence in general.

6. Conclusion

Many professions are reinventing themselves, and Design is one of them. Acting as mediator between innovation and the market, through visual manifestations (such as brand and visual language for example) and experiences that seek to immerse the user in the universe of the product or service to be offered.

Designer (it's now) manager. Designers who develop managerial skills contribute to building a team that understands the importance of a well-done, useful product. They must use different leadership styles to improve team performance and adapt to their circumstances. In this way, it is possible to increase the productivity of companies and create new and better products and services.

Certainly, the companies that are growing (and rising) together with Industry only have to gain when they offer great experiences with products and services focused on the user. After all, whoever dictates the rules of trends, services and demands is the user, companies must work to ensure that these wants are met, since those who talk equally with their target public have a guarantee of success in the innovation industry.

References

Natallia Hantsuk. 2017. The role of design management methods and styles in increase of the productivity. Master's Thesis. Universidade Europeia

Cocoonfxmedia. 2019. *Design Management IS important.* Retrieved from https://www.cocoonfxmedia.co.uk/business/design-management-important

Interaction Design Foundation. 2019. *Design Management (An Introduction) - Taking Charge of Processes and People*. Retrieved form https://www.interaction-design.org/literature/article/design-management-an-introduction-taking-charge-of-processes-and-people

Peter Gorb. 2001. *The design management interface*. In Designthinkers (ed.). edited conference transcript. Ontario Science Centre, Ontario: The Association of Registered Graphic Designers. pp. 1–13.

Guy Bilgorri. 2019. *The right design for productivity*. Retrieved from https://www.designcouncil.org.uk/news-opinion/right-design-productivity

R. Morris. 2009. The fundamentals of product design. AVA Publishing

Cpg, Fmcg & Retail. 2015. Understanding the power of a brand name. Retrieved from https://www.nielsen.com/us/en/insights/news/2015/understanding-the-power-of-a-brand-name.html

Hersey, P. and Blanchard, K. H..1969. *Management of Organizational Behavior – Utilizing Human Resources*. New Jersey/Prentice Hall.

Stewart. 2010. *Management Design: What. Why. How.* Retrieved from https://stewarthayes.wordpress.com/2010/04/25/management-design-what-why-how/

HSLU. 2016. *The Role of Design Management*. Lucerne School of Art and Design. Retrieved from https://cdn.ymaws.com/www.dmi.org/resource/resmgr/pdf_files/Lucerne_School_of_Art_&_Desi.pdf

Sickles, R., & Zelenyuk, V. 2019. *Measurement of Productivity and Efficiency: Theory and Practice.* Cambridge: Cambridge University Press.

Chapter 5

How to manage and improve inventory control, demand pattern and safety stock[5]

Nóbrega, Márcio and Ferreira, Mário

Abstract

Nederman has a long term goal of improving their supply unit in Helsingborg. One step of this is to investigate if there are any improvements to be made in the inventory control in terms of stock levels and service level. The purpose is to improve the inventory control at Nederman by lowering the stock level given the goal of the service level. This master thesis has been performed with a systems approach. An abductive research method has been used and the authors have been moving back and forth between theory and practice. A huge amount of numerical data from different sources has been used throughout the master thesis why most of the analysis has been quantitative, but it has been supported with more qualitative analysis in terms of interviews.

[5]This paper is based on Arrelid, D., & Backman, S. (2012). How to manage and improve inventory control (Master's thesis). Lund University.

1. Introduction

Nederman & Co is a company that develops, produces and sells systems for improving the safety and working conditions in factories and other facilities. The variety of different parts and products are increasing continuously and to be able to control the flow of goods and optimize the inventory cost Nederman is putting more and more effort on their inventory control system.

The distribution of material and goods are also essential for a company´s development and without the capability to transport, deliver and store products at the right time and place, the development will grind to a halt.

In a sophisticated computer system, all types of functions could be optimized and completely automatically updated. Everything from the analysis to support functions and maintenance could be controlled automatically and the focus for the supply chain unit could instead be put on future development and optimization. The price of a system could hardly be justified if only parts of the functions are used, and before implementing a new system a company needs to ensure that they have the competence and knowledge to use these functions. This is a situation Nederman and many other businesses are facing now and in the near future.

The tools and methods used for the inventory control at Nederman are among the staff perceived as quite blunt. The major reason for this is that all products are controlled likewise when setting a proper safety stock based on the same two parameters, frequency and product value. All products that are stock items are divided in two different groups, manufactured and purchased goods. All the products from each group are distributed in a matrix, one for each group and this is the tool used for controlling the safety stock. The matrices are based on the value and frequency where every combination is assigned a certain amount of safety days that serve as the base for every products safety stock. These matrices are called SS-bas matrices and the value (amount of safety days) is called SS-bas.

This creates the following quite clear problem statement:

“Find a way to divide the products into different classifications based on their demand pattern in order to improve the inventory control.”

And in order to make improvements the second focus will be:

“Finding ways to control the different classifications that will lead to improvements on stock levels given a certain service level.”

2. Literature revision

2.1 Inventory Control

Supply chain management is for more or less all companies an important part of the business.

Inventory control cannot be totally separated from other functions and units in a company like for example production, purchasing and marketing. There is often even a conflict between these different functions, just because of the fact that their objectives differs a lot.

One of the important activities in an inventory control system is a clear mapping of the flow of material, goods and information.

2.2 Mapping

Mapping is a way to illustrate the supply chain in a simplified way. Supply chains become more and more complex due to todays globalized world and the extreme competitiveness between supply chains and value chains. In order to capture this complex structure and to be able to understand, analyze and explain it, a good tool to use is mapping.

Mapping is also a very powerful way to illustrate less complex structures and becomes therefore very useful for many different aspects in logistics and other areas as well. Mapping is like a visual language that is used to make people working with logistic to easy understand different things. There are many different shapes that are used in this language and some of them are displayed in figure.

2.3 Replenishment systems

To be able to have the right amount of goods at the right time and the right place, and also optimize the cost of handling, ordering and deciding volume for transport, the majority of companies use some kind of replenishment system. This is used to order new goods at the right time and size but also to minimize the cost.

There are three types of replenishment systems: reordering systems; economic order quantity – EOQ; Safety stock.

3. Methodology

The overall perception or fundamental assumptions of the world will affect how we as a human perceive data and results. The paradigm acts like a bridge between the fundamental assumptions and the methodology.

There is a close relationship between paradigm and methodology and multiple methodological approaches can exist within the same paradigm. It is also possible that one methodological approach can find inspiration in several paradigms. There are three different research approaches within the area of methodology in business economics: analytical approach; systems approach and actors' approach.

Analytical approach it originates from the analytical philosophy and the main object is that the totality is equal to the sum of the separate parts.

The system approach states that the totality is separated from the sum of the parts. The relationship between the different parts can give both positive and negative effects to the totality and is therefore a synergy.

Actors approach is the youngest of the three approaches and it implies that the totality could be understood from the properties of the parts. This approach has no interest in being explanatory and is focused on understanding the social totality.

Systems approach is the most suitable approach for this investigation, since many different parts and activities are analyzed both separately and as a system.

3.1 Research method

3.1.1 Qualitative and Quantitative approach

There are two general approaches used in scientific research methods, qualitative and quantitative methods. Quantitative methods are all methods where information and data can be measured and analyzed numerical. Qualitative methods are used where a deep understanding in a specific subject or situation is the goal. There is also one fundamental similarity between them and that is that their goal is to create a better understanding of the society.

Qualitative approach has for a long time been used by social scientist and a main character is participating observations. Unstructured interviews are another method where the interviewer is looking for more deep information from the interviewee by letting him or her wander away from the subject.

Quantitative approach is very similar to the approach of natural science. Examples of different quantitative research methods are surveys, structured observations and content analysis and all those are ways to collect large amount of data for analysis. Quantitative research can be seen as a part of a special language which contains many expressions used by scientists when observing the nature. Some of them are *variables, control, measuring* and *experiments* and it implies that the quantitative approach is a way to create models based on science of nature.

The purpose of this investigation is to use the theory and then compare the conducted empirical data with the theory in order to find the best optimal solution for the company based on their specific data in the context of existing theory.

This makes abduction the best fitted approach for this problem.

They based their study on a combination between quantitative and qualitative research. Data in terms of numbers is very important in the analysis and is standing as the base. But to support the quantitative analysis the authors uses qualitative methods to reach a deeper understanding in desired fields.

3.1.2 Data

Some of these methods are interviews, observations, literature studies and data collected from databases. Different methods are suitable for different purposes, but they can all be divided in two different main groups, primary and secondary data. Primary data are all types of new data that has been collected to a specific project. It could be interviews, test or observations that directly could be associated to the project. Primary data could always be adapted for the purpose since the research is done for the specific project. Secondary data is based on historical data and the information has not been collected to the specific project and it is information

collected by another person than the investigator. This investigation used: Interviews; Observation; Databases; Literature studies; Data from existing projects and tests.

One way to increase the credibility of a study is to use many different methods on the same material, to get several perspectives. This is called triangulation and is used when more than two methods are used on the same material to reach the same purpose.

4. Analyze results

The first part of the analysis was to analyze the current situation at Nederman to be able to understand their working methods and processes along with their different software in order to find any potential for improvements.

In order to understand the quite complex structure of the product range, how the different types are controlled and how they are linked together. This gave also information about which products that where more interesting than others for the analysis and the implementation.

The next step in the current state analysis was to understand how the stock products where controlled by the matrices along with the formulas and how this was used and performed in reality.

The analysis of the two SS-bas matrices gave indications of that it in every cell could be products with many different demand pattern resulting in a smoothing of all different demands to one average line, which would give some products a way to high safety stock and others way to low. The very positive thing about those matrices is that they create a very easy tool to handle the huge complexity of the products and that it controls the warehouse at an acceptable level, but that it in order to make any improvements needed to be further developed.

The second phase analysis It was divided in four main parts, which creates the base of the analysis. These four parts was divided in several smaller parts, demand pattern, selection of matrices, new start value and implementation.

Demand Pattern; During the first step different demand patterns from the raw data was analyzed and further put in different groups after pikes, variability and frequency.

Selection of Matrices; The groups created in the first step ended up in new SS-bas matrices, based on purchased and manufactured products.

New start values; In the third step the new values for the matrices was calculated, based on products in the group and the old SS-bas.

Implementation; Last the selecting of the test group and control groups was made, and also an updating model was made.

5. Conclusions

To be able to make any general conclusions whether the purpose and goals for this master thesis are fulfilled, the main targets of the master thesis need to be discussed. This master thesis main purpose was to improve the inventory control at Nederman in Helsingborg. Two problem

statements. Find a way to divide the products into different classifications based on their demand pattern in order to improve the inventory control.

Finding ways to control the different classifications that will lead to improvements on stock levels given a certain service level. The demand patterns were classified, and the products were divided into different groups. After modeling these groups, it became clear that the inventory control could be improved. The stock level did decrease and therefore improved during the implementation, but this was not done to a certain service level from a theoretical aspect.

By using a theoretical established formula for calculating the safety stock it was concluded that the wanted service level would be more likely to reach the targeted level.

During the demand pattern phase, there was two different aspects to discuss. The first thing was the product varied a lot, the second thing to discuss was the limits between make to order and make to stock. There are many products among the product range at Nederman that are suitable for make to order. The implementation showed that Nederman can draw benefits from controlling products on different variables depending on historical demand pattern. Nederman has the possibility to change the inventory system and control products more individually and can maintain or increase the service level and decreasing the stock level.

The new matrices after the limits were set for the dividing, seven different matrices was concluded as the proper amount, more matrices give a more individually controlled system with smaller groups and to find an optimal number of matrices is essential.

The new start values, the decision of how to calculate the start values was between two different methods. One was to use a more theoretical method that was adopted after a specific service level and another method that was more based on the current system and not specified after a service level. The conclusion from this is that alternative based on the current system would give the best answer to the question if the existing system could be improved by adding one additional dimension, while the other alternative would have given a more accurate stock level based on a certain service level.

The implementation showed that Nederman can draw benefits from controlling products on different variables depending on historical demand pattern. Nederman has the possibility to change the inventory system and control products more individually and can maintain or increase the service level and decreasing the stock level.

References

Arrelid, D. & Backman, S. (2012). How to manage and improve inventory control. A study at AB Ph Nederman & Co for products with different demand patterns. Helsimburg: Lund University [Master Thesis].

Chapter 6

Utilizing Big Data and Internet of Things in a Manufacturing Company: A case study of using technological advances in the production process of Swedish Match - The Resume [6]

Peças, Ana and Mateus, Cátia

Abstract

As a flexible and innovative company, Swedish Match works to have the right strategy, people, competencies, products, and structure in place in order to rapidly meet changing market conditions. Due to the competitive landscape, SM product portfolio has become more complex, with a reduction in the individual batch sizes and an increase in the number of different batches resulting in longer changeover times and less efficient usage of machinery and subsequent lack of flexibility necessary due to increased complexity. The ability to successfully use technological advances, such as Big data and IoT, are becoming key to maintaining competitiveness. The aim of this master thesis authors was to investigate how the production process could be optimized using Big Data and IoT and thus contribute to increase knowledge within the company as in the industry in general as well as of how it could be used in a production process and be viable in the manufacture of functional and mature products. A single qualitative case study with inductive reasoning approach was performed to respond to the purpose presented and the combination with a literature study, provided an understanding of how it could be used in a production process. Four elementary gaps were detected: lack of internal process integration, a reactive approach rather than a proactive, high pressure placed on employees and lastly, many of the data are saved and unavailable. The study expected to be a qualitative report with more of a strategic focus rather than presented in monetary terms.

Keywords: Big Data, IoT, Industry 4.0.

[6]This paper is based on Karlberg, H., & Pettersson, S. (2016). Utilizing Big Data and Internet of Things in a Manufacturing Company. (Master's thesis). Lund University.

1. Introduction

The phenomena Industry 4.0, Big Data and IoT are in an early research phase and are considered to be core components of Industry 4.0 and help enabling the revolution. Big Data and IoT do not only impact technological aspects, but also organizational and competence related aspects.

As fourth industrial revolution considers the smart factory, Big Data and IoT (Ramin, 2016) as two of the nine enabling technologies of Industry 4.0 enabling collection of more accurate data to improve productivity and quality in the factory as well as monitoring and controlling all elements of the production. Big Data analyzes massive amounts of data while IoT partly generates the data needed for the Big Data analysis.

According to the authors, when considering new technological advances, such as Big Data and IoT in a manufacturing company, it is important to understand the company's supply chain strategy. This enables a deeper understanding of the underlying reasons for implementing new technology in the firm.

During the study, the overall research questions identified by the authors were:

RQ1. How can Big Data and IoT be utilized to optimize the production process at Swedish Match?

RQ2. Why should Swedish Match utilize Big Data and IoT?

RQ3. What are suitable applications of Big Data and IoT at Swedish Match?

RQ4. In which parts of the production process is it most appropriate to start

1.1 Problem Description

Company's product portfolio has become more complex, with a reduction in the individual batch sizes and an increase in the number of different batches and large number of batches results in longer changeover times and less efficient usage of machinery.

The current production process of the company is standardized which makes it not flexible enough to meet the increased complexity.

Presently, data is collected both manually and automatically. This procedure can result in information islands preventing efficient data sharing and credible decision-making.

Big Data and IoT facilitate the digital transformation in manufacturing industries as more widespread information sharing in an organization can also result in mitigation of problems associated with information islands providing new motives to transform the company's production process.

Thus, more efficient data sharing as well as improved credibility in decision-making can also be realized also can ultimately result in creation of improved customer value.

It is of great significance to plan exactly what data to collect and from which source defining the minimum data sources needed to establish a comprehensive picture of the current condition

1.2 Purpose and Focus

Previous research suggest that Big Data and IoT can be applied in a manufacturing process to enhance its flexibility and efficiency being crucial to understand what they want to achieve by its implementation therefore being vital to understand the company's supply chain strategy as well as the product, its requirements and the corresponding production process (Jingran et al., 2015).

Through the usage of Big Data and IoT, companies can increase the efficiency by optimizing the production process while optimizing its real time control.

This digital transformation is expected to improve the performance in the production process and, in this particular case, to understand how the manufacturing company Swedish Match can optimize their production process by utilizing Big Data and IoT conducting an examination of the production process of a specific product.

1.3 Definition of business relevance

According to Waller & Fawcett (2013), Big Data enables collection and analysis of substantial amounts of data to find new and sometimes unexpected correlations.

Big Data enables a massive data collection. This is considered to contribute to both improved quality of decision-making and profitability (Waller & Fawcett, 2013). Data can be leveraged by firms to make their services or products adapted to be more in line with the customers' needs, develop new revenue sources as well as optimizing both operations and infrastructure which can help companies to understand the behavior of the customer, improve the efficiency on a factory site in terms of inventory, quality and maintenance, and adapt the product when the sales decline.

Historically, the manufacturing industry has been dominated by a reactive approach, applying a proactive production approach allows the company to take the control required to act prior to a future situation occurs in which Big Data and IoT can provide the possibility to find problems in that manner enabling companies to find new, previously unidentified and unexpected correlations (Waller & Fawcett, 2013) besides through both identifying invisible problems and working proactively, the problems can be solved before they actually occur (Lee et al., 2013).

The general challenges faced by companies are when top management does not consider digitalization as a matter of high priority nor employees with inadequate knowledge in the area as the adoption of IoT, upgrades or replacements of machines and devices may be required.

Fox & Do (2013),cited by the autors, believe that it is important for managers to be able to see through the hypes in order to realize what both Big Data and IoT actually can do and add to their businesses but also to ensure understanding of the limitations of the technologies to avoid unrealistic expectations.

It may allow to understand who buys the product and how it will be used attaining a holistic picture of the market.

Manufacturing firm can make their quality management better by gaining this deeper knowledge regarding where the actual problems are in their current production process with the opportunity to find and pinpoint issues in a much timelier manner additionally giving the opportunity to find and pinpoint issues in a much timelier manner being focused on predicting and preventing upcoming events.

Furthermore, exploiting Big Data and IoT a manufacturing company can increase the flexibility in the production process and enable manufacturing of smaller batch sizes in an economically feasible way. Self-optimization of devices enables automated adjustments of settings based on the characteristics of the unfinished good besides potentially reducing maintenance costs significantly.

Nowadays, product life cycle is shortened, and Big Data can be used to accomplish qualified predictions with support from historical data assess which part of the equipment that can be reused somewhere else.

1.4 Outline of the case study

In order to describe and understand the potential of Big Data and IoT at SM according to Yin (2013), a case study design was applied during the process and citing: "(i) Investigates a contemporary phenomenon in depth and within its real-world context, especially when (ii) the boundaries between the phenomenon and the context may not be clearly evident.".

Applying a holistic perspective, it was authors' intention to gain an in-depth understanding of the phenomenon allowing to answer to the questions why, what and how.

Complementing the research questions, the case study approach It's suitable for an early, not fully developed phenomenon or an exploratory investigation (Voss, Tsikriktsis, & Frohlich, 2002) which meets the early stages where both matters are.

The study was organized the following way: two interviewers participate during all interviews, interview guides are used, and lastly the interviews are recorded.

The choice had to do with increased complexity in the product portfolio that creates new motives to overlook the digitization in the production process, the shift in the business environment and its conditions that is caused by the increased competition from price-pressuring companies, owns the production process, from raw material to finished product and finally large interest in Big Data and IoT from the management at the company.

To identify how Big Data and IoT can be applied to optimize the production process at Swedish Match, a supply chain analysis, a gap analysis and a risk analysis were conducted and both Big Data and IoT can help the production process in terms of its better understanding, predicting errors, making more accurate decisions and understanding what data is collected.

Once established that there are actually applications of Big Data and IoT that are appropriate to apply in the production process of SM, an analysis regarding how these can be

implemented in a more detailed manner can be performed being also important to assess the risks associated with a potential implementation.

2. Literature Review

With the purpose of gaining an understanding of the terminology, literature review is included in early stages of the study enabling to adequately construct the research questions as well as facilitate the data collection and give an idea of how the data can be analyzed as pointed out by Bryman & Bell (2011).

Based on literature search, keywords were identified and formed the basis of the search namely Industry 4.0, Big Data, Internet of Things, Industrial Internet of Things, Product Life Cycle, Functional product, Innovative product, Supply Chain Strategy.

3. Methodology

To answer the research questions presented in section previously on this document, a single qualitative case study with an inductive reasoning approach is initiated. To gain insights in the case organization, in-depth interviews and observations are conducted in order to provide an understanding of how Big Data and IoT can be used in a production process.

3.1 Research Design

Semi-structured interviews were conducted to gain a deep understanding of the studied case including open questions and the interviewers could ask subsequent questions freely encouraging opinions of the participants and detailed answers.

Semi-structured interviews conducted with SM employees intended to complete a comprehensive data collection and to answer two of the three research sub-questions, RQ2 and RQ4. Observations are also conducted as a supplementary research method to the interviews in order to collect additional qualitative data.

These research questions were related to understanding the different parts of the current production process, their improvement opportunities, and what consequences that are related to them. Likewise, the selection of interviewees is based on an assessment of their influence in the production process or projects related to the production process.

Being the focus on understanding the function of the system as well as its inter- and intra-relations, the most appropriate theory is the system theory which is limited to a production process at SM and the decision is supported by the clear limitations of the system as well as the flows of physical elements and information along with human integration.

In this study, the whole system contains three subsystems, namely the mill, pasteurization and packaging process which depend on each other.

Also, a qualitative research strategy with an inductive reasoning approach was applied and the authors' choice was sustained by the need to understand the nature of the study, its purpose, and the research questions. The adopted approach shown to be more suitable as its purpose is

to generate theories which are formed based on findings in interviews and observations (Bryman & Bell, 2015).

The motivations for that choice allows to address the matters of understanding and interpreting to develop a holistic comprehension of the actual case studied while investigating a novel research area with low or moderate prior insights.

The exploratory character of this study is appropriate when gaining elementary knowledge of where, when and how the phenomenon is applicable.

4. Data Analysis

An inductive approach was applied in this study to discover concepts and theories in the empirical data. Added to this was the knowledge gained during the literature review.

Open coding was the analytical process used in order to identify the concepts by their properties and dimensions and as an iterative approach, the coding is continuously reviewed, further analyzed, and in this final stage theoretical concepts are generated to answer the purpose and research questions of the study and in this particular case, the coding mainly includes identified issues that potentially weaken the production process and improvement opportunities.

In the empirical data, four main issues were identified in production process of SM. The authors composed Table 1 in which they provide a comparison of the current situation, the desired situation as well as the resulting gap between these two formers.

Four gaps were pointed out by the authors, one for each issue identified in the empirical data and were within the fields of a lack of internal process integration, a reactive approach, a high-pressure put-on employees, and data management.

A comparison of the current situation, where the issues weakening the production process exist, and the desired situation, where the issues are solved, is conducted including description of how various applications of Big Data and IoT can be implemented to reach the desired situation and optimize the production process.

Clearly, SM can minimize the identified gaps through utilization of Big Data and IoT and shows that there are several applications of Big Data and IoT that are suitable to use in the production process of SM and in the present study.

The functional product and the physically efficient supply chain strategy motivate introducing applications of Big Data and IoT associated with manufacturing optimization as well as preventive and predictive maintenance besides being closely aligned with SM's current motives to change and the issues that the company is experiencing which will lead to the quality of the end product as is of significant importance throughout the production process.

5. Conclusion

Data must both be stored and analyzed in an efficient way and to be successful the right competencies are needed both on an operational and a strategic level.

It is of high importance that companies actually understand the requirements of their own products which vary depending on the maturity of the product.

According to the authors, the company should have a clear picture of what they actually want to achieve by adopting Big Data and IoT giving way to several potential applications including in the areas of design, manufacturing optimization, preventive and predictive maintenance, logistics, and product recovery.

Furthermore, it is clear that there are two main application areas of Big Data and IoT that are feasible when manufacturing functional and mature products

Gaps were identified namely lack of internal process integration, reactive approach instead of a proactive, high-pressure put-on employees, and much data is stored without being available, combined or visualized at the right place.

The application in manufacturing optimization as well as in preventive and predictive maintenance can contribute to attaining increased efficiency in the production process while minimizing costs as well as increased quality of the finished products.

Gaps identified proven that could be reduced with the help of Big Data and IoT as its root cause could often be found at an early stage of the process.

According to the authors, SM should implement Big Data and IoT in their production process, because it will help the company to address a number of gaps in this process mitigating the lack of internal process integration, a reactive approach, instead of a proactive one helping SM to increase the efficiency in their production process while minimizing the costs and ultimately increase quality throughout the process as well as of finished goods.

The two main application areas are within manufacturing optimization as well as in preventive and predictive maintenance.

References

Karlberg, H and Pettersson, S. (2016), *Utilizing Big Data and Internet of Things in a Manufacturing Company – A case study of using technological advances in the production process of Swedish Match*. Lund University, Lund, Sweden.

Tables

Table 1.
Gaps revealed by comparing current situations with the desired ones

	Current situation	Desired situation	GAP
1	Limited information sharing between sub processes in the production process	Well-integrated internal processes	Lack of internal process integration
2	The process steps and the goods are controlled after they are completed, which comprises quality, efficiency of resource usage and maintenance	Steer the process steps and prevent errors from happening, all to improve quality, resource usage and maintenance	Reactive approach, instead of proactive
3	Work based on previous experience and decisions based on human judgment	Standardized approach to work-tasks and decision-making based on data	High pressure is put-on employees
4	Data is collected in a non-standardized manner	Collection of data that is combined, visualized and made available to employees	Much data is stored, without being available, combined or visualized at the right place

Note: Retrieved from (Karlberg, H and Pettersson, S.,2016). Utilizing Big Data and Internet of Things in a Manufacturing Company – A case study of using technological advances in the production process of Swedish Match