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Implementing Industry 4.0 Concepts to a Media Content Supply Chain and a Food Processing Business: Case Studies from Finland

Sajal Kabiraj*
Markus Paul**
Max Stucki***

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Abstract

Industry 4.0 is an ongoing revolution and is affecting profoundly in the media industry and is changing the manufacturing sector. The research elucidates a clear understanding of the Fourth Technology Revolution, Industry 4.0. The study focusses critically on the benefits and possibilities that Industry 4.0 technologies bring to operational supply chain and customer outcomes. Two case studies from Finland viz, Sanoma Media Finland's (Sanoma) content supply chain and a Southern Finland located meat product manufacturer (hereafter referred as Company X is a food processing business) have been studied. Sanoma Media Finland is the leading multi-channel media house in Finland and Company X is a Helsinki-based food processing SME specialising in producing and delivering raw doner kebab. The authors have tried to research the concept of the Fourth Industrial Revolution by conducting a literature review, and to create a scenario where those concepts are implemented to the supply chain in the two case companies. Findings from the Sanoma Media Finland case illustrates that using Industry 4.0 technologies, media companies can take advantage of knowing the consuming habits of the audience. Using available data for building automated content supply chain would decrease the costs and increase the accuracy of content popularity. Findings from the case of Company X, illustrates that the Industry 4.0 aspects substantially helps to push the company in the right direction. Automated manufacturing processes, data gathering from machines for remote monitoring via the IoT, and more automatic inventory and order management helps to cut costs and reduce spoilage, while simultaneously improving the quality and increasing the output. The research study concludes that implementation of Industry 4.0 ultimately leads to improved financial performance and enable companies to remain competitive. Transformation requires that every stakeholder in the supply chain commits to the new standards.

Keywords: Industry 4.0, Content Supply Chain, Finland, Food Processing, Scenario analysis

Corresponding*, School of Entrepreneurship and Business, Häme University of Applied Sciences Ltd., Valkeakoski, Finland.
Email: Sajal.kabiraj@hamk.fi
**, Helsinki School of Business (Affiliated to The University of Northampton, United Kingdom), Helsinki, Finland.
Email: markus.paul@mediatailor.fi
***, Helsinki School of Business (Affiliated to The University of Northampton, United Kingdom), Helsinki, Finland.
Email: max.stucki@gmail.com

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Introduction

The purpose of this research is to state a clear understanding of the so-called Fourth Technology Revolution, Industry 4.0. This research is focusing critically on the benefits and possibilities that Industry 4.0 technologies bring to operational supply chain and customer outcomes.

The authors attempt to research the concept of the Fourth Industrial Revolution by conducting a literature review, and to create a scenario where those concepts are implemented to the supply chain a chosen company. First, the company is introduced. Second, the literature review regarding the Fourth Industrial Revolution is presented. Third, a scenario is created where the concepts of the said revolution are applied to the supply chain of the company.

This research illustrates the real effect of the technological revolution in the supply chain management using Sanoma Media Finland's (Sanoma) content supply chain as a point of reference. Sanoma is the largest commercial media house in Finland and reaches almost every Finn weekly (Sanoma, 2020). Consumption of digital videos is increasing, and the competition between online video services will intensify (Wayne, 2018). Taking advantage of modern technology is necessary for media companies like Sanoma to compete the most significant online video platforms such as Netflix, Amazon and Hulu.

The authors use two cases studies to elucidate the Industry 4.0 concepts implementation viz, Sanoma Media Finland's (Sanoma) content supply chain and Company X, a food processing business in Finland.

The Industry 4.0: Review of Literature

The first industrial revolution began in the late 1800s and was initiated by the introduction of mechanical looms, an early form of automation. This was followed by the second industrial revolution roughly at the end of the 19^{th} century, which created the conveyor belt-based division of labour and mass production. The third industrial revolution started in the late 1960s as new digital innovations began to offer robotised solutions to manufacturers and it has lasted up to the present day (Drath & Horch, 2014; Kovács & Kot, 2016). The Fourth Industrial Revolution, or Industry 4.0, is a concept that was first coined in Germany in 2011 (Xu, Xu & Li, 2018), although similar developments were also taking place in other European countries at that time (Tjahjono *et al.*, 2017). The concept, even though being currently discussed in many contexts, still in many cases, lacks a clear definition (Hermann, Pentek and Otto, 2016; Piccarozzi, Aquilani & Gatti, 2018). Indeed, as Szozda (2017) states, Industry 4.0 is still developing in many directions and continues to remain unexplored in many respects, thanks to its still unfolding nature. Industry 4.0 is a vast domain that touches on a wide variety of fields including, but not limited to, manufacturing, data management and competitiveness (Piccarozzi, Aquilani & Gatti, 2018). Despite the difficulty of defining the boundaries and concept of Industry 4.0, its very essence can be seen in the ability of the machines, components and systems to communicate with each other, which makes self-regulated production, real-time production planning and self-optimisation possible (Pan *et al.*, 2015; Kovács & Kot, 2016; Sanders, Elangeswaran & Wulfsberg, 2016). Opportunities of Industry 4.0 are considered extensive. For example, lower transportation costs, easier mass customisation, environmental sustainability and increased flexibility in production are some of the benefits that the next industrial revolution is supposed to realise (UNIDO, 2018).

Even though the concept still lacks clear and universally shared definition which makes a theoretical study of it difficult (Hermann, Pentek & Otto, 2016; Piccarozzi, Aquilani & Gatti, 2018), the core of Industry 4.0 can be identified as the use of novel and emerging information technologies that tie together the business operations, manufacturing and services which leads to a growing efficiency and cost reductions (Wang *et al.*, 2016; Szozda, 2017; Drath & Horch, 2014). According to Prause and Atari (2017), technologies especially related to the Industry 4.0 are Internet of Things (IoT), Big Data, 3D printing and Artificial intelligence which facilitate the emergence of smart manufacturing and logistics operations and processes. These enable inter-machine communication and greater automation of production, as well as deeper insights into production issues with minimal need for human involvement (Tjahjono *et al.*, 2017). Although these technologies are not necessarily new, their price reductions have made them widely available, thus ushering in the advent of the next industrial phase. However, they point out that the wide-scale introduction of these technologies may take another 15-20 years (Strange and Zucchella, 2017).

Especially in the manufacturing industry, additive manufacturing, or 3D printing, has garnered significant attention. 3D printing helps in producing complex but still lightweight and durable parts in a relatively short time. Furthermore, it can reduce waste and create cost savings by reducing the need for machine tools (Joshi & Sheikh, 2015). 3D printing is already in use, for example, in the aerospace industry (Joshi and Sheikh, 2015) and the automotive industry (Wee *et al.*, 2016). However, it does have some limitations. As Joshi and Sheikh argue (2015), the mechanical properties of 3D printed parts can still be qualitatively weaker than those produced in the traditional manner.

The Internet of Things, also a vital component of Industry 4.0 is making smart manufacturing a reality. The internet of Things (IoT) refers to the information network of physical objects; the machines collect and deliver data regarding their processes. The IoT eases monitoring and data analytics, providing insights into the production processes, and also makes it possible for the machines to communicate with each other. There are many fields where IoT is already being utilised; for example, in power generator manufacturing, where on-going data collection has helped in improving the reliability of the machinery (Rymaszewska, Helo & Gunasekaran, 2017).

Linked to the IoT is also the concept of Big Data, which refers to the data obtained from the various, e.g., manufacturing processes through the monitoring capabilities of the machines themselves. By analysing the data, patterns that are not readily visible may be detected to gain information regarding possible pain points of the production process. One example of Big Data usage is in semiconductor manufacturing, where leveraging it has helped in fault detection and predictive maintenance (Moyne and Iskandar, 2017).

Although much talked about, Industry 4.0 is still unfolding. Indeed, some of the interest garnered by the Fourth Industrial Revolution can be explained by the fact that as the previous revolutions could only have been observed ex post facto, the arrival of Industry 4.0 was announced beforehand and it, as an industrial revolution, can be argued to take place presently (Drath and Horch, 2014). Perhaps Industry 4.0 should rather be seen as a vision (Hermann, Pentek & Otto, 2016), or as a strategy (Johansson *et al.*, 2017) that is a child of the digital revolution (Hahn, 2019), than a singular concept. It seems certain, however, that its full implications still remain to be seen.

The modern world is familiar with digital elements when consuming products and services, for example, in mobility, housing, dining, entertainment and retail. Product manufacturers and service providers can take advantage of new technologies that Industry 4.0 brings to provide better and smarter services and products to the customers. Technologies considered to be part of the Industry 4.0 have similar feature outcomes like automation and connectivity. The connectivity between users, machines and applications is called as Internet of Things (IoT) (Davies, 2015; Szozda, 2015; Louis & Dunston, 2018).

Connectivity and automation enable companies to produce services and products in a more efficient way using digital platforms, robotics, artificial intelligence and big data which are all digitally connected, providing a highly integrated supply chain (Davies, 2015). Disruptive innovations are creating the trends and companies are looking for new solutions all the time. Full automation of the flow of materials and products in production lines creates valuable data for managing purposes (Szozda, 2015).

Increasing productivity in the supply chain

Industry 4.0 creates improvements and significant enhancements in productivity and revenue growth (Piccarozzi, Aquilani & Gatti, 2018). The speed of product manufacturing will improve. For example, models are created digitally, and the data can be transferred automatically to the production robots. According to Davies' (2015) data-driven supply chains can impact the manufacturing process by accelerating the time needed to deliver orders up to 120%.

Different products can be produced in the same factories, and even small lots can be taken into production fast and effective way. This flexibility leads to innovation because prototypes can be produced quickly. Automation of the production process, monitoring of the product throughout the production chain and use of configurable robots enable continuous optimisation (Davies, 2015).

To reach productivity benefits of IoT, organisations need to invest in modern equipment, ICT and computing skills and integrations. In some cases this can even outweigh the benefits of improved performance (Louis and Dunston, 2018).

Full visibility into the supply chain

The connected environment in the production supply chain enables companies to analyse information in real-time (Szozda, 2015). This information is valuable for streamlining the production processes and the whole supply chain. Transparency will increase the effectiveness by enhancing the collaboration between suppliers, manufactures and customers (Tjahjono et al., 2017). Customers will be able to track their orders, check availability, and even be part of the design process (Davies, 2015). This kind of flexibility may give the company a competitive advantage in its market; for example, Nike has an e-commerce service where customers can design their running shoes and order them straight to the home door.

At the same time, the customer's quality awareness level increases as well, and the demands for better service, products and customer experience is rising. Transparency in supply chains also gives increasing power to clients, providing them with additional ways to compare products and services (Willems, 2018).

Better understanding and decision making based on shared data

More than ever, end users have a willingness to share data and interact. Data and metrics provide valuable insights into customer needs and behaviours (Willems, 2018). Data analyses bring great value to companies to provide enhanced customer experience, products and services. Increased value of services and products allow companies to invest more resources to research and development and improve supply chain productivity and efficiency (Willems, 2018). Knowledge and understanding helps organisations to make a better decision regarding business strategy development (Piccarozzi, Aquilani & Gatti, 2018).

Big data and shared information also create a responsibility to handle critical data safe and secured. There is a growing need for costly expert resources in legal issues related to data processing and liability, and intellectual property management (Davies, 2015). Data protection and management, especially the processing of personal data, is strictly regulated in Europe (Wachter, Mittelstadt and Russell, 2017). Companies need also invest in cybersecurity, data capacity and secured connections (Szozda, 2015). There is also a more significant risk for reputation issues if some critical data leaks outside of the company. Companies need to be clear of the ownership of the data and the storage method. Data can include critical and confidential personal or industrial data, which cannot be leaked to the competitors (Davies, 2015).

Transformation in organisations

Robotics, automation and artificial intelligence used with other IoT technologies enhance production processes, efficiency and data management (Piccarozzi, Aquilani and Gatti, 2018). Automation reduces the need for manual labour for certain parts of the supply chain. The benefits are cost-saving in human resources in performing positions (Karandeep, 2019). Therefore, Industry 4.0 is creating fears of an irreversible technological impact on jobs (Willems, 2018).

Simultaneously companies need to hire more experts to build and maintain the sophisticated technology and to run the new business models (Davies, 2015). When the organisation is living in the digital transformation period, also the leadership is under pressure to enhance and develop to keep organisational performance competitive in accelerating changing markets (Niemi and Pekkola, 2019). Innovative thinking and excellent problem-solving skills are mandatory to achieve competitive advantages (Para-González, Jiménez-Jiménez & Martínez-Lorente, 2018).

Media Content Supply Chain: The Case of Sanoma Media Finland

Sanoma Media Finland is the leading multi-channel media house in Finland. Almost 100% of Finnish people spend time with Sanoma's print and digital media weekly (Sanoma, 2020). Sanoma provides content in their newspapers, magazines, tv and radio channels, online and mobile services. Sanoma’s broadcasting department, Nelonen Media, operates four national television (TV) channels and Video-on-demand service Ruutu. Majority of commercial broadcasters' profit comes from tv, radio and online advertisement. Even if we tend to think that media companies produce content for audience, the gained attention is actually the product which is sold to the customer. Advertiser is the customer, not the audience.

The knowledge about Sanoma and its processes is based on meetings and interviews with Sanoma's technology and commercial leadership within the last three years.

Industry 4.0 in the media industry

Industry 4.0 is affecting profoundly in the media industry because today almost every company can be a media company. Free online video platforms, such as Youtube, Facebook, TikTok and Instagram, gives companies and individuals the possibility to create their channels and start building an audience. Media companies and broadcasters are competing for the same audience.

Television advertising revenue has been decreasing, and Internet advertising will overtake broadcast television advertising (Wayne, 2018). This is why media companies need to have a clear strategy of how to stand out from this increasing flood of video content. Most TV-companies have started to focus on online services instead of traditional TV-distribution. Media companies also need to decrease their costs in the content supply chain.

Video-on-demand (VOD)

Video-on-demand is an online video streaming service where the audience can choose what content they want to watch, when and where. Video-on-demand has enabled vertical integration for TV-companies to charge the audience for watching (Wayne, 2018). Subscription-based video on demand (SVOD) is based on monthly fees that the audience is paying for holding access to the content. When the customers can choose their content, their expectations are rising, and patience capabilities are falling. If the content they are watching is not pleasing, they will change the program or even the video service provider.

Competition between media companies has been changed, and there are new competitors in the markets. Digitalisation and online video services have enabled large service providers like Netflix, Hulu and Amazon to take market share from traditional TV-companies and broadcasters (Wayne, 2018). In Finnish local markets, the competition is between Ruutu, mtv.fi and Areena.

The content supply chain for Video-on-Demand

Video services need to provide as accurate content as possible to audience to keep the customers committed. For example, Netflix has invested heavily in the company's movie recommendation system (Hallinan & Striphas, 2016). In this point of view, the content sourcing department is the most valuable asset in the content supply chain. Licenses for content is usually sourced trough broadcast license selling companies also called as the distributors. TV-company's content sourcing department negotiates with the distributors for the licenses to show the content in the companies' online channels. After the deal is done, the studio and the Media Management starts to discuss the media and data delivering methods. This is a time-consuming period because no industry standards for data deliveries exist.

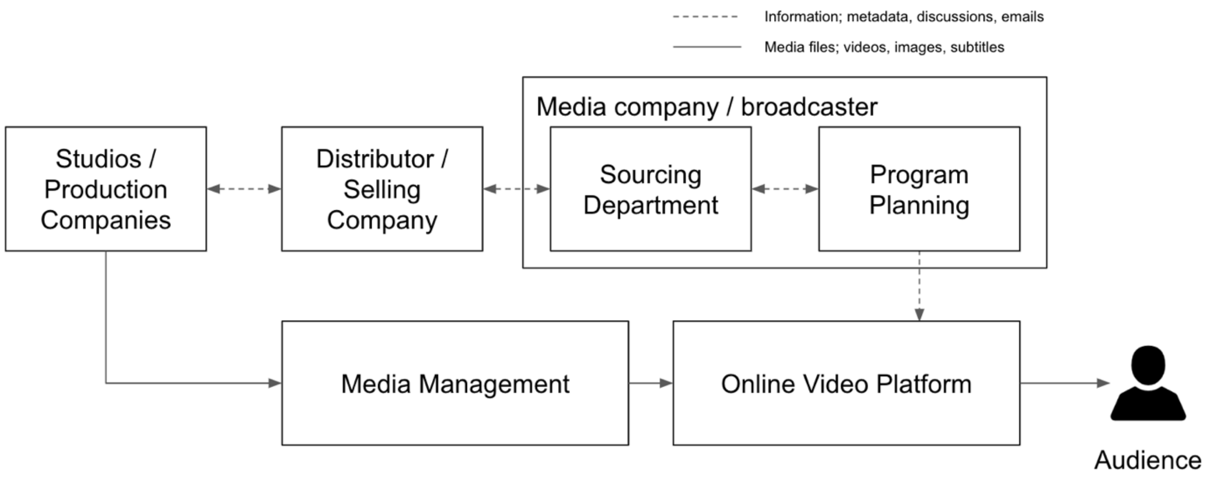

Figure 1 Media Content Supply Chain

Sourcing department needs to have extraordinary know-how on what kind of content and when the customers prefer to consume. Sourcing Department needs to have enormous databases of all available content in the world and also excellent negotiating skills and analysing tools to get good enough content at an affordable price.

Usually, content sourcing is collecting data from online video platform about customer behaviour. They have various data sources to keep up with main content trends all over the world. Data is analysed manually, and many sourcing decisions rely on the expertise of individual content professionals.

After sourcing the content, the data about the licences and publishing rights agreement will go to the Program Planning department. They need to design a schedule for publishing to maximise the views in the licensing period. In addition to estimation about upcoming program, it's target audience and it's behavioural hypothesis, the program planning department uses historical data and competitor information to schedule the publishing.

Content sourcing platform (IoT)

Content sourcing and planning can be optimised using a centralised platform to collect all the data that affects customers behaviours and watching habits. Machine learning environment combined with historical and new data would create a hypothesis about the most valuable video content and when is the best time to do the publication. Predictions about view rates can be created even before the actual sourcing.

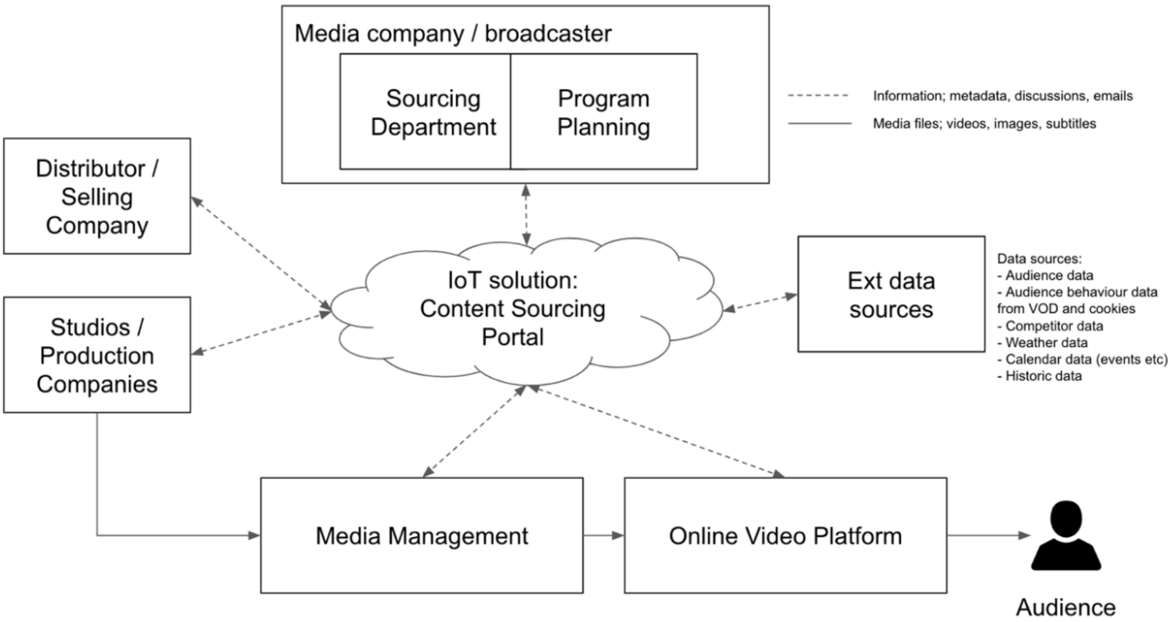

Figure 2 Media Content Supply Chain using IoT platform

Orders from the TV-company for new content could be provided automatically into the distributor's customer relation management (CRM) system and delivered to the enterprise resource planner (ERP); also, the automation of managing the actual media files would enhance more efficiency. Incoming media assets from the studios and production companies could be automatically linked to the program metadata and processing and publishing would be fully automated.

Benefits

Operational efficiency is increased when all the metadata for program assets are handled automatically in the databases and platforms. Automation reduces manual labor and risk for human errors (Davies, 2015). Also, the sourcing and planning department could be leaned down to a few because the IoT generates accurate hypothesis and predictions. Customer experience would also increase when the content sourcing is not based only on human knowledge but then overall data targeted for each audience segment.

Food Processing Business: The Case of Company X

The case company is a Helsinki-based food processing SME Company X. The company is specialised in producing and delivering raw doner kebab. Having a turnover of little under 8 million euros and employing seven people, Company X controls roughly 20% of the Finnish doner kebab market. The product portfolio of the company currently only contains doner kebab, and it does not produce or deliver any other products. Company X is organised as a limited liability company.

The main customers of Company X are the various doner kebab restaurants around Finland. The densest concentration of customers is located in southern Finland, but also central, and north Finland have several restaurants that order from Company X. The company both manufactures the products and delivers them to the premises of the customers. The company has grown its customer base over the last five years but faces heavy competition both from local manufacturers as well as those importing doner kebab from abroad. The main competitive advantages of Company X have been its excellent quality, reasonable price, and good delivery system.

An author of this text has worked for the company. The knowledge here is based both on direct experience as well as on studying the entire supply chain of the company as part of the previously held job.

Introducing Industry 4.0 concepts to the supply chain of Company X: A Scenario

In here, first the current state of Company X's supply chain will be presented. After this, a scenario will be developed its in which the concepts and technologies of Industry 4.0 are applied to Company X's supply chain to propose improvements to operations. Company X is currently suffering from both slowness in manufacturing, relatively high labour costs, as well as high spoilage rates. The slowness in manufacturing is associated with old machinery, i.e., lack of automation and slow rate of information exchange. This also leads to spoilage, as the meat processing systems are entirely operated by hand, which causes problems with precision regarding the amounts of ingredients, possibly leading to a suboptimal product. Furthermore, as the rate of automation is negligible, the labour costs are relatively high. The need for human hands in the production process is significant, as all of the machines need to be filled and emptied by hand and monitored by humans. Furthermore, the current supply chain suffers from slowness of information exchange. The raw materials are always ordered when the stocks are running low; there is no automatic data transfer system that would alert the raw material suppliers that replenishment is needed. This has led to situations where the raw materials stocks have run dangerously low. Similarly, the orders from customers are recorded by hand, since there is no automated system which they could use to place orders.

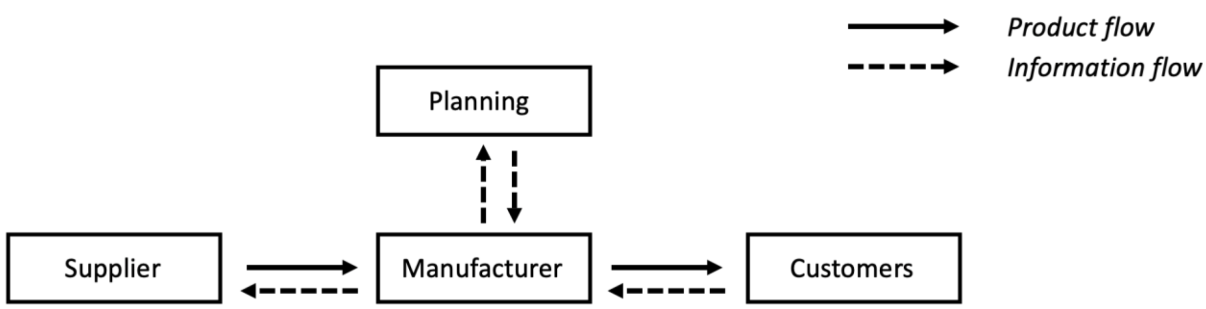

Figure 3 Company X supply chain, modified from Szozda (2017)

To address all of these problems, several smart digital solutions, including investments in new machinery, could be made. The first thing is to automatise the production of the doner kebab meat. This is done by procuring machinery which can operate with a high degree of autonomy; the only thing that is needed to be done by a human should be to pour in the raw materials with a pallet truck and start the process through a digital interface. The machines should be compatible with the IoT. This would enable automated production monitoring, as well as monitoring the quantities of raw materials used; there would no longer be any need for humans to observe whether the meat mass has reached the desired consistency as the machines are to be programmed to complete the production cycle automatically. The investment in these new machines would lead to a higher manufacturing capacity thanks to more efficient production cycles due to the reduction in need of human interaction. Furthermore, there would be less spoilage thanks to the greater precision of the automatic machine monitoring. Due to these improvements, the labour costs and spoilage rates would go down while the production efficiency could be significantly improved along with the overall quality of the product. Higher quality would also reduce the number of complaints and increase customer satisfaction; there would be a decrease in the need to give discounts due to faulty products which would further increase the profits.

A further positive development would be that thanks to the digital data streams collected from the machines, the production could be optimised by analysing the individual task times (such as filling up the machine, storing away and freezing the ready product, moving the products to trucks) and by creating a new workflow based on the most opportune times to complete each task. As the machines would be running the whole day, it would be a significant improvement that the entire working time could be utilised to manufacture new batches. Currently, there are delays due to suboptimal workflow planning and outdated machines, as well as because of the heavy reliance on human labour.

Also, the introduction of more centralised data collection could help in managing the inventory; by looking at previous data, the changes in demand could be anticipated better. This way, the stock could be kept at an optimal level, reducing possible losses due to spoiling. Also, more automated inventory management would eliminate the need to keep the inventory information up to date by hand, which is currently the case; this would both saved work and make sure that the oldest batches would always be sold first. Also, by automatizing the raw material stock monitoring, the supplier could be automatically informed through a shared cloud service that there would soon be need for replenishment. The customers as well could be let into the cloud service to place their orders. This data could be instantaneously fed into production planning systems which would calculate the production need; something which currently is completed entirely by humans.

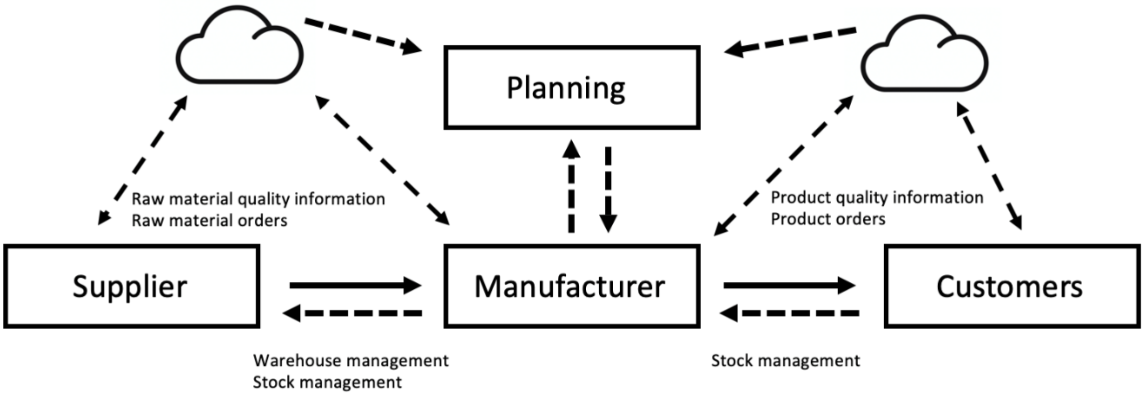

Figure 4 Company X supply chain with Industry 4.0 implementation, modified from Szozda (2017)

The introduction of above-mentioned technologies would increase both the profit margin as well as customer satisfaction. Higher quality, reduced spoilage and waste, and reduced labour costs thanks to automation and better work planning would all contribute positively to the future financial performance of Company X.

Limitations

Connected supply chain requires that all parts in the supply chain have a contemporary architecture software to control their operations. In the media industry, there are a large variety of companies of different sizes and with unique processes. IoT solution requires the enforcement of all the stakeholders to upgrade their systems to provide interfaces and data sharing functions according to predefined standards.

Megatrends in the world drive customers behaviour in the ocean of digital video content. Watching habits can change so fast that automation might not be able to collect and analyse enough relevant data to make long term hypotheses.

Conclusion

Industry 4.0 is an ongoing revolution and is affecting profoundly also in the media industry. TV-companies are facing continuous transformation and challenges with keeping their positions in competition with the world's leading online video services, and also the individual content creators. Media companies need to publish accurate content for their audience in a cost-effective way. Using Industry 4.0 technologies, media companies can take advantage of knowing the consuming habits of the audience. Using available data for building automated content supply chain would decrease the costs and increase the accuracy of content popularity (Hallinan and Striphas, 2016).

Industry 4.0 technologies enable companies to remain competitive, but at the same time, they require a complete transformation in the organisations. New kind of know-how needs to be increased, and business models and organisational units need to modify to face the new requirements. New technologies need to be tested and evaluate with new experts or technology partners. Transformation also requires that every stakeholder in the content supply chain commits to the new standards.

The Fourth Industrial Revolution is changing the manufacturing sector. However, its entire impact will only unfold in the coming years, as it in many ways remains largely unexplored as pointed out by Szozda (2017). Yet, many of the technologies vital to Industry 4.0 can already be implemented in various contexts.

In the case of Company X, the Industry 4.0 aspects would substantially help to push the company in the right direction. Automated manufacturing processes, data gathering from machines for remote monitoring via the IoT, and more automatic inventory and order management could help to cut costs and reduce spoilage, while simultaneously improving the quality and increasing the output. All this would ultimately lead to improved financial performance.

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