DATA DRIVEN LOGISTICS, PLUG AND PLAY READINESS

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1. Introduction

Digitalization and the introduction of data driven logistics are developments that Dutch SME's cannot afford to ignore. Maybe for the moment it is possible for companies using outdated digital technology, but on the long run they will lose the competition against major global players, which digitalize fast and harvest the advantages of data driven logistics. The COVID-19 pandemic has shown how important resilience is for companies that can be enhanced by digital means (Zouari & Ruel, 2021).

There is definitively a gap to close. From the 100 top logistics companies 20% is seriously involved in digitalization and only 5% uses it to its full potential. Mostly, the smaller the company, the less is it involved in digitalization (Moonen, 2021). Numerous SMEs in the logistic sector lag behind on the field of chain digitalization, data communication and they are not yet fully informed about the possibilities that data driven logistics offer for increasing their added value.

The introduction of Web 2.0, Industry 4.0, the Internet of Things (IoT), and other related digital innovations makes it possible to collect and aggregate large amounts of data from different sources. Data science and advanced analytics have a direct relevance for logistics; in recent literature different tools and techniques to make data driven supply chain management decisions have been proposed (Govindan, Cheng, Mishra, & Shukla, 2018). Heilig et al. (2017) define digitalization as a sociotechnical process, in which digital tools in a broader social and institutional context are implemented, as opposed to digitization, in which is merely analog sources are translated into digital information. Digital transformation is described as a broader process of transformation of, on among others, strategy, governance and leadership and possibly the business model of the company. In digital transformation processes use is made of technical enablers, digital technologies and concepts. Enablers are for example cloud computing, Internet of Things, cyber-physical systems, blockchain, (real time) data science, such as big data and machine learning. The definition of Heilig et al. (2017) indicates that next to the technological aspects of digitalization, as described above, the social and institutional context is equally important. Correspondingly, Mathauer & Hofman (2019) emphasize the importance of technology acceptance for digitalization. From these definitions it is clear that digitalization has two major aspects: technological enablers, as described above and non-technological aspects such as human resources (knowledge, skills), technology acceptance, strategy and legal aspects. For this reason the project will also be divided into technological and non-technological aspects, but it has to be kept in mind that these aspects are often interlinked.

In this paper the State of the Art of digitalization is described to show how the project builds on existing knowledge on the subject. This paper focuses on the technological enablers. Firstly, the academic literature on digitalization and data driven logistics is explored, secondly, scans and tools from the gray literature are discussed, synthetized into research methodology. After a short discussion, the paper ends with a conclusion. Figure 1 Shows the enablers of digitalization.

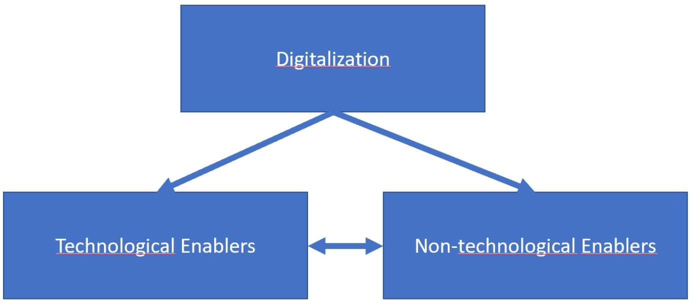

Figure 1 The enablers of digitalization

2. Digitalization and data driven logistics in the academic literature

In this section digitalization and data driven logistics in the academic literature is discussed. Actually data communication would have been also a relevant topic to discuss, however on this topic there was so much literature that the analysis of it would have been to lengthy for this paper. As it partially overlaps with the other topics, it is not included here.

Digitalization

Heilig et al. (2017) define five levels on which digitalization takes place. The first three levels relate to the changes within the company, while the fourth and fifth levels refer to supply chain level. At the last, fifth level the revision of the business model and strategy takes place, such as restructuring or outsourcing the activities, including new products and services and change long standing alliances and practices.

The importance of digitalization is pinpointed in the literature on different logistic fields, for example for process planning logic in manufacturing (Xu, H.-M., Yuan, & Li, 2009), estimation of product availability in retail networks (Derhami, Montreuil, & Bau, 2021) and transparent demand forecasting of spare parts (Andersson & Jonsson, 2018). The resilience of logistics service providers is also a major topic in the literature. Herold et al. (2021) mention the enforcement of digitalization and data management as one of the five strategies that has helped logistic service providers to survive the Covid 19 pandemics. They claim that there is a demand on the logistics field for example for better prediction, and digital measurement of packages. Better use of data could make better tracking of products possible, which could be used for slow steaming to apply ships as floating warehouses. However, according to the authors, numerous companies, especially the smaller ones, lag behind in digitalization, because companies often resist innovation and they are unwilling to change (Herold, Nowicka, Pluta-Zaremba, & Kummer, 2021). Bergström (2016) especially recommends digitalization to third party providers, who are according to him "stuck in the middle", they lost their competitive advantage in performing customer servitization and cannot produce economies of scales to compensate for it.

According to Herold et al. (2012), there is an urgency in digitalization, as Amazon and Alibaba have already patented anticipatory shipping, which allows them to ship the products, before they were even

ordered and store them in local warehouses, close to the customers. The volume of data that these major companies possess, allows them to make reliable predictions.
The majority of the literature on data driven logistics address optimization based on big data analytics in physical distribution, routing systems, such as Wang et al (2021) on the field of inventory and Zunic et al. (2021) for city distribution. Other articles focus on location optimalization, such as Nguyen et al. (2020) in dry ports and Lv et al. (2020) in steel logistic parks. Chenhao et al. (2021) use data analytics for the efficient sorting of e-commerce packages and Gutierrez-Franco et al. (2020) intend to optimize last mile operations of forward- and reverse logistics. Some articles apply risk analysis, for example Xu et al. (2019) on the field of the efficiency of e-commerce logistics and Wu et al. (2016) for cargo loss. Most articles use quantitative analysis on a high abstraction level, creating calculation algorithms, combining different methods to be used in individual companies. In the recent academic literature there is no attention whatsoever for generic practical methods and tools that can help increase the level of digitalization in individual companies. Before discussing the gray literature, which contains more useful insights, data driven logistics is discussed as it consists of the enabling technologies of digitalization.

Data driven logistics

Data Driven Logistics is a recently introduced notion, which has not been clearly defined in the literature yet. The working definition of Data Driven Logistics for this project is data driven decision making in the logistics domain, aimed at creating value from existing data and mining additional data to create more value. Especially the last part of the definition is important, data should be closely aligned with strategic goals and the value propositions. There are numerous data driven solutions, here the most important ones are described and explained here namely, Big data, Blockchain, Robotics, Sensor technology, Internet of Things and Artificial Intelligence/ Machine Learning. Figure 2 Gives an overview of data driven solutions, described here.

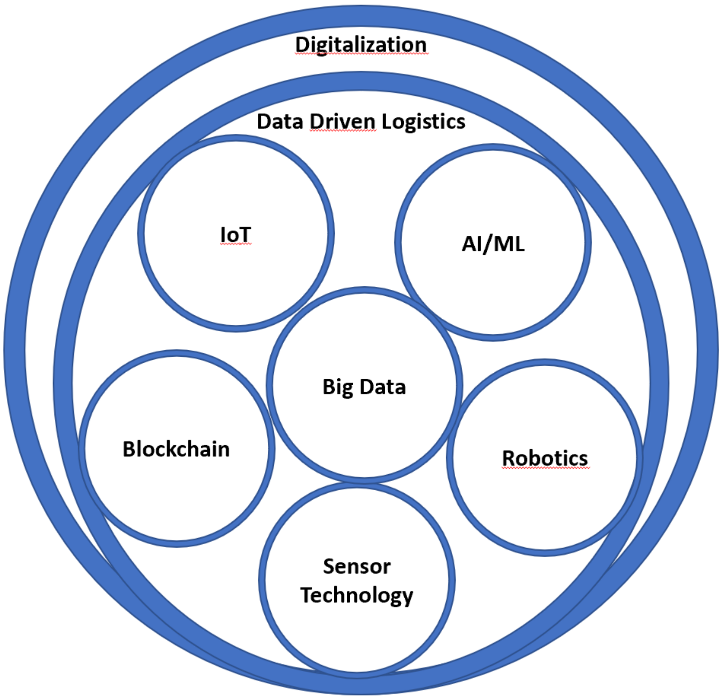

Figure 2 An overview of the data driven solutions described here

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Big data is connected to the availability of cheap sensors has made it possible to collect massive data sets. The value creation happens mostly through automated decision making, which works best without human interference. The amount of data that is being aggregated is simply too much to oversee for humans. Big data analysis could be done for example rerouting in the supply chain, planning preventive maintenance for transport units or determining the storing place for a product in a warehouse (Manners-Bell & Lyon, 2019).

Blockchain is a peer-to-peer ICT network that keeps records on digital transactions of assets using Distributed Ledger Technology (DLT) DLT means that there is no central party or intermediary, that would own the data, the exact copy of the dataset is stored at a number of computers, called nodes (Min, 2019). The most important advantages of blockchain networks are fast and cheap transactions, the becoming superfluous of intermediaries, supply chain transparency and connectivity between supply chain partners. Kshetri (2018) identifies the benefits of the application of blockchain in the supply chain as costs, speed, dependability, risk reduction, sustainability and flexibility (Kshetri, 2018).

Robotics includes industrial automation solutions, and self-driving cars, drones and robots for different household applications. Within logistics robots are mostly used for handling and process operations, which they can carry on for a long time without a break. Robots can be autonomous, in this case, Artificial Intelligence is included. The processes to automate do not necessarily be physical, for example Robotic Process Automation (RPA) which automates business processes connecting different existing applications. The introduction of robotics have been criticized as they will probably lead to a loss of employment, even though they will also create new jobs. At the same time they can reduce for example annual maintenance costs by 10%, inspection costs by 25 % and down time by 20% (Sinha et al., 2020; Fernandez & Aman 2021).

Sensor technology is supported by the availability of a large variety of sensing devices from simple thermo sensors to advanced video systems. There are simple sensors with a straightforward input-output systems, such as diverse temperature sensing devices, photoelectronic sensors, detecting light, warmth, distance, movement, voice and pressure sensors. Another category of sensors is smart sensors, such as vision systems, which generate a more complex output. The data from different sources can be combined by sensor fusing, which makes information from the data. For example, it can indicate that somewhere a crowd is forming with temperature sensing. Time correlated data from multiple sensors can facilitate decision making (Lea, 2020). Sensor technology facilitates IoT.

The Internet of Things (IoT) is a term related to the use of sensors, technology and networking to allow buildings, infrastructures, devices and additional "things" to share information without requiring human to human or human to computer interaction. It can create richer data and deeper intelligence for all parties in a supply network. Sensors can be attached to appliances to perform predictive maintenance (Manners-Bell & Lyon, 2019). IoT makes extensive control of processes possible.

Artificial intelligence (AI) and Machine Learning (ML) are often used interchangeably, but ML is a subset of the broader category of AI. AI refers to the general ability of computers to emulate human thought and perform tasks in real-world environments, while ML refers to the technologies and algorithms that enable systems to identify patterns, make decisions and improve themselves through experience and data. Today, AI is at the heart of many technologies. Companies are incorporating techniques such as natural language processing and computer vision to automate tasks and accelerate decision making (Manners-Bell & Lyon, 2019).

3. Digitalization and data driven logistics in the gray literature

From the literature review it became clear that digitalization needs to be connected to the business model/ strategy. Heeroma et al. (2020) developed a business scan for the applicability of blockchain to logistic SMEs. They examine the added value of the company from a strategic point of view, followed by exploring the power relations in the supply chain and the critical processes of the company. Lastly, they analyze the critical processes further, in order to assess the applicability of blockchain technology. They have selected from the academic literature research methods and tools on strategic, tactical and operational level and combined them. The proposed tools and methods are the SWOT analysis together with a confrontation matrix, SCOR metrics, Business Process Notation (BPMN or swimming lane analysis), RACI or RASCI that explores the responsibilities of employees in the processes within the organization, and finally the Olson criteria are used for the assessment of information quality. This scan was originally intended for research on the application of blockchain, nevertheless it is also useful for a problem driven approach to digitalization and data driven logistics. However, it is necessary to include a scan that is specifically meant for digital maturity, which is discussed in the next section.

Digiscan of evofenedex

Evofenedex is the Dutch association of 15,000 production and trading companies. In order to help its members to digitalize, evofenedex has developed a digital maturity scan (evofenedex, 2021). For the scan companies need to answer 260 questions on 18 topics. As research of evofenedex showed, one of the main reasons for companies not to invest in digitalization is the lack of time. The filling of 260 questions, on 18 topics takes way too long for companies. Therefore there is a short version of the Digiscan online, which consists of 50 short questions. The topics of the Digiscan include, next to the technoligical elements that are discussed above, company culture, customer value, budget and (human resources) strategy and more. The scan starts with non-technological elements. These seem to be even important as the technological elements, because they define whether you, as a company, are able to define your goals and whether you will be able to reach them. The technological elements are (only) enablers. Based on the results the scan calculates on which digital maturity level a company is situated. It is possible that companies are at different maturity levels based on different departments. There are four maturity levels described which are; digital core, connectivity, technologies and disruption. Within the Digital core level, companies are structuring their business in order to collect reliable and relevant data. In the connectivity level they retrieve from and share data with supply chain partners. In the technologies phase they implement techniques in order to analyze the data and in phase 4 they use the outcomes of phase 3 in order to change their business model. The levels are comparable to the levels of Heilig et al. (2017) although de Digiscan has one level less.

There is a common denominator in the scans of Heeroma et al. (2020), evofenedex (2020) and the levels of change of Heilig et al. (2017) that digitalization starts with a digital strategy and ends with the change in the strategy, a new business model or a disruption. Given the fact that it is expected that digitalization and data driven logistics will develop further and that there is no end to technological development, the model that frames this development should be circular, see Fig. 3.

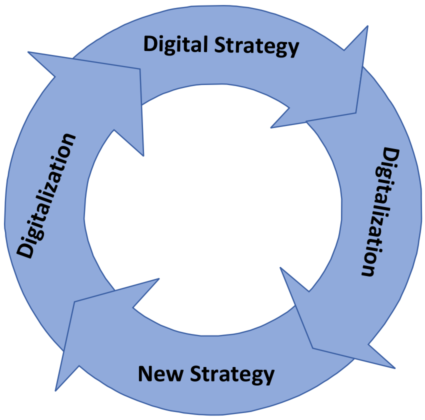

Figure 3 A circular model of strategy and digitalization (own creation)

The goal of the Digiscan is to give advice to companies about what the next steps are for them in digitalization based on their digital maturity level. For example, for a company that is on level one, the digital core, some steps should be taken before it can start initiating a blockchain implementation. Next to Digiscan, there is another tool that can advise companies about their advancement in digitalization based on a decision tree, which is introduced in the next section.

Platform Datagids

Poort8 is a consultancy company which specializes in solutions for federative data sharing (Poort8, 2021). It has developped Datagids, a platform for companies looking for the next step in digitalization. Companies need to fill in a decision tree which starts from their motivation, goals and the obstacles that they experience in digitalization in order to guide them to the solution. Based on the answers the company is provided with the data of the parties that can provide a solution to the company's problem. Basically, it is a matching platform for problems and solutions and the parties that can help. For this research it is a relevant tool as it contains solutions that are accumulated by years of research.

4. Discussion

This paper provides an explanation of a research proposal on digitalization and the introduction of data driven logistics in Dutch logistic SMEs, consisting of a review of the academic literature and some practical sources from outside of it. The paper proposes a methodology as follows: the participating companies are firstly scanned by the scan of Heeroma et al. (2020) which is used in this case for a more general purpose, than it was originally meant for. This scan will deliver the connection between the company's strategy and the possible added value of digitalization, and the practical use of digitalization in its critical processes. The next step is to perform the Digiscan, to establish the digital maturity level

of the company. From the digital maturity level it can be derived what the next steps are that the company can take to digitalize more and strive towards data driven logistics. The solutions can be sought for in the decision tree of Datagids. This step validates the database and eventually found solutions can enrich it further, thus improving this tool to help SMEs to digitalize. Up till now the research has a linear flow, parting from a digital strategy towards data driven methods. However, as the outcome of digitalization changes the business model and that the technological development is endless, the model of the research is supposed to be circular.
This approach does have a bottleneck. The research focuses on individual companies, while according to both Heilig et al. (2017) from phase 4 and according to the Digiscan from phase 2 digitalization takes place between companies by means of data communication. In order to tackle this problem, the research is conducted as much as possible with companies that are supply chain partners or clients of each other's. This, however, poses the problem of confidentiality and the fear for data sharing. The project aims to prove to the participating companies that data sharing offers advantages by exploring its added value. However, there may be a need for this of a maturity scan for data sharing.

5. Conclusion

This paper started by a short review of the academic literature on digitalization and data driven logistics combined with the discussion of a source from the grey literature, a Digiscan and a matching platform between problems with digitalization, solution and parties who can provide it. The paper proposes a methodology of combining two scans, that of Heeroma et al. (2020) and the Digiscan of Evofenedex together with applying the decision three of Datagids. The research is advised to use a circular model, instead of a linear one for digitalization. The assessment of digitalization after level 4 of Heilig et al. and level 2 of the Digiscan become problematic as from that point more parties are involved in the supply chain. This poses the problem of confidentiality and it is likely that for this part of the project additional methodology is needed.

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