Digitalization and Data Driven Logistics at Dutch Logistic SMEs

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Abstract. Dutch logistic Small and Medium Size companies (SMEs) are lagging behind on the field of digitalization. They concentrate on operational processes, which are obstructed by the increasing influx of data, that they have trouble processing, especially if there are disruptions, such as the consequences of the COVID-19 pandemics. This paper contains a brief literature review on the topics digitalization in logistics and data driven logistics providing definitions and an exploration of the field. The paper concludes that the notion data driven logistics does not exist in the literature. The papers treating data driven applications in logistics contain analyses on a high abstraction level, which are not suitable for SMEs. Based on the literature it is concluded that digitalization both starts and ends with the definition of a digital strategy, which means that it should have a circular model. Further, the paper proposes an applied research methodology to explore the problem of lack of digitalization at SMEs by performing a scan of Heeroma et al [1], the Digiscan of evofenedex and searching for solution at the platform Datagids. These sources are found in the gray literature. The author poses a question on how to proceed with the research when digitalization is to be assessed instead of the company level on the supply chain level, which should be a subject of future research.

Keywords: Digitalization · SMEs · Data driven logistics · Industry 4.0 · Scans

1 Introduction

The shift towards digitalization and data driven logistics are developments that the Dutch Small and Medium Enterprises (SME's) cannot afford to ignore. It may be possible for companies to use outdated digital technology at the moment, but in the long run, they will lose their competitive position against major global players, which digitalize fast and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.

There is definitively a gap to close. From the Dutch 100 top logistics companies, 20% is seriously involved in digitalization and only 5% uses digitalization to its full potential. In general, the smaller the company, the less likely it is to digitalize [2]. Numerous SME's in the logistic sector lag behind on the field of chain digitalization and data communication, and they are not yet fully informed about the possibilities

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that data driven logistics offers for increasing their added value. The added value can be efficiency, supply chain integration and a better business model. The problems with digitalization are mostly caused by priority on operational processes and the lack of time. The problems with data communication are mostly caused by the lack of trust between companies, which makes them reluctant to share data. The lack of applying data driven solutions on its turn is caused by the lack of knowledge.

At the moment, companies are mostly offered help in digitalization in a technology driven manner., however, companies are more interested in and benefit more from an approach that starts from their (digital) strategy, bottlenecks in their operational processes and their digital maturity [2].

This paper describes a project proposal for enhancing digitalization, data communication and data driven logistics at Dutch logistic SMEs. The project proposal: *Data Driven Logistics Plug and Play Readiness* aims to be a starting point for preparing SMEs in the Netherlands to shift towards digitalization and data driven logistics. This is well-aligned with the aim of The Netherlands, as part of European Union, to use innovation such as application of technologies, in order to achieve competitiveness and sustainable performance in logistics [3–5]. Therefor, the central research question of this paper is, which methods are there in the literature that help SMEs digitalize and how should they be used?

After this introduction, Section 2 presents the status quo in the academic literature about digitalization data communications and data driven logistics. Section 3 explores a scan from the grey literature and two practical approaches. Section 4 provides a discussion on the feasibility of the project after which the conclusions are presented.

2 Materials and Methods

In order to answer the central research question in this paper first a comprehensive exploratory literature review is performed in the academic literature on digitalization and data driven logistics. The search procedure, terms and the results are described in Sect. 2. As the literature review has delivered only contextual results, the search was continued in the gray literature and among practical solutions, which is described in Sect. 3 Here the choice was made eclectically and practically, which is suitable for applied research. The advised methodology is a synthesis of the found tools, that is to be tested in the proposed research project empirically.

This section contains a concise literature review on two topics, digitalization and data driven logistics. The third subject, data communication in logistics, has delivered too many hits for a comprehensive literature review about them, and as it overlaps with the other two topics, it is not discussed here separately.

2.1 Digitalization in Logistics

The search “digitalization” and “logistics”, “peer reviewed” publications “from the last 5 years”, in “English” has delivered 87 hits, which after removing the duplicates, editorials, too specific, geographical, application of industry related articles, left nine relevant items.

First of all digitalization needs to be defined. Heilig et al. define digitalization as a sociotechnical process, which implements digital tools in a broader social and institutional context, as opposed to digitization, which is merely translating analog sources into digital information. The authors specify digital transformation as a broader process of transformation on among others, strategy, governance and leadership, which use enablers, digital technologies and concepts. As enablers they list cloud computing, Internet of Things, cyber-physical systems, blockchain, real time data science, such as big data and machine learning.

Heilig et al. define five levels on which the changes take place. The first three levels relate to the changes within the company, while the fourth and fifth levels refer to supply chain level. On the first, localized level, there are minor changes by the implementations of production planning and inventory management systems. On the second level internal technical and organizational integration takes place, facilitating cross functional integration and connecting internal data silo's by implementing ERP systems and data warehouses. On level three there is a complete business process redesign, to increase the integration achieved on level two. Further integration between processes enables more streamlining, coordination, and monitoring. Level four moves outside the organization and helps redesign interorganizational networks. On this level data exchange standards, such as EDI is applied and it could include collaborative planning, management, collaboration and data exchange. 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 [6]. Figure 1 shows these levels of digitization in logistics including examples of enablers of technologies used for each level.

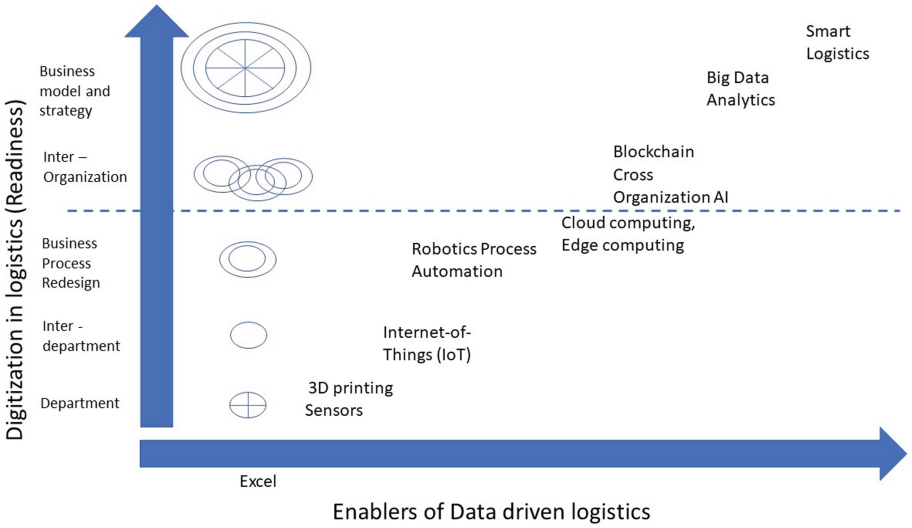

Fig. 1. A framework summarizing the levels of digitization in logistics and various technological enablers for each level.

Heilig et al. also define three dimensions of digital transformation, scope, scale and speed. Scope can be seen as trans-functional, as they overlap different business processes. The scale tackles problems with upscaling the infrastructure and possible information overload. Speed refers to competitiveness, which requires fast action, supply chain control by joint access to data, inter organizational network forming by digital innovation – all sources of value creation [6]. For this research it is important to consider the levels and dimensions of digital transformations as they can be different at companies at different digital maturity levels.

Zouari uses the definition of digital tools of Frank et al. digital tools as technologies that provide intelligence and connectivity [1, 7]. Heilig et al.'s definition indicates that next to the technical aspects of digitalization the social and institutional context is equally important. Correspondingly Mathauer & Hofman emphasize the importance of technology acceptance for digitalization [8].

The importance of digitalization is pinpointed in the literature on different logistic fields, for example for process planning logic in manufacturing [9], estimation of product availability in retail networks [10] and transparent demand forecasting of spare parts [11]. The resilience of logistics service providers is also a major topic in the literature. Herold et al. 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 [12]. Bergström 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 [13]. According to Herold et al., 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 [12].

Pan et al. explore the interoperability of digitals systems with the Physical Internet, which promise to interconnect and coordinate logistics system worldwide. They conclude that there are four challenges on this field: (1) the data sharing format, which is a question of standardization, (2) open communication, which is related to the trust issue between companies, (3) privacy, security and access restrictions, and finally (4) the combining product and order related data [14]. Table 1 gives an overview of the topics articles in digitalization in logistics.

Concludingly it can be stated that the recent literature defines digitalization as a broader process, which includes next to the technical aspects, strategy, leadership, a social and institutional context and technology acceptance. The technical aspects are comprised by enablers, the concrete technologies. On the field of technology Pan et al, treat the interoperability of digital technologies with the Physical internet and defines four bottlenecks [14]. The literature emphasizes the urgency of digitalization, especially

Table 1. An overview of the topics of the articles on digitalization in logistics

Topic	Authors
Definitions	
Digitalization	Heilig et al.
Digital tools	Zouari, Frank et al.
Technology acceptance	Mathauer & Hofman
Classifications	
5 levels, 3 dimensions	Heilig et al.
Importance of digitalization	
Process planning logic in manufacturing	Xu et al.
Estimation of product availability in retail networks	Xu et al.
	Derhami et al.
Transparent demand forecasting of spare parts	Andersson & Jonsson
Resilience of logistics service providers	Herold et al. (2021), Bergström
Interoperability of digitals systems	Pan et al.

to small parties, i.e. logistic providers, to enhance their resilience and supply chain integration. The literature distinguishes different levels of digitalization. At the highest level there is a change in the strategy and business model.

2.2 Data Driven Logistics

The literature search for "data driven logistics" and "peer reviewed" and "English" has delivered ten thousands of hits, while an additional restriction: "publications from the last 5 years" has led to thousands. In order to reduce further the number of articles to a feasible amount, only the publications from 2021 are considered, which delivers 21 hits. After a similar selection as described in the previous paragraph, 14 articles were selected. In this section, after a discussion on the definition of data driven logistics the 14 articles are reviewed.

Conspicuously, none of the thousands of articles have data driven logistics in their title, instead, they address a data driven topic in a certain logistic area. This produces a doubt whether such a notion as "data driven logistics" actually exists in the literature. Consequently, there is no definition of data driven logistics found in the articles. Thus, in this paper, a working definition of data driven logistics is created based on the analogy of the definition of digital transformation by Heilig et al. as applying enablers, digital technologies to enhance the business performance of companies or networks of companies, using data [6]. These enablers are according to Davis et al. are Internet of Things, artificial intelligence, cloud infrastructure, big data analytics, nano-technology, advanced robotics/robotic process automation, sensors, blockchain, 3D printing, augmented reality, quantum and edge computing [15].

The majority of the articles address optimization based on big data analytics in physical distribution. Two of them propose routing systems, such as Wang et al on the field of inventory [16] and Zunic et al. for city distribution [17]. Another two articles focus on location optimalization, such as Nguyen et al. in dry ports [18] and Lv et al. (2020) in steel logistic parks [19]. Chenhao et al. use data analytics for the efficient sorting of e-commerce packages [20] and Gutierrez-Franco et al. intend to to optimize last mile operations of forward- and reverse logistics [21]. Two articles apply risk analysis, Xu et al. on the field of the efficiency of e-commerce logistics [22] and Wu et al. for cargo loss [23]. All these articles use quantitative analysis on a high abstraction level, creating calculation algorithms, combining different methods. Table 2 gives an overview of the literature on data driven logistics. The approach proposed in these articles is not suitable for this research as the companies involved in it are on a too low digitalization maturity level to implement these data driven applications.

Table 2. An overview of the literature on data driven logistics

Topic	Logistics application	Authors
Definitions		
Enablers		Davis et al.
Optimization based on big data analytics in physical distribution		
Routing systems	Inventory management	Wang et al.
	City distribution	Zunic et al.
Location optimization	Dry Ports	Nguyen et al.
	Steel logistics	Lv et al.
E-commerce efficiency	Sorting packages	Chenhao et al.
	Last mile	Gutierrez-Franco et al.
Risk analysis	E-commerce logistics, cargo loss	Xu et al.
	Cargo loss	Wu et al.
Supply chain capabilities and financial performance		Yu et al.
The impact of industry 4.0 applications.		Davis et al., Keane et al., Shaw et al., Sheares

An exception is the paper of Yu et al., which analyzes the effect of big data analytics on supply chain capabilities and financial performance. They address four supply chain capabilities – information exchange, coordination, activity integration and responsiveness. They conclude that especially coordination and responsiveness increase financial performance [24].

A separate category of articles are the four publications on the applications of industry 4.0 of the journal Economics Management and Financial Markets. These articles are based on data of diverse consultants and interviews conducted by the authors with

professionals from the industry and their opinions about the impact of industry 4.0 applications. These articles can be useful for the research as a comparison of the results [15, 25–27].

Concludingly it can be stated that the literature on digitalization treats definitions, classification, the importance of digitalization in different domains of logistics, next to the definition of enablers on Optimization based on big data analytics in physical distribution. One article analyses the effects of data driven logistics on financial and supply chain performance. A series of articles inventories the expectations of professionals from the industry 4.0 applications. The literature on digitalization helps to formulate a working definition of digitalization and data driven logistics as a process of transformation of strategy, governance and leadership, which use enablers, digital technologies and concepts. However, except for the framework of Heilig et al. and the work of Yu et al. the academic literature does not provide much help in finding a methodology to perform the research for Dutch SMEs to explore the possibilities of digitalization, data communication and Data driven logistics for them. In order to find a methodology the search is extended to the grey literature and practical solutions.

3 Results

In this section a number of other methods and sources are discussed, about which have not been published in the academic literature (yet). The selection method of these is practical, they are developed by parties from the consortium of the project proposal. This section treats the following topics, firstly the blockchain feasibility scan of Heeroma et al., secondly the digital maturity scan of Evofenedex and thirdly the platform Datagids.

3.1 Blockchain Feasibility Scan

From the literature review it became clear that digitalization needs to be connected to strategy. Heeroma et al. 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 [28]. 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.

3.2 Digiscan of Evofenedex

Evofenedex is the Dutch organization of shippers, which, in order to help its member to digitalize, has developed a digital maturity scan [28]. For the scan companies need to answer 260 questions on 18 topics. The topics include, next to the technical issues, company culture and (human resources) strategy. 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 aspects. There are four maturity levels described, digital core, connectivity, digitalization and disruption. The levels are comparable to the levels of Heilig et al. although de Digiscan as one level less.

There is a common denominator in the scans of Heeroma et al., evofenedex and the levels of change of Heilig et al. 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. 2.

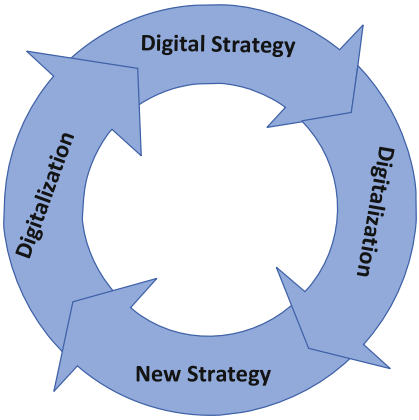

Fig. 2. A circular model of strategy and digitalization.

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.

3.3 Platform Datagids

Poort8 is a startup consultancy company, which specializes in data sharing solutions in logistics [29]. It has developed 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. When based on the questions it becomes clear what the company exactly wants, the company is provided with the data of the parties that can provide the solution. 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. The way how this platform can be integrated into the research is discussed in the next paragraph.

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. 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. 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 Conclusions

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. 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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