TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

The data ambition matrix

Citation for published version (APA):
Gelper, S., Atan, Z., van Woensel, T., & Grefen, P. W. P. J. (2019). *The data ambition matrix: awareness and ambition about data integration in supply chains*. European Supply Chain Forum.

Document status and date:
Published: 01/05/2019

Document Version:
Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy
If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Download date: 13. Nov. 2024

The Data Ambition Matrix

Awareness and Ambition about Data Integration in Supply Chains

Sarah Gelper, Zumbul Atan, Tom van Woensel, Paul Grefen

School of Industrial Engineering & European Supply Chain Forum
Eindhoven University of Technology

A White Paper of the Data2Move Community
https://escf.nl/community/data2move

Published by the European Supply Chain Forum
https://escf.nl

May 2019

1 Introduction

The effective use of data in business settings is becoming increasingly important in the contemporary economy. Whereas traditional business economists state that a business organization relies on the three pillars *materials*, *personnel* and *finance*, modern economists add *data* as a fourth, equally important pillar. Data can be used to feed decision making on all levels. At the operational level, it can be used to control the activities of an organization. At the tactical level, it can be the basis for making an organization reactive in a dynamic market context. At the strategic level, data can be the basis for plotting the future of an organization.

Many organizations in practice do not use the full potential of data on all levels. An important barrier is how data are organized, usually in isolated functional silos. Such data in isolation is of little value within the organization – and even less when multiple organizations are involved in a supply chain or business network. Data that is fully enclosed in a business silo (for example a business function like procurement of manufacturing – or even a part of such a function) can be used to control that silo to some extent, but not to coordinate business activities across silos within the organization, or across organizations. To enable high-level control, data needs to be exchanged and integrated in an organization or in a network.

To help organizations define how to organize their data in line with their operational, tactical and strategic goals, we have developed the Data Ambition Matrix (DAM). This matrix is a tool that helps organizations determine where they currently are in data integration and what their ambition is (or should be) towards the future. The matrix is based on widely accepted academic theory: the *Value Chain Model* of Porter (Porter, 1985). It is configured such that it can be easily applied in practice.

In this paper, we first present the Data Ambition Matrix. Next, we briefly explain the academic theory background of the DAM. Then we discuss why the DAM is important for business practice. We discuss the first practice experiments we have conducted with the DAM. We end this short paper with an outlook of future developments.

2 The Data Ambition Matrix

The Data Ambition Matrix, shown in Figure 1, is a matrix that can be used by business organizations to determine their current and future positions with respect to their use of data to connect links in supply chains. The matrix is based on two dimensions: an *integration* dimension and an *implementation* dimension.

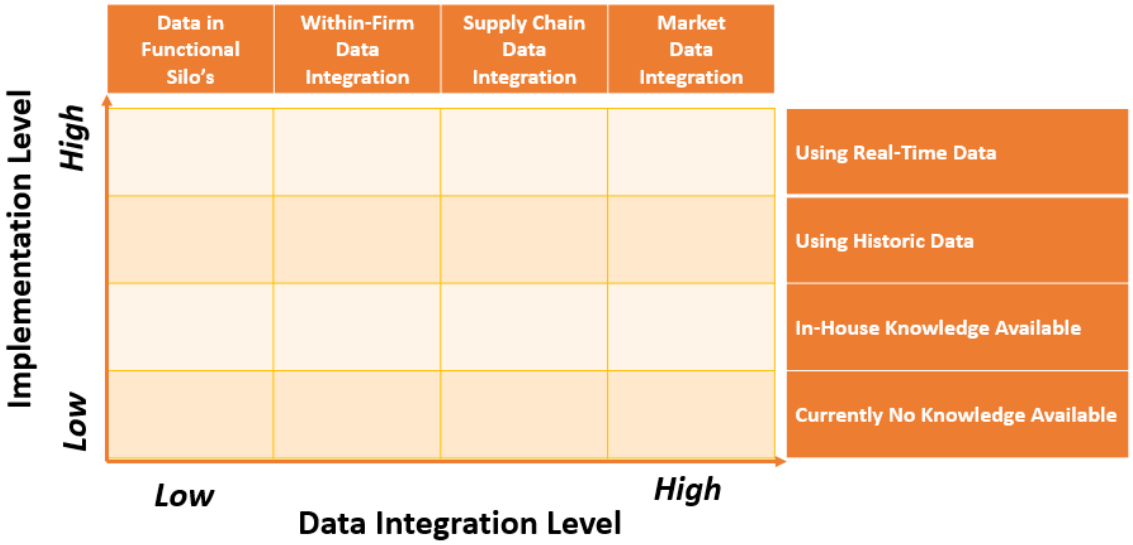

Figure 1: Data Ambition Matrix (Grefen, 2018)

Data integration, placed on the horizontal axis in the matrix, is defined as the level in which data from different sources is collected and used into one source (Lenzerini, 2002). These sources can be either within the own company, within a static supply chain (with fixed partners) or even within a market (with changing partners). On the axis, the further to the left a company is positioned, the less integrated the company is with regard to data; the further to the right, the more integrated. The axis can be roughly divided into four levels or stages of data integration. The least integrated companies keep their data in multiple individual silos, located within the company's different business units. A common problem that occurs when keeping data separated in different silos is that discrepancies occur when referring to the same data, or that important data that one business unit should have does not get passed on due to this data being stored in another silo at another business unit. Moving forward on the axis, the next stage of integration is to have data integrated over all the silos, thus within the whole company. Moving even further on the axis brings a company to the third stage, which implies having data not only integrated within one's own company but over the whole supply chain. The most integrated stage that can be achieved by moving the furthest to the right on the axis is the stage of market integration, which means having data integrated over multiple supply chains within a market.

The vertical axis measures how a company is currently positioned when it comes to the implementation of data integration – this is a *maturity* dimension. The *implementation level* indicates how advanced a company is in realizing the data integration indicated on the horizontal axis. On the lowest implementation level, a company has no explicit knowledge about data integration and hence has no concrete plans to realize data integration. Moving forward on the axis would bring a company to the next stage. Achieving this stage implies a company

having knowledge about data integration and plans to use this knowledge, but having no actual data integration realized yet: the intention is there, but it does not work yet. Moving further to the next stage entails the usage of historic data in the active decisions making. This allows the company to look back and extrapolate, but not yet to respond to the latest changes. The final stage on this axis can be achieved by the usage of real-time, which implies that data are available immediately, allowing the company to respond quickly on the operational level.

Generally, the DAM is meant to be used to measure how a company performs right now and to define its ambition on where it strives to be in two and in five years. The DAM is thus to be used as a thought provoking tool, resulting in increased awareness about data integration and to generate a sense of urgency for companies to realize their ambitions.

3 Theory behind the DAM

The DAM is based both on years of knowledge of working with industry practice, research on abstracting this practice and technological developments such as systems for dynamic supply chain integration (for example Grefen et al., 2009). In particular, the DAM is conceptually based on Porter's value chain model (Porter, 1985; Porter & Millar, 1985). Porter's value chain model, shown in Figure 2, provides the foundation of the horizontal axis.

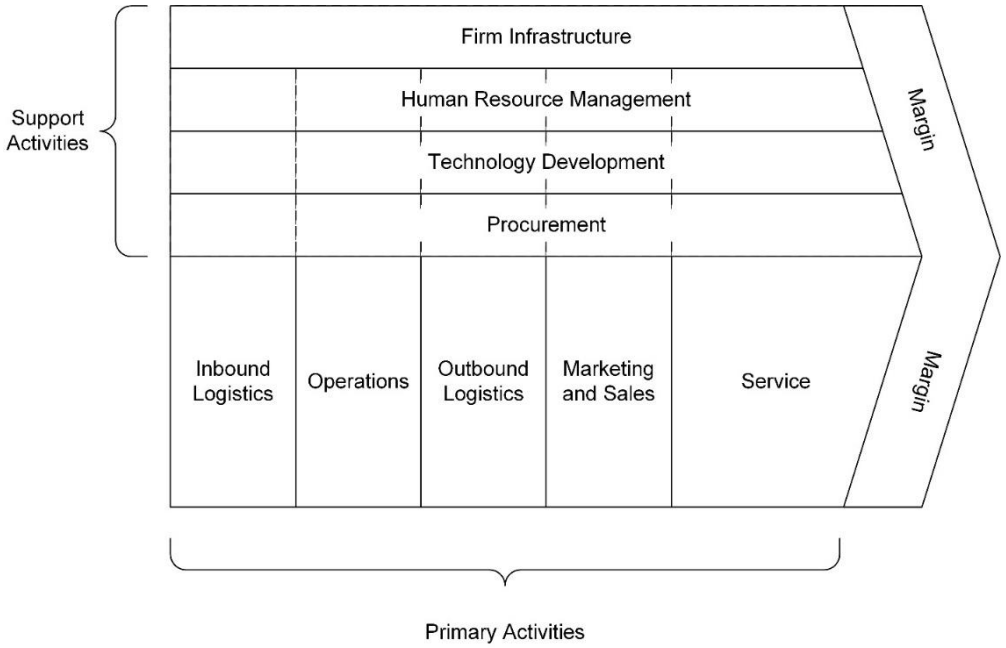

Figure 2: Porter Value Chain Model (Porter, 1985)

The silos where data is kept in isolation at the first level of the horizontal axis can be found in Porter's value chain model as the different primary and support activities, such as procurement and sales. This is illustrated in Figure 3.

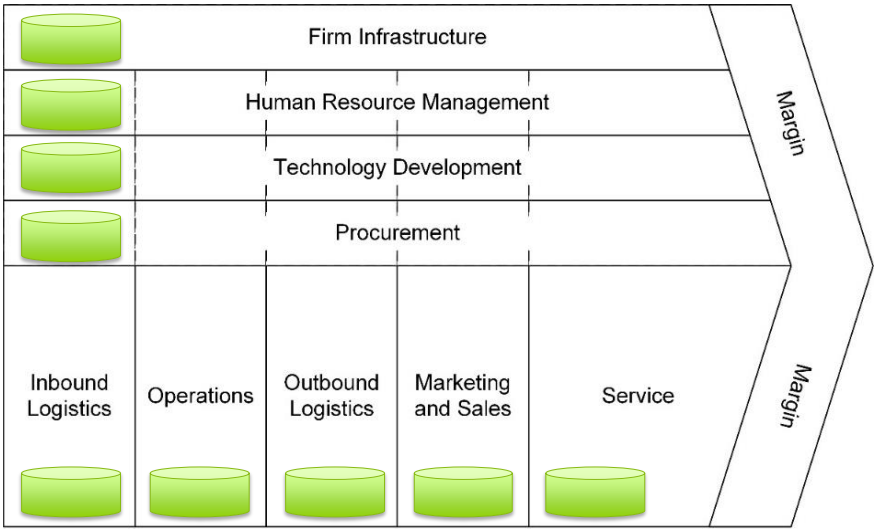

Figure 3: Value Chain Model with data isolated in silos

Moving forward on the integration axis implies data integration over these different activities. At the *within firm data integration* level, data is integrated across the business functions within the boundaries of a single firm. Consequently, the procurement function (department) knows what materials the operations function needs, the service function knows what has been sold by marketing and sales, etcetera. This means that the organization has an enterprise data store (either physical or virtual) that contains all the data required for synchronizing business functions. This is illustrated in Figure 4. A physical enterprise data store is a single centralized database within the organization; a virtual enterprise data store is a collection of distributed databases within the organization that are connected to be used as a single database.

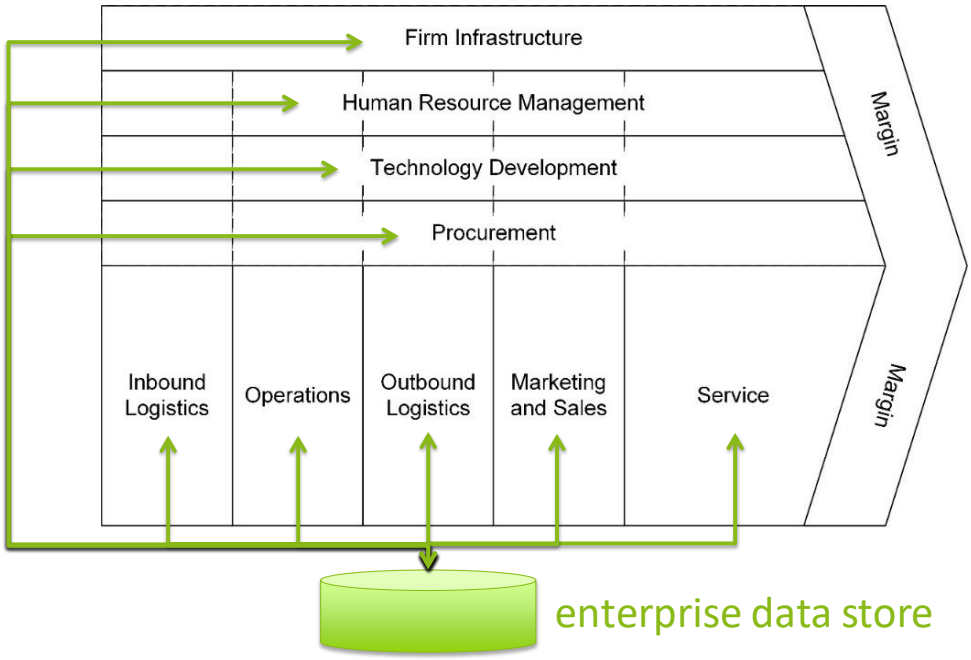

Figure 4: Value Chain Model with data integrated in an enterprise data store

The next step on the horizontal dimension, called *supply chain data integration*, is to integrate data across multiple organizations operating within the same supply chain. This entails an integrated data collection over both suppliers and customers. We show an example in Figure 5 with a provider and a customer organization in a supply chain. Here, data of the *marketing and sales* function of the provider is integrated with the *procurement* function of the customer; the same goes for *outbound logistics* of the provider and *inbound logistics* of the customer. Consequently, data on the material flow in the supply chain is integrated across links in the chain.

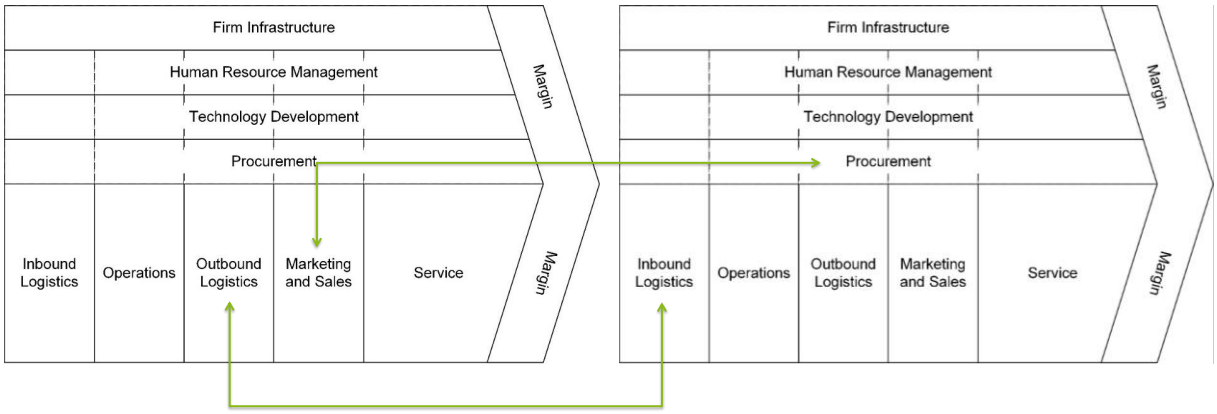

Figure 5: Supply chain data integration across two fixed value chain partners

To realize the most advances stage in the horizontal dimension of the DAM, *market data integration*, companies need to integrate data of multiple of these supply chains, thus with multiple organizations on the provider and/or customer side. Doing so, they obtain data-based control over their position in the entire market (business ecosystem) in which they operate. This last stage is graphically represented in Figure 6, where multiple value chains are used to construct different dynamic supply chains. In this figure, we see how the central organization can dynamically integrate data with a set of providers (on the left) and a set of customers (on the right) to support various supply chain configurations in a market.

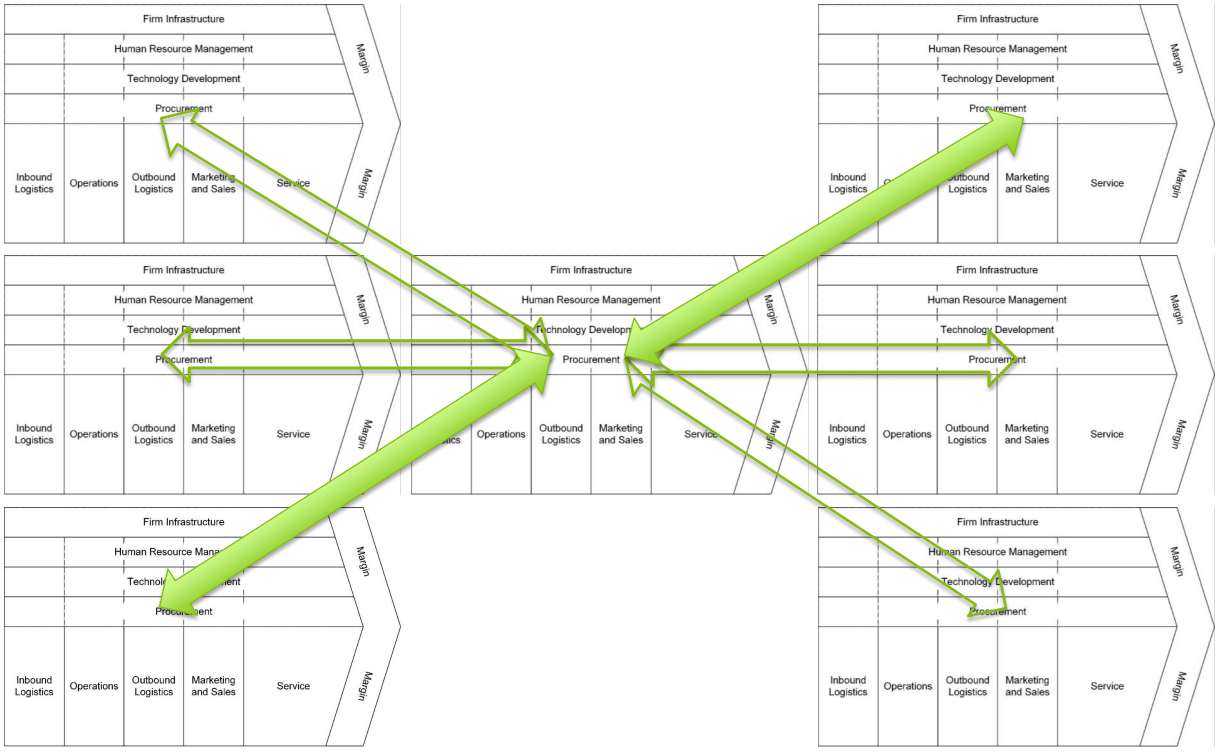

Figure 6: Market data integration with multiple dynamic supply chains (Grefen 2018)

The vertical axis of the DAM is a maturity dimension that indicates how capable an organization is to actually realize data integration in practice. The design of this axis is inspired by other maturity models in the information system domain. We have chosen the values in this dimension pragmatically, based on our experience with practice in industry. Moving upward on the vertical axis means to improve the capturing and usage of data.

4 The importance of the DAM for business

The DAM is meant for practical use by business organizations. With the DAM, companies can determine where they are regarding the data integration spectrum and where they want to be in the near future. Furthermore, using the matrix companies can see if they should improve the usage of their data, the integration over their supply chain or both. The DAM plays an essential part in becoming aware of one's current choices and one's ambitions regarding data. Not using the matrix could imply an ignorance on data analytics and eventually result into losing competitive advantage as competitors might make progress on data usage. The usefulness of the DAM is multidimensional.

Besides that companies can position themselves and move forward on either or both of the axis, it is also possible to compare markets or even supply chains. In particular, the DAM can help to compare different companies in an industry domain, i.e., to benchmark a company in its context with respect to data integration and implementation. Keeping ahead of competitors is a vital aspect in today's market economy, especially with rapidly evolving information technologies, such as the Internet of Things (Li, Xu & Zhao 2015).

One might assume that the DAM is only useful for relatively large companies, as they tend to have more money to collect and integrate data and more to gain from optimization. However, the DAM is also useful for small to medium sized enterprises, as data collection is getting cheaper and virtually all enterprises are collecting data one way or another (Chen & Storey, 2012).

Perhaps the DAM's most important function is to assist in making a company future-proof. It may be the case that a company does not experience competitive disadvantage due to ignorance on data integration and analysis right now. However, due to rapid technological increase and highly competitive markets it is essential to have an edge on one's competitor (Huang, Dyerson, Wu, & Harindranath, 2015). The DAM can be used to analyze how the market will behave and in what regard a specific company should behave in order to retain competitive advantage.

5 A Real-Life Experiment with Companies in the Data2Move Community

Data2Move is a research community focusing on the interface of the domains of the Internet of Things, Big Data and Logistics/Supply Chain Management. The community consists of academics, students and industry partners who collaborate to deliver results that are both practically and scientifically relevant. The community aims to research how data can be used to improve supply chain processes.

Part of the Data2Move agenda consists of events where all members can come together and discuss the current challenges, projects and future programs. The DAM was first introduced during one of these events on February 20th, 2018. To familiarize the industry partners with the matrix, a workshop was organized. Participating industry partners were divided over groups with one academic as the moderator of the discussion. As a first step, every problem-owner had to think about where his/her company is right now, wants to be in two years and would like to be in five years. One can imagine this strongly depends on perceptions. Therefore, discussion started immediately, even between persons of the same company. ICT providers had to think about the ambitions of their customers and they indicated the current and future positions regarding the use of data for their 'average' client. After every representative had positioned his organization in the matrix, results were discussed within the group. By doing this, companies had to explain and justify their choices, which helped them to become aware of their individual as well as shared ambitions and challenges.

How do companies position themselves in the matrix? In Figure 4, the results of the workshop are presented in an anonymized fashion. Each company determined their current situation (starting position), their ambition for 2020 (middle position) and for 2023 (end position). We present the results of two type of firms: the problem-owners and the ICT providers. The problem-owners are firms with a physical supply chain, while the ICT providers can provide their clients with support for the implementation of their data management system. We asked the problem-owners to position themselves, while we asked the ICT providers to position their typical client.

Regarding data integration, most ICT providers and problem-owners indicate that nowadays data is stored in separate functional silos or data is integrated within the firm. Most problem-owners stated that they are currently already using historic data, while 5 out of 7 ICT providers stated that their clients have in-house knowledge available, but do not use historic data yet. Although companies feel reluctant to admit their current position in the matrix is not the place where they would like to be at the moment, it can help to see and realize that other companies face similar problems.

All participants indicated they aim to use historic or real-time data and want to be in the upper part of the matrix in 2020. On the integration level, most companies strive to integrate data within the firm or with supply chain partners in two years' time. The five-year ambition for most firms is to use real-time data collected and integrated across the supply chain. Some participants do not strive to use real-time data but instead strive to use historic data – these are in general companies that operate in highly specialized, static supply chains. The same holds for data integration: part of the participants strive to integrate data over the supply chain whereas others

strive to integrate data from the entire market. Although the ambitions of problem-owners and the ambitions of ICT-providers with respect to the ambitions of their clients are mostly overlapping, ICT providers face some stronger ambitions of their clients for 2023 than the problem-owners at the workshop indicated.

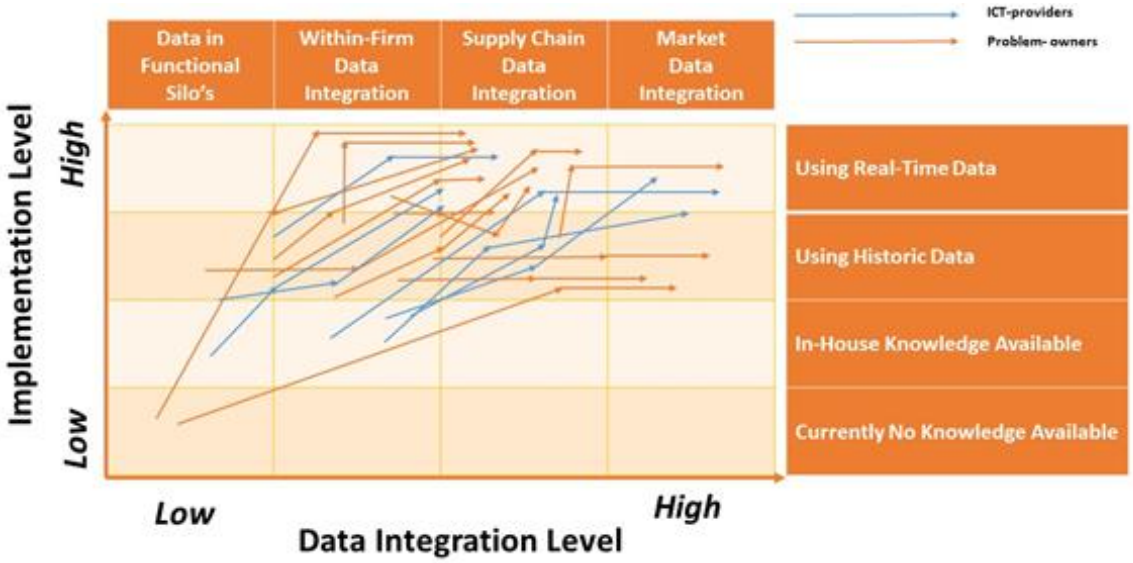

Figure 7: Results of the Data Ambition Matrix workshop in February 2018

Companies determine their ambitions based on several factors. First of all, the type of industry affects the level of ambition; not every company will strive to have market data integration. For example, a company that solely relies on one supplier and does only care about quality is not inclined to integrate data with new suppliers. Another important factor is the level of competition in the market a company is operating. Companies who face a lot of competition do not want to lack behind and will try to distinguish themselves from others. Lastly, the capabilities and resources of the company determine the level of ambition.

One thing becomes very clear when looking at the results: all companies strive to move forward and aim to be at a higher level at both the implementation and integration level in five years' time. But are these ambitions realistic? In order to answer this question, companies need to investigate if the information needed to change the use of data on both the implementation and integration level can be obtained within respectively two and five years' time. Moreover, the company should take action now to ensure ambitions for 2020 and 2023 can be realized. A clear strategy and clear guidelines for the upcoming years are essential to enable this.

The DAM helps companies to actually position themselves and to provide clear directions for the future. Moreover, the results show that companies need to spend time and effort now to realize future ambitions. Although the DAM does not provide guidance how to achieve goals, it emphasizes the importance of moving forward on the use of data in companies. Therefore, the DAM serves as a first step to tackle the challenge of implementing and integration data in supply chains.

6 Conclusions and Outlook

In this white paper, we have introduced the Data Ambition Matrix and its background. We have also shown how it can be used in a practical workshop for industry to facilitate discussions about and between companies with respect to their steps towards data integration. This workshop has shown that typically there still is ample room for improvement in the practice of data integration.

We aim at addressing this room in the Data2Move community[1]. The Data2Move community can support companies to realize ambitions and goals. The community facilitates an integrated approach on the use of data in logistics by combining knowledge from different supply chain partners (manufacturers, retailers, transporters, ICT providers) as well as academic research. Moreover, the community can assist companies to define valuable projects and to start working on them with ambitious students and other industry partners involved in the community. In this way, members of Data2Move can learn from each other by sharing best practices and discuss the problems and challenges they face. Partners can not only learn from each other, but can also help each other in achieving goals. Members of Data2Move are strongly motivated to work together and join forces. By doing this, companies can realize ambitions in an efficient and collaborative way.

Using the Data2Move community, we aim at the one hand on furthering our insight in data integration in supply chains and on the other hand using this insight to help the members in the community with improving their data integration in practice. As discussed in this white paper, we are convinced that data integration is one of the main pillars of a firm that is future-proof in its market.

[1] The Data2Move community can be found online at https://escf.nl/community/data2move.

7 References

Chen, H., & Storey, V. C. (2012). Business Intelligence and analytics: From Big Data To Big Impact. *Mis Quarterly*, *36*(4), 1165–1188. https://doi.org/10.1145/2463676.2463712

Grefen, P., Eshuis, R., Mehandjiev, N., Kouvas, G. & Weichhart, G. (2009). Internet-Based Support for Process-Oriented Instant Virtual Enterprises. IEEE Internet Computing 13(6): 65-73.

Grefen, P. (2018). Data Integration in Supply Chain Management. Presentation slides for Data2Move Community Event, Eindhoven.

Huang, K.-F., Dyerson, R., Wu, L.-Y., & Harindranath, G. (2015). From Temporary Competitive Advantage to Sustainable Competitive Advantage. *British Journal of Management*, *26*(4), 617–636. https://doi.org/10.1111/1467-8551.12104

Lenzerini, M. (2002). Data Integration: A Theoretical Perspective. *Proceedings of the 21st ACM SIGMOD-SIGACT-SIGART Symposium on Principles of Database Systems (PODS)*, 233–246. Retrieved from http://tanca.faculty.polimi.it/wp-content/uploads/images/documents/TIS/lezioni/1_3_integration-lenzerini.pdf

Li, S., Da Xu, L. & Zhao, S. (2015). The Internet of Things: a Survey. Information System Frontiers 17(2): 243–259, Springer.

Porter, M. (1985). Competitive Advantage: Creating and Sustaining Superior Performance. Free Press, 1985.

Porter, M. E., & Millar, V. E. (1985). How information gives you competitive advantage. *Harvard Buiness Review*, *63*(4), 149. https://doi.org/10.1038/bdj.2007.481