BVL International
The Global Supply Chain Network

Trends and Strategies in Logistics and Supply Chain Management

Digital Transformation Opportunities

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DVV Media Group GmbH

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DIGITAL TRANSFORMATION OPPORTUNITIES

Trends and Strategies in Logistics and Supply Chain Management

Imprint

Preface

Dear Readers,

In 2017 the Global Supply Chain Network (BVL) follows the guiding principle "new thinking – digital living". Considering the achievements of the BVL study series, "Trends and Strategies", which has reached its thirteenth edition, this is an appropriate imperative. Digitalization is not merely a continuation of the status quo at a higher level of technology; it becomes a game changer in many sectors of the economy – also in logistics and supply chain management.

The development of data-driven business models, as well as the necessary strategic decisions in an economy managed via platforms, requires a comprehensive understanding of digital economy: Dynamic network effects replace the classical benefits of economies of scale, and disruptions change market positions that were perceived as secure. It is, therefore, a positive result that 73% of the respondents in this study associated (very) prominent opportunities with the digitalization for their company.

Optimism and confidence are important preconditions for rapid digital development and venturing into new practices: This resonates with the "fast failure" culture that counts on a willingness to experiment and positive error handling. This approach not only accounts for the success of many high-tech companies on the US pacific coast but should, in the authors' view, also be implemented more energetically in the logistics industry.

We would like to express our sincerest appreciation to all the inquisitive logistics specialists who contributed to this study: First and foremost, we thank the authors who connected the many loose ends in this complex field to produce a very vivid thematic network. Then, there are the many participants in the expert interviews, focus groups, and the online survey, who contributed significantly by their willingness to share their experience and knowledge with us. Last but not least, the BVL management competently supervised the design and implementation of this study.

We hope you find this to be stimulating reading and trust that the study brings you new insights and impulses.

Warmest regards,

Prof. Dr.-Ing. Raimund Klinkner
President and Chairman

Dr. Christian Grotemeier
Head of Research and Events

Preface

Dear Readers,

More than twenty-five years ago, the Global Supply Chain Network (BVL) launched the study series "Trends and Strategies in Logistics and Supply Chain Management". Since then, the project has produced information about future developments and possible courses of action, so that it functions as a leading source for logistics and supply chain management experts.

This year's edition appears at a time of profound change. Companies find themselves in an increasingly volatile environment. The trends already identified in the previous edition, such as individualization, complexity, and volatility are still relevant, shaping both the industry and the individual company environment. Increasing digitalization leads to new business models and puts the existing structures to the test.

Logistics is increasingly determined by connectivity and new mobility concepts. The current edition, therefore, focuses on the topic "Digital transformation opportunities". The study examines these opportunities on the basis of four, from our point of view, essential, perspectives: innovative technology concepts, changes in the supply chain, changed competence requirements, as well as new and adjusted business models.

As in previous editions, this report is based on our analysis of expert interviews and an online survey. In addition, this study has been expanded to include focus group discussions, in which options for companies' digital transformation were discussed. We now would like to thank all participating experts, other participants, as well as the BVL management most sincerely for their active and successful cooperation!

We hope that this study will be a launching pad for new ideas and inspiring, thought-provoking dialog that will possibly also trigger new digital initiatives. If you have any comments or suggestions, we will appreciate your feedback.

We hope you enjoy reading this report!

Prof. Dr. Dr. h. c. Wolfgang Kersten
Hamburg University of Technology

Dr. Gabriele Reich
Lufthansa Industry Solutions

Prof. Dr. Mischa Seiter
International Performance Research Institute

Dr. Ralf Sauter
Horváth & Partners

Study team

Topics

Trends and opportunities, innovative technology concepts, changes in the supply chain and strategy map

LogU – Logistik und Unternehmensführung

Prof. Dr. Dr. h. c. Wolfgang Kersten
Birgit von See
Niels Hackius
Marius Indorf

The Institute for Logistics and Business Management (LogU), directed by Prof. Dr. Dr. h. c. Wolfgang Kersten at Hamburg University of Technology, focuses, in the context of its research, on particularly three central topics: Logistics, supply chain management, and the use of applied management methods. Over the last few years, numerous working groups met, and studies, as well as comprehensive projects on specific topics, were undertaken in cooperation with industrial and service companies. The development of practical concepts using interdisciplinary research collaborations has been the focus throughout. Contemporary topics have not only been examined in research projects but are also the focal points in teaching and training programs for young researchers in the logistics field. LogU is a project partner in the competence center Mittelstand 4.0 Hamburg which focuses on digitalization in logistics and supply chain management. LogU has organized several lectures, workshops, and scientific publications on digitalization.

Lufthansa Industry Solutions

Dr. Gabriele Reich
Dr. Carsten Böhle

Lufthansa Industry Solutions is an IT-service company focusing on process consulting and system integration which supports companies with their digitalization and automation of business processes. It is an independent, medium-sized company, which covers the entire spectrum of digitalization: Big Data and Smart Data Analytics, Internet of Things, Mobility, IT-Security, Collaboration, and Cloud Computing. The company combines its project experience and industry knowledge with a comprehensive service and technology portfolio. In addition, they have conducted numerous implementation projects with customers from all logistics areas including, for example, Hamburg Port Authority (HPA), Hamburg Süd (HSDG), and Lufthansa Cargo.

Topics

Changed competence requirements, as well as new and adjusted business models

IPRI INTERNATIONAL PERFORMANCE RESEARCH INSTITUTE

Prof. Dr. Mischa Seiter
Dr. Caroline Rosentritt
Timo Maurer

The International Performance Research Institute (IPRI) is a non-profit organization directed by Prof. Dr. Mischa Seiter, which focuses particularly on the topics of performance management in organizations, as well as companies and business networks. There are various applied research projects, like those undertaken by the working group "Industry 4.0 – focus on business research," which are done in cooperation with the University of Ulm, the IHK Ulm, and approximately 20 companies from the regions of Stuttgart and Ulm. This provides a platform across companies for the discussion of various topics such as the economic evaluation of CPPS. The IPRI will also organize regular symposiums. The IPRI's focal points are to carry out publicly assigned research projects and studies, as well as to implement the findings.

HORVÁTH & PARTNERS MANAGEMENT CONSULTANTS

Dr. Ralf Sauter

Horváth & Partners is a specialist in company management and performance optimization of private, as well as public organizations, and has an independent steering lab that develops and implements Big-Data solutions. They have implemented numerous projects in various areas, as for example, the digitalization and optimization of supply chain processes. Horváth & Partners help companies to increase their competitiveness by using opportunities arising from digitalization for company management and performance optimization. Together with a best-of-breed partner network, they implement sustainable value-generating solutions for the entire company, and also for the individual business and function areas (strategy, innovation, organization, sales, operations, procurement, controlling, finance, and IT).

Executive summary

Background and objectives

Increasing digitalization affects virtually all processes, products, and business models. In concrete terms, the digital transformation of companies refers to **"a change in value creation processes by means of developing existing digital technologies and implementing new ones, adjusting business strategies to fit new digitalized business strategies, as well as acquiring the requisite skills and qualifications for digitalization" [1].**

Undoubtedly, these changes also considerably influence logistics and supply chain management. Still, there is a lot we do not know about how and the extent to which digital transformation changes various industries and, thus, also the associated organizational functions.

The main objective of this study was to investigate digital transformation regarding current trends and relevant strategies in logistics and supply chain management. Our focus was specifically on the opportunities in these areas resulting from the digital turn. To achieve the research objectives, the authors defined four central themes:

- *innovative technology concepts*
- *changes in the supply chain*
- *changed competence requirements, and*
- *new and adjusted business models*

Methodology

The research project followed four consecutive methods. First, we performed a literature review, the results of which were used to develop a questionnaire. The questionnaire was used in conducting interviews of approximately one hour each, with 38 experts in manufacturing, logistics services, trade, and consultancy. These results were taken further quantitatively in an online survey with 1351 participants, of which 363 completed data sets assured a statistically reliable and detailed analysis. Finally, the results were discussed and interpreted in six focus group workshops attended by company representatives, to identify possible actions.

Findings

Overall, we identified 15 trends. Cost pressure, individualization, and complexity are the top trends having an external impact on companies – as already stated in the previous study conducted in 2012. The digitalization of business processes, transparency in the supply chain, and stronger interconnection and cooperation of companies were also highly relevant. The sustainability trend exhibited an exceptionally high increase in relevance.

Innovative technology concepts function as drivers of digital transformation and change. The widest distribution and highest relevance of these concepts were established in an investigation of Enterprise-Resource-Planning (ERP) systems and Warehouse Management systems. An increase in the importance of predictive analytics, clients' mobile access to data, and sensor technologies for monitoring the supply chain, is expected in the next couple of years. First, a relatively large portion of the survey participants plans to introduce these concepts. Second, the different data streams are so interconnected in these spaces that the suggested solutions complement each other perfectly. Predictive analytics specifically optimizes processes so that they achieve significant savings in practice. Autonomous vehicles, drones, augmented reality, and blockchain are also identified as disruptive technologies – as soon as these technologies have adequately matured, they will comprehensively change logistics and supply chain management.

Optimization drives *change* in the *value creation chain* and also enhances the achievement of logistic goals. The survey made it clear that delivery reliability and meeting specific client requirements are of primary importance in achieving logistics aims. Consistently keeping to these aims is required, as changed buying behavior necessitates the product, service, and product flow individualization. Because of this, increasingly exchanging data – also across numerous supply chain participants – is inevitable. Besides a need for data and interface standardization, it was established that there is expansion potential, specifically with data on material flow disruptions, inventory and production planning, demand forecasts, and start and end of production: For instance, 61% of the demand for data on material flow disruptions is currently not met. At the same time, 34% of the companies who, as yet, do not share information, were prepared to do so with partners in the future. Good client relationships demand rigid customer centricity, real-time visibility and agility in delivery networks for logistical services and supply chain management. The end customer drives digitalization in logistics; at the same time, logistics service provision and supply chain management critically determine positive buying experiences. The complete alignment of all processes is, therefore, of paramount importance to the end customer. In business transformation, this means that one has to anticipate purchases in advance, support omni-channel solutions in the same way as flexible delivery concepts, and guarantee the tracking of the shipping and delivery status at all times.

The change to an increased use of data, leads to *changed competence requirements*, and to developing new job descriptions in spite of, or exactly because of, the otherwise highly significant trend of staff shortages. The demand for IT knowledge is as high as the willingness and permission to experiment in practice. This so-called "fast failure" culture counts as a key to innovation capability. The surveyed companies have many of these capabilities, at least to some extent. The most needed IT knowledge requirement is the managers' and specialists' intuitive interaction with information technologies. It was established that the second most needed requirement – mainly among specialists – was extensive programming knowledge, as this was limitedly available in almost half of the companies. In the area of further education and training, substantial barriers were too few business resources, on the one hand, and concerns about the loss of qualified personnel, on the other hand. Know-how about the structured collection or storage, as well as the statistical analysis of data, will become increasingly important to businesses in future.

The utilization of services with varying costs enables *new and adapted business models*, which make it possible to respond more specifically to customers' wishes. Flexibility – which remains a central competitive advantage – is taken to a next level as a result of these services. Quality and cost of performance, as well as the ability to adjust to changing market requirements, together take the second place as important competitive advantages. Nevertheless, in logistics, business models that integrate digitalization still lag behind: The overwhelming majority of companies do not plan, in part or completely, to become digitally-driven businesses. Instead, digitalization is largely associated with the utilization of different data sources. The data analysis then functions as an instrument for using business data for optimizing own performance and/or more efficiently satisfying the customers' needs.

Conclusion

Overall, the digital transformation has given rise to the development of substantial opportunities across all sectors. Of those surveyed, 73% rate this as high or very high for their companies. Even so, more than half of the companies indicated a wait-and-see attitude until tried and tested solutions are available for practical application. This attitude can be damaging to business, as in a digital era very quick innovation is more important than before. The digital transformation, therefore, has to be tightly integrated with all facets in the logistics and supply chain management strategy. Besides extending well established systems further, it is especially important to bear omnipresent sensory technologies and predictive analytics of business data in mind. Regarding IT infrastructure, the often historically developed systems seem to reach their boundaries. Sooner or later, every business will need to "tidy up" their IT landscape so that they will be able to handle the vitally important future data flow, as well as the real-time analysis of such data.

The inter-business data exchange is already being done comprehensively in the area of transport data; there is great potential in the fields of inventory, demands, as well as material flow disruptions. Working with such data and with new digital technologies does require a suitable competence profile of employees – they need to focus on the development of IT competences, as well as a culture of experimenting and learning. The end customer who, from the perspective of the survey participants, is still the largest driver of the digitalization theme, should remain pivotal in future innovations.

We summarize: Logistics is now facing historical possibilities of controlling ever more complex material flows, of increasing the productivity to at least stable flexibility, and of fulfilling most individualized customer demands in good ways not contemplated before. Use your chances now!

Quick overview – Core findings of the study

Trends

1. **Cost pressure, individualization, and complexity** remain **top trends** being driven externally, even in the age of digitalization.
2. **Digitalization of business processes and transparency in the supply chain** are the most important trends, and ones that companies will need to develop considerably in the future.
3. Compared to 2012, the importance of **sustainability** has **markedly increased**.
4. The overwhelming majority of companies still have **substantial potential for improvement** in terms of their **individual capacity to adapt** to existing trends. Here, the answers to our survey indicate a very wide spectrum.
5. The most urgent action required relates to the growing **staff shortage** and upcoming applications of **business analytics**: More than 60% of the companies we surveyed have, to date, **not been able to adjust sufficiently** to this.

Opportunities and risks of digital transformation

6. **Seventy three percent (73%)** rate the **opportunities** that digital transformation holds for their companies as high to very high. However, more than **half** of the companies take a **wait-and-see position**, until tried and tested solutions become available.
7. At the same time, **one third** of those surveyed, rate digital transformation as carrying **high to very high risk**.
8. In the sectors of **manufacturing and logistics services**, more than **half** of the companies expect to either **gain revenue or reduce expenditure**. In **retail**, as many as **two thirds** of the companies expect **additional earnings**, but only about **40% expect reduced expenditure**.
9. **The most important driver** of digitalization is the **end customer**.
10. Companies that acknowledge **digitalization** as important and **press ahead** with implementation, also tend to deal **better** than others **with the customer-driven requirement**.

Innovative technological concepts

11. **Predictive analytics** and the application of **artificial intelligence** hold enormous potential for **optimizing logistics processes.**
12. **Access to data via mobile devices** is highly relevant and will be extended considerably in the future.
13. **Sensor technologies** are set to become substantial **data sources for monitoring and improving.**
14. **Driverless vehicles, machine-to-machine communication across companies, and augmented reality concepts** are areas of **high expected growth**.
15. One of the **biggest challenges** in the introduction of new technologies lies in their **incompatibility with existing systems and interfaces.**

Changes in the supply chain

16. The most highly prioritized **logistics goals** refer to **satisfying customer expectations, delivery reliability, and logistics costs.**
17. Changes in distribution channels in the direction of platforms and portals lead to **small scale logistics services that are individualized for customers.**
18. The ability to **connect to uninterrupted IT systems** is set to become a **matter of survival** for suppliers/contractors.
19. Currently, in the supply chain, the **need for data** is **often not satisfied** (e.g. 61% material flow disruptions); however, one can already recognize a growing **willingness to share** the data.
20. The companies largely expect a **reduction** in **inventory, warehousing, and administrative costs** as a result of digitalization. Trade, however, expects this to bring **increased costs in packaging and returning** goods.

Changed competence requirements

21. Regarding knowledge on a specialist and management level, the future will require even more **intuitive IT interaction** than before.
22. To keep up with the tempo of digitalization, it helps to implement a **"fast failure" culture**. This encourages eagerness to experiment and a positive way of dealing with mistakes.
23. New competences are specifically required with a view to **dealing with large quantities of data**. In logistics, the data scientist has become an imperative career description.
24. If the **required qualifications** are **not met**, it will be **due to a lack of available resources** rather than poor employee willingness.
25. **Digital competence screening** can extrapolate a company's specific **qualification needs** in a **structured** way.

New and adjusted business models

26. **Flexibility, adjustability, quality and readiness** are **central competitive features required** in all sectors in the next five years.
27. To date, nearly **half** of the companies we surveyed have **not planned** to **transform their business models digitally yet.**
28. Even so, almost **half** of the companies had at least already begun to **expand the digital services** of their **existing business model.**
29. Besides digitalizing the customer interface, **analytics-driven and customer-driven business model innovations** are foreseeable.
30. Conventional ways of doing business could lead to the **loss of end customers** due to digital platforms being easily accessible.

Suggested actions

31. The best **time to start** with digitalization is **now**.
32. Digital transformation entails a number of strategic focal points such as **changes in the company**, **further development of IT in utilizing data**, as well as **advancement of innovation**.
33. Digitalization is developing so rapidly that, in spite of planning, there are no alternatives but to **experiment and readjust**.
34. Digitalizing brings into play **new business partners** with a different company culture that have to be **productively integrated**.
35. All actors are challenged to **put in a joint effort** so that companies as well as industrial locations can position themselves successfully in the contemporary digital contest.

Methodology

Between March and October 2016, this study identified current trends that influence logistics and supply chain management, and representatives of the industry evaluated the future significance of these trends. The applied research methodological design (see Figure 1-1) enabled a thorough analysis of the subject field by combining different methods. The following explanation is presented in four phases. The structural layout of the study is done according to the illustrated theme blocks.

Literature analysis

In the literature analysis phase, we identified manifestations of digitalization in logistics, emerging or new technologies, and trends in a structured way. For the analysis and first selection of manifestations and trends, a bibliometric analysis was done. Articles published since 2011 in distinguished scientific publications and at selected conferences, served as the data base. For the identification of digitalization's key aspects, a word frequency analysis was conducted on these publications' executive summaries by using the software KNIME analytics platform. This enabled us to derive frequently mentioned concepts and, therefore, a selection of possible trends. Emerging technologies in the logistics area were identified by doing online database searches. For the identification of further potential trends in this phase, we selected the most cited articles published in 2014 and 2015 and analyzed them in detail.

Expert interviews

Based on the literature study results, we developed interview guidelines. On the one hand, this included questions about current trends in logistics and supply chain management, as well as the resulting challenges to companies likely in the future. On the other hand, these guidelines addressed developments, as well as the strategic elements of digital transformation described in the four thematic blocks. In 34 semi-structured interviews with 38 experts in logistics and supply chain management positions, we identified specific trends and strategies in the sectors of logistics services, retail, and manufacturing in various industries (automotive engineering, chemistry and pharmaceuticals, mechanical and plant engineering, consumer goods, etc.) (see Figure 1-2). Additionally, interviews with consultants brought new insight regarding current digitalization projects from a wide variety of sectors and industries.

Online survey

Based on the findings of the literature analysis and expert interviews, we developed an online questionnaire. The objective of the online survey was to analyze the identified topics across all the various industry branches and to identify possible common ground. In addition to information on demography and logistics indicators, the questionnaire covered the following topic areas:

- Trends and opportunities in logistics and supply chain management
- Digital transformation

(see Figure 1-3)

Figure 1-1: The study's research methodological design (left) and thematic focus (right)

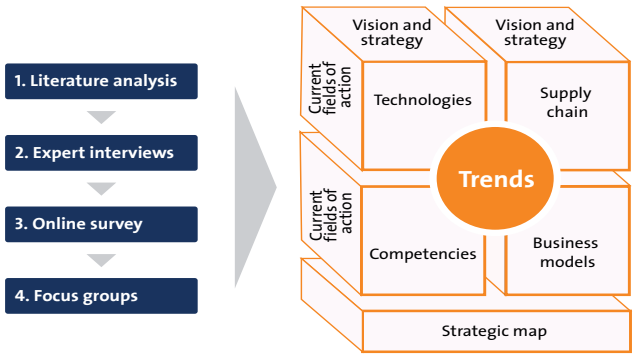
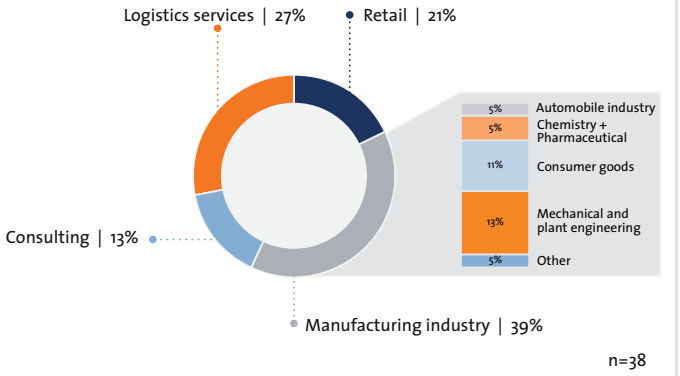


Figure 1-2: Sample of the survey interviews



The survey was conducted in both German and English, and was distributed to logistics and supply chain experts. Between mid-July and the end of August 2016, a total of 1,351 experts responded to the survey, of which 363 complete data sets made a statistically sound and detailed analysis possible. Ten percent (10%) of the answers are from international participants domiciled in a foreign location. A detailed breakdown of the represented sectors, branches, and company sizes is listed in Figure 1-4.

The data collected from the online survey was descriptively analyzed and subjected to statistical significance tests according to the addressed target groups in order to determine the differences that are specific to a sector, industry, or company size.

Focus group discussions

Subsequent to the online survey, six focus groups discussed the findings. In this phase we aimed to identify approaches to action and success patterns for the control or use of the recognized trends, particularly focusing on digitalization. Each focus group consisted of five to ten participants from practice and research. The results were jointly recorded – for example in the form of a mind map (see Figure 1-5).

Figure 1-3: Topic areas of the online survey

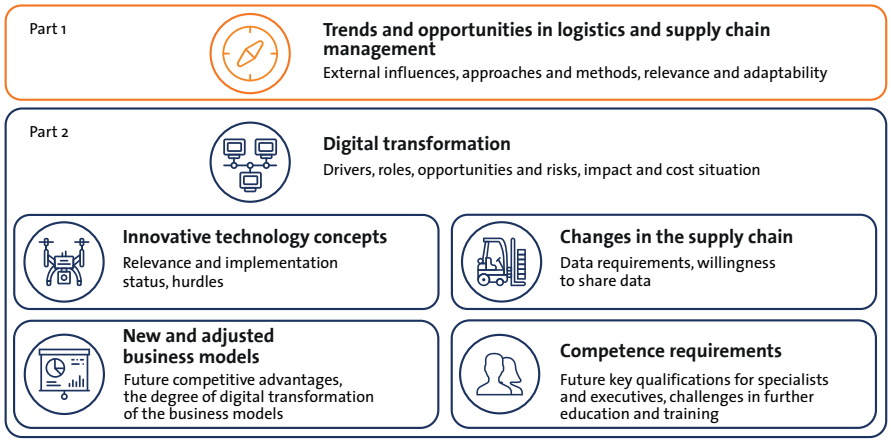


Figure 1-4: Breakdown of the online survey sample

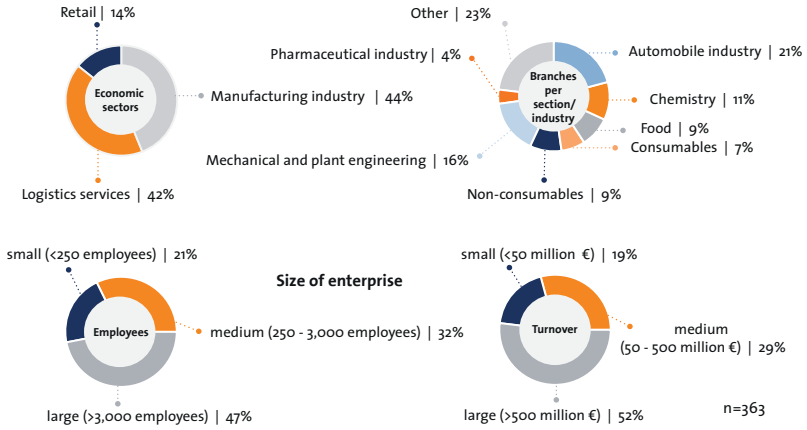
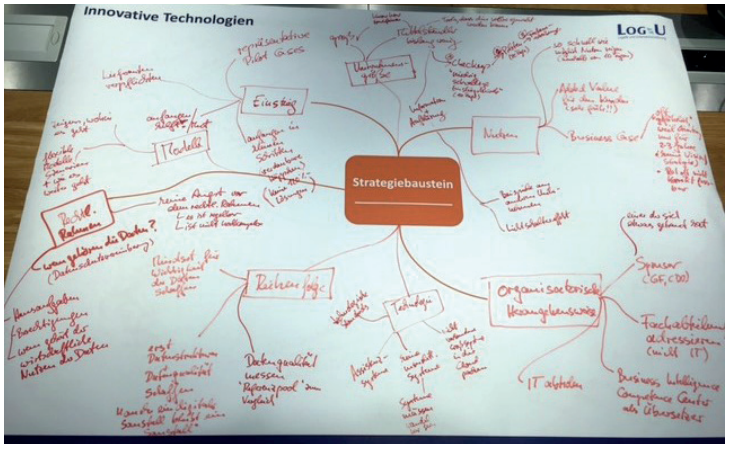


Figure 1-5: Mind map example as one result of the focus group discussions in context of the "Zukunftskongress Logistik"



Trends and opportunities in logistics and supply chain management

Over the last few years, logistics and supply chain management have undergone a transformation: It evolved from the classic "transport, handling, warehousing" business with a strict functional orientation into a global, network-integrating tasks field. Currently, logistics is regarded as an essential part of the scope of services offered by a company. At the same time, supply chain management has made a decisive contribution to the competitiveness of companies. As the first result of this study, we discuss how this new development continues, which trends exist, and which opportunities they open up for companies, based on the following core issues:

- What are the current trends that will change logistics and supply chain management in the future?
- How well can business deal with these trends currently?
- What needs for action arise for companies in the areas of logistics and supply chain management?

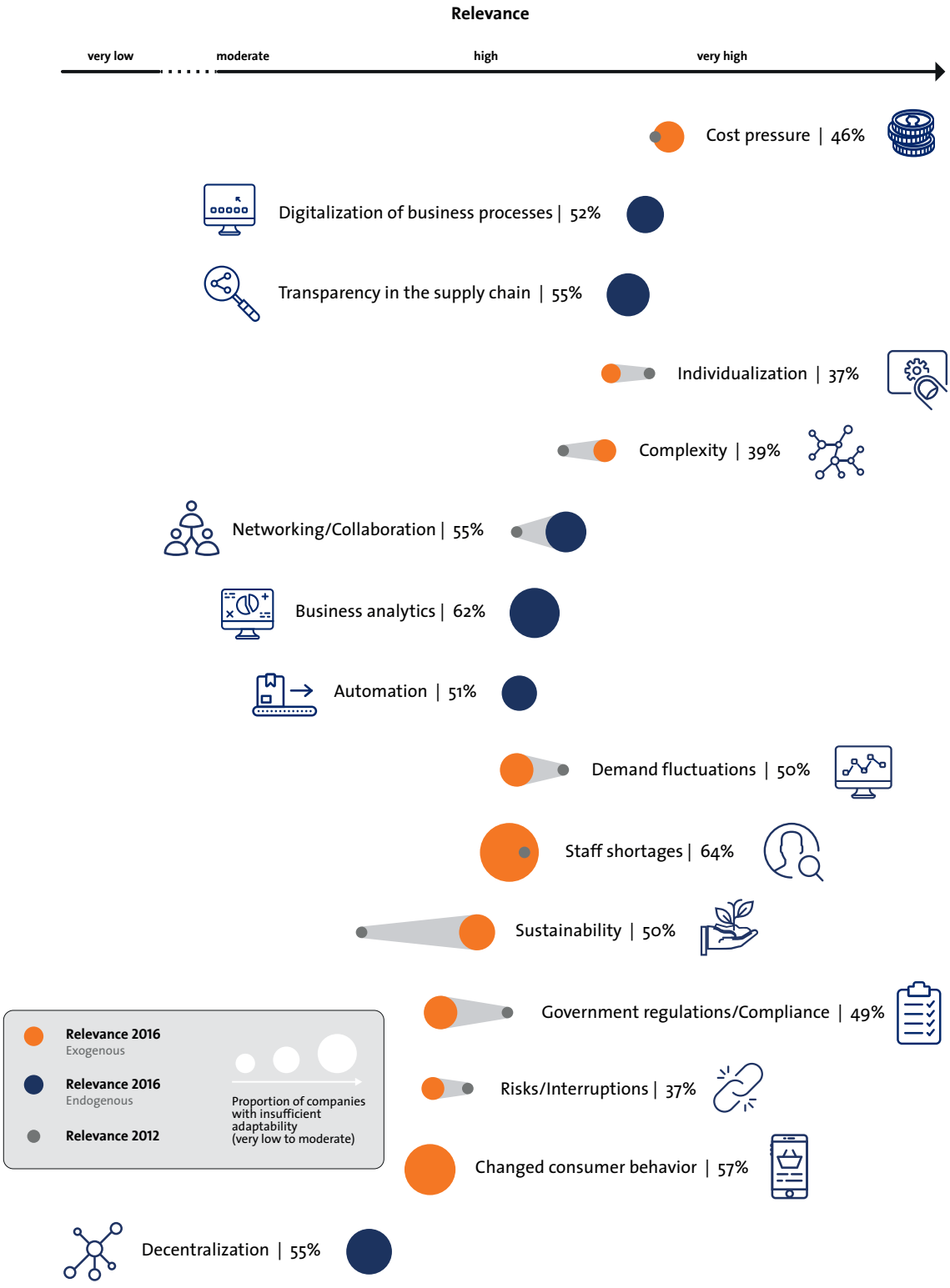
The analysis of the research literature (phase 1) and the interviews conducted with experts (phase 2) revealed 15 central trends in logistics and supply chain management. These can be distinguished as external developments (exogenous trends), or as developments that are driven by the company itself (possibly with other companies) (endogenous trends).

Exogenous trends	What external developments must I manage?
Endogenous trends	With which internal developments am I confronted?

Companies can influence exogenous trends only to a very limited extent and, therefore, they have to find appropriate internal ways of adapting. For this, they can partially use the endogenous trends. For example, they can counter the increasing lack of staff by lowering the automation threshold.

However, controllable endogenous trends can put a single company under pressure if it ignores them. For example, it is possible that competitors who decentralize their structures and systems, increase their robustness and consequently develop a competitive advantage. A passive company would fall behind in the new developments. The examples illustrate the variety of dependencies and correlations of the identified trends. Figure 2-1 provides an overview of the current trends' relevance for logistics and supply chain management and, in addition, differentiates the previously discussed dimensions.

Figure 2-1: Relevance of current trends in logistics and supply chain management, and the adaptability of firms to these developments



The trends at glance

Exogenous trends

Cost pressure

Cost pressure is the driving force behind logistics and supply chain management. Higher price transparency and sensitivity, as well as increasing international competition with simultaneously rising logistics costs create special challenges for the companies to deliver orders as cost-effectively as possible and to take full advantage of existing savings potential.

Demand fluctuations

The volatility of customer demand is on the increase. Seasonal fluctuations are relatively easy to anticipate, but irregular fluctuations require intelligent analysis and forecast mechanisms. Flexible structures in the product or service creation, as well as complementary logistics processes, help to compensate for these fluctuations. Large (intermediate) depots/warehouses for buffering unforeseen demands have become outdated.

Government regulations/ compliance

Government regulations define the action framework for supply chain management. Politics and policies strongly influence developments in this field. Companies must comply with laws, guidelines, toll provisions, duties, etc. (compliance). The current revamping of inner-city routes and searching for suited logistics concepts, for example, are directly relevant to this discussion.

Individualization

Specific customer requirements lead to a high level of product diversity and also to a diversification of logistics services. A wide range of products at the point of sale is, in logistic handling, often associated with a demand for small quantities and short delivery times. Then companies are challenged to adjust their existing production and logistics systems by developing more flexible logistics structures and delivery concepts to accommodate small, individualized batch sizes.

Staff shortages

Lack of qualified personnel is the biggest challenge in logistics. Experts and managers in supply chain management and logistics remain scarce. Demographic change, as well as increasing digitalization with its changed competence requirements, exacerbate the situation.

Risks/interruptions

Risks can influence logistics and supply chain management in various ways. Natural disasters and the increasing threat posed by cyber-attacks are, in addition to volatility due to the global economic and political situation, serious disturbance variables. Failure in one link of the supply chain can bring the entire chain to a standstill and, therefore, has to be anticipated at an early stage (supply chain risk management).

Complexity

Complexity is caused by an increasing number of products, parts, suppliers, services, etc. that need to be coordinated, and also by change or development over time (dynamic). This is often not a linear relationship; its complexity increases exponentially according to the number of entities. Digitalization can assist with making complexity manageable again.

Sustainability

Sustainability is a trend that becomes increasingly important. In addition to economic aspects, companies or entire supply chains should, therefore, concentrate on the ecological and social consequences of their actions and communicate how they do this to their stakeholders. Electric cars are only one of many examples which could be a first step in the direction of a “greener and more social” future.

Changed consumer behavior

Current consumer behavior is increasingly shaped by the customer’s digital capacity in the B2C and B2B contexts. Changes in distribution channels towards platforms and portals lead to small scale logistic services that are individualized for customers. In addition, compared to previous generations, the product ranges that clients desire change.

Endogenous trends

Digitalization of business processes

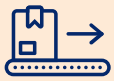
Information, communication, and data processing systems increasingly support business processes. Digitalization becomes the foundation for data exchange across all value creation stages. Defined interfaces or uniform systems are required for this exchange to work, which is quite a tall order in complex value creation networks.

Business analytics

The analysis of logistics processes, supply chain structures, or buying behavior which aims to process optimization and more efficient design is currently a pertinent topic. However, extensive practical implementation is clearly still a long way off. To achieve this, business analytics envisage digitalization of business processes and comprehensive transparency. Although new services and tools can emerge in the context of intelligent data analysis, companies, to a large extent, still have to develop the appropriate skills.

Transparency in the supply chain

In supply chain management, transparency has always been a high priority in all the supply chain stages. Digitalization creates new opportunities for enabling such transparency where it has not been achieved thus far. Therefore, transparency in value chains has become one of the most important trends in logistics and supply chain management. There is, however, still optimization potential with data sharing between partners.



Automation

The objective of digitalization is to increase productivity, not only through repetitive, but also through varying work processes of machines or software. With new, innovative warehousing strategies goods can automatically be transported to the requested location, for example with a robot. Companies now particularly reflect on the issue of human and machine interaction in the logistics system.

Networking/ Collaboration

Companies network increasingly in the competitive environment to improve their competitive market position. This does not only apply to the partner within the supply chain (vertical), but also to the exchange with actors from the same supply chain level (horizontal), universities, and associations. The importance of such networking has continued to increase in the last couple of years. Companies currently recognize the need to build dynamic networks that react flexibly to changes and adjustments in the logistics system.

Decentralization

The decentralization trend has two components: physical structures and control/ decision-making processes. On the technical side, this compromises, for example, the geographical distribution of smaller warehouses that can supply the customers faster and more cost-effectively. At the same time, modern architecture increasingly aspires to decentralized and dispersed units that allow for decentralized process control due to an interconnected cyber-physical system.

Exogenous trends

A cross-sectional comparison of the data collected in 2012 [2] shows that experts have evaluated cost pressure, individualization and complexity to be highly relevant exogenous trends.

The top trend, cost pressure, reflects the sensitivity to cost of logistics or the logistics function across all branches and companies. Customers' increasing sensitivity to prices for logistics services and increasing competition with rising logistics costs result in special challenges for logistics. Forty-six percent (46%) of the surveyed firms have indicated that their adaptability regarding this is moderate to very low. In addition to the requirement for cost-effective logistics services, the experts also mention rising customer expectations with regard to flexibility of logistics solutions. In many cases it is not possible to fulfill both aspects.

Customers want customized products and services, which often go hand in hand with increased complexity. Complexity is caused by the increasing number of products, parts, suppliers, services, etc., as well as their dynamic changes over time; these all need to be coordinated. It is, therefore, not surprising that surveyed experts estimate the relevance of the complexity trends for small companies (<250 employees) to be significantly less than that of the representatives of medium-sized and large companies.

The lack of qualified personnel in logistics is a further obstacle for companies; 64% of the surveyed companies indicated a moderate to low ability to adapt to this development. This result supports a thesis of the 2012 study, which describes this as the greatest challenge in the coming years [3]. In 2012, a significant growth in the relevance of all identified logistics trends was predicted for the following years. However, this could not be confirmed by the data collected in the 2016 online survey. For example, the trends of individualization, fluctuations in demand, risks, and interruptions, as well as state regulation actually showed slightly reduced relevance (see Figure 2-1). In contrast, the sustainability trend which, comparatively, became increasingly relevant in logistics and supply chain management, stands out. In the opinion of the surveyed experts sustainability is an overarching requirement and must, therefore, be considered from the supply chain perspective. At the same time, 50% of the respondents estimated their company's ability to respond to sustainability requirements as moderate to very low.

Endogenous trends

This year's edition of the study focuses more strongly on the trending topics with an endogenous character. These trends are assessed as highly relevant to the areas of logistics and supply chain management (see Figure 2-1). Because of the novelty of these approaches, many companies (>50%) are not in a position to control them adequately yet. The digitalization of business processes and transparency in the supply chain, which the experts rated very highly, are examples of such trends. An increase in support of business processes by means of information, communication, and data processing systems is a necessary condition for the creation of end-to-end transparency in companies, as well as in the supply chain. Between fifty-two percent (52%) and fifty-five percent (55%) of the surveyed companies indicated only a small to medium sized ability to adapt to these trends.

The analysis shows that trends such as digitalization of business processes, transparency in the supply chain, and automation are estimated as much less relevant by experts of small companies than by experts of medium-sized and large companies ($p<0.037$). Further, there is a correlation between the ability of companies to adapt to (a) the endogenous trends which have a digitalization focus, and (b) the exogenous trends which have a customer focus (see Figure 2-2). Companies better adapted to the digitalization trends indicate that they can also better adapt to customer-driven trends. This correlation allows us to conclude that companies which recognized the potential digitalization holds and adopted it, will also deal better with customer-driven requirements.

Digital transformation opportunities

The discussion about trends is strongly influenced by developments in the digitalization context, such as business analytics and transparency. Of the surveyed companies, 73.0% trust in the opportunities offered by a digital transformation and regard their relevance as high to very high. In this assessment, they overall rate the opportunities higher than the possible risks (see Figure 2-3).

Digital technologies can reduce costs by, for example, intelligent forecasts or operational support for the employee, thus also increasing productivity. Implementing these technologies can also improve customer relationships and open new business areas. The majority of companies in the manufacturing sector (79.9%), logistics services (85.5%), and retail (74.5%) recognize these and similar positive effects of a digital transformation (see Figure 2-4). The respondents in the manufacturing sector mostly

Figure 2-2: Correlation between the capabilities in dealing with exogenous and endogenous trends

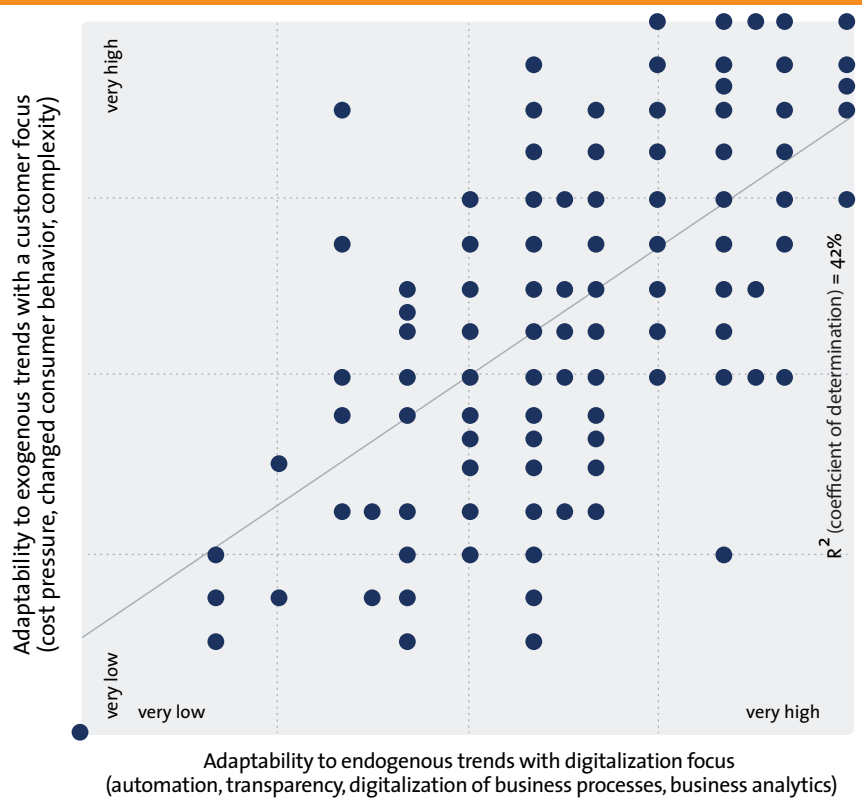
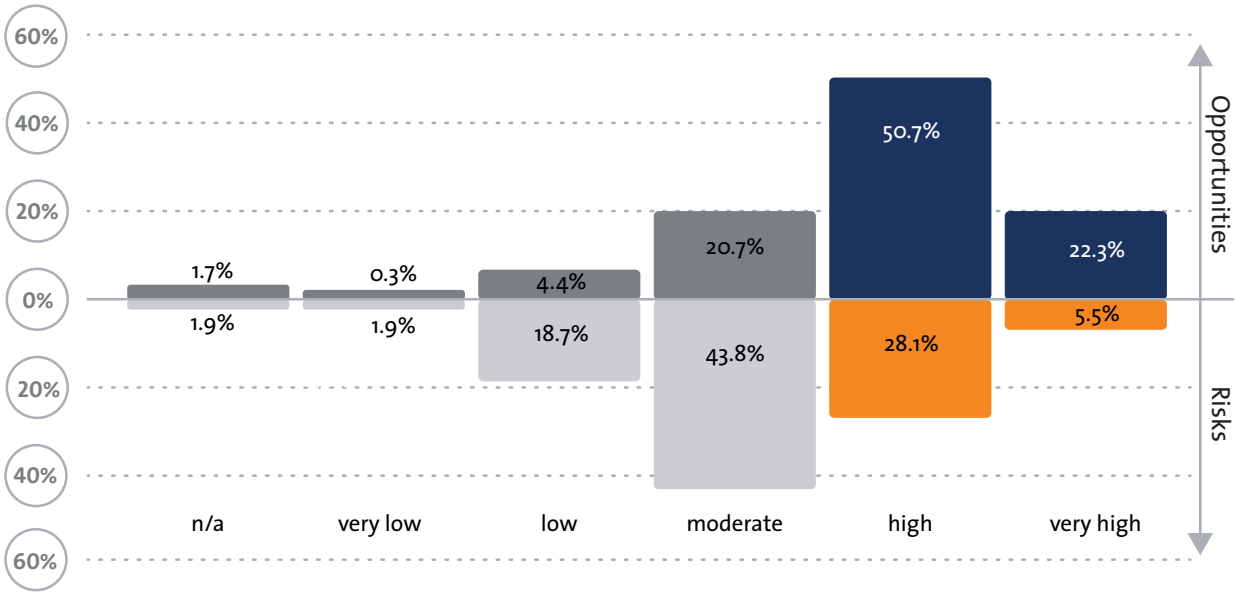
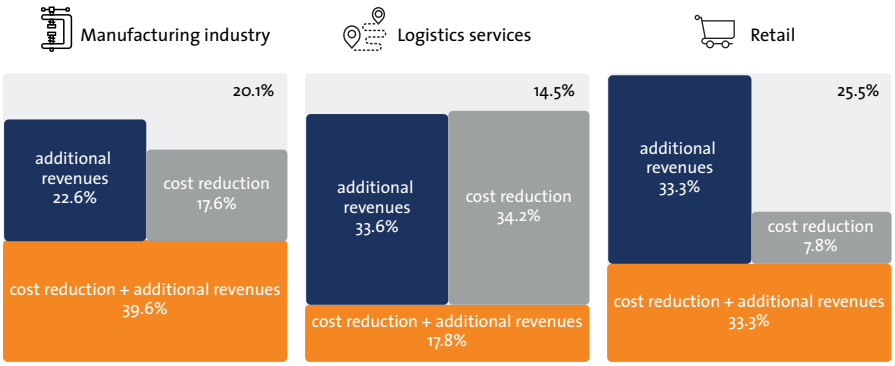


Figure 2-3: Comparison of the estimated opportunities and risks of digital transformation for companies



indicated that they expect a cost reduction, as well as increasing revenue (39.6%) in their company. In the retail sector the tendency is that companies appreciate the positive impact regarding cost reduction as considerably less (7.8%) than the possible additional revenue increase (33.3% additional income + 33.3% cost reduction + additional revenues). The surveyed parties in the logistics services sector show disagreement: While one part recognizes the possibility of gaining additional revenue through digital transformation (33.6%), a similarly large proportion expects cost reduction through digital transformation (34.2%) (see Figure 2-4)

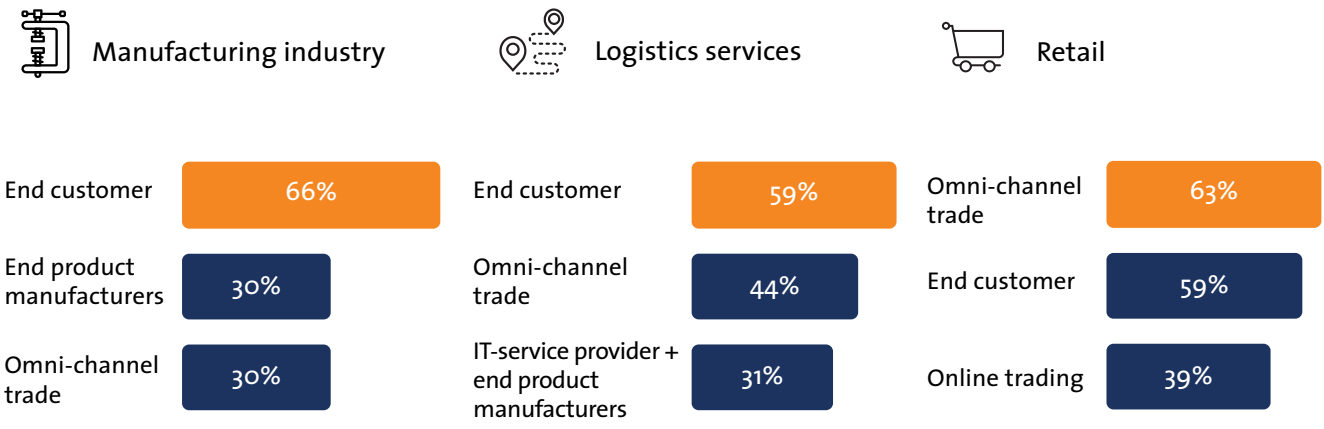
Figure 2-4: Expected impact of digital transformation on the cost situation in companies



The surveyed companies' perspective was that digitalization is driven by the end of the supply chain (see Figure 2-5). The majority of companies across all sectors perceive the end customer, as well as omni-channel retail as the driving forces of the digital transformation. This is particularly interesting considering the very heterogeneous access to end customers within the supply chain. A consequence of this could be that suppliers without a high level of market power and, thus, without access to end customers, are disadvantaged in the development of new solutions.

It is, therefore, essential for every company to look closely at technological evolution and, in its future strategic alignment, to take the relevant actors into account. The further processing of the study findings is divided into the following subject areas: innovative technology concepts, changes in the supply chain, changing skill requirements, as well as new and adapted business models.

Figure 2-5: Perspective of the surveyed sectors on drivers of digital transformation*

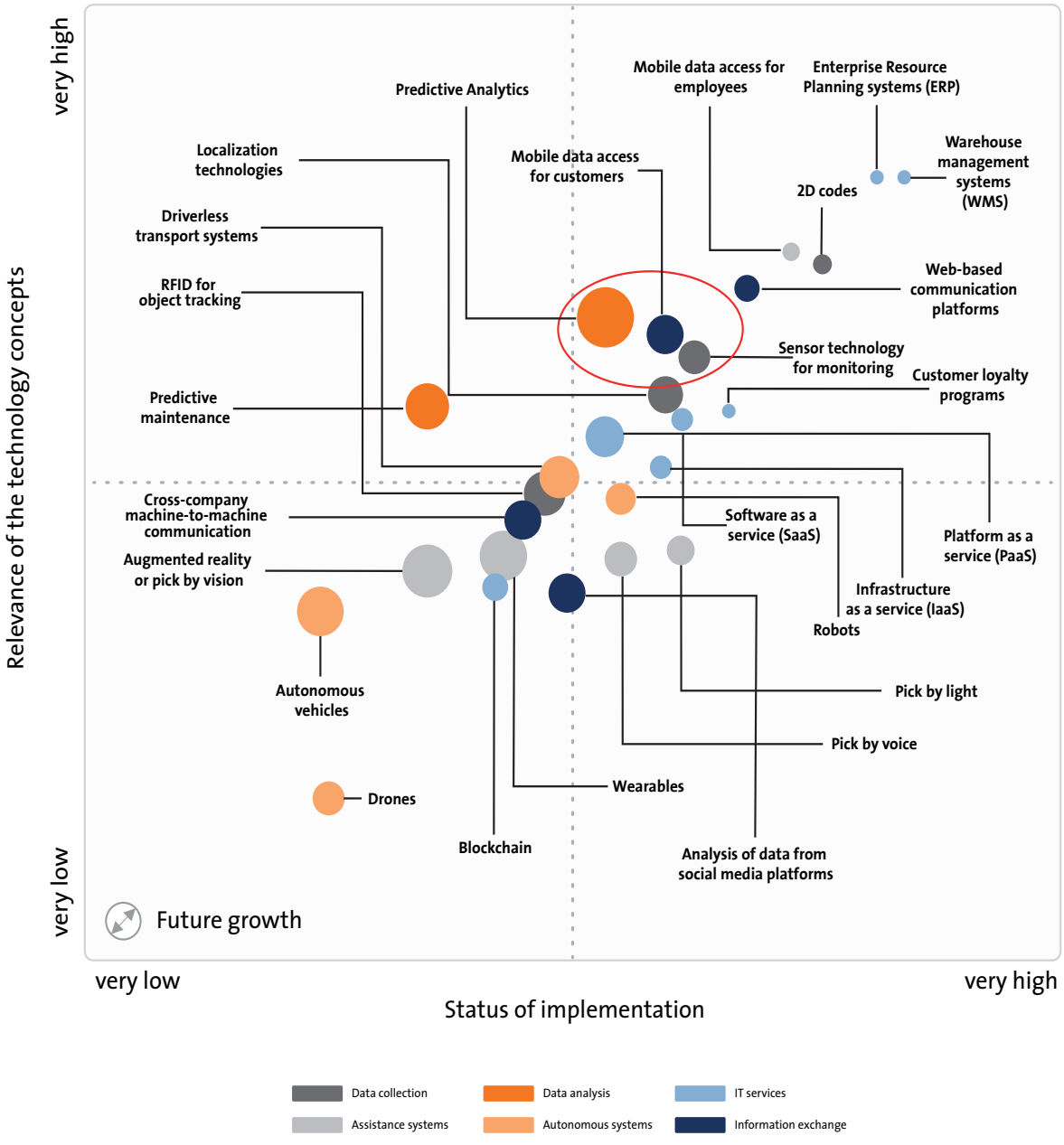


* Proportion of companies that considered the players named as drivers of digital transformation. Multiple answers were possible.

Innovative technology concepts

The digital transformation goes hand in hand with the practical application of a large number of technological concepts. Existing and new technologies become the driving forces of change in supply chains by increasingly using possibilities of information and data exchange via previously unconnected supply chain members. This enables the establishment of new business models but also results in a need for new skills. Conversely, new projects and well-trained staff constantly demand new technological solutions. Technologies are, thus, one of the fundamental pillars of digital transformation and, at the same time, are driven by the ongoing change.

Figure 3-1: The relevance and implementation status of the studied technology concepts



In this study, we initially collected the technology concepts currently being discussed in logistics and supply chain management, and then, by means of the online survey, we tested the relevance and implementation targets of these concepts within the companies. The following key questions determined the investigation:

- What is the significance of innovative technology concepts in logistics and supply chain management?
- What innovative technology concepts are used in logistics and supply chain management, and which of these concepts are likely to be increasingly introduced in the next few years?
- What are the advantages of these technology concepts?

The total of 26 investigated technology concepts was, for the sake of clarity, divided into six sub-areas which are indicated in different colors in Figure 3-1. Noteworthy in this display of technology concepts, is their average implementation level despite their high relevance. Particularly those technology concepts that a large proportion of companies plan to implement within the next five years (great circle diameter), will shape the environment in logistics and supply chain management.

Current fields of action

Data collection

Data-driven decisions and the use of artificial intelligence in supply chains need a corresponding data base. Localization or sensor technologies are, in addition to many others, survey sources for creating such a data base. To ensure the evaluation of order and business data across company borders, an appropriate method for capturing, storing, and transferring data is required. In the retail sector, there are already comprehensive approaches for the electronic exchange of data and the digitized handling of administration tasks for orders.

Worldwide, order tracking in the retail sector, as well as in the manufacturing and logistics services, will play a major role. The logistics service providers, however, regard localization technologies as significantly more relevant than the experts from the manufacturing or retail industries who regard them as only of moderate relevance. The localization technologies here refer to technical systems such as GPS, GLOSNASS, or, in future, also Galileo, for determining positions globally. A further development in the use of these systems can specifically be expected in the area of logistics services companies, considering that 12.4% of the logistics service providers indicated plans to introduce corresponding technology concepts in the following five years.

Object tracking at product level is essential for trading companies and the manufacturing sector. Therefore, two-dimensional bar codes have high relevance, for example, QR or data matrix codes, which can be read optically [4]. Currently, 2D codes are the technology concept with the highest relevance in data collection. In evaluating this trend manufacturing companies were more inclined to assign very high relevance, while the logistics service providers differed significantly, assigning only moderate relevance. The concept is already largely established in practice: 60.9% of the companies use 2D codes fully or at least partially; only 6.1% of the companies indicated still wanting to introduce 2D codes within the next five years.

Radio Frequency Identification (RFID), the contact-free alternative or complementary approach to 2D or bar codes, is on average only evaluated as having moderate relevance. Regarding this trend, the retail sector is strongly inclined to low relevance and, thus, differs significantly from the manufacturing sector's assessment which

Figure 3-2: Use of sensor technology in the various sectors

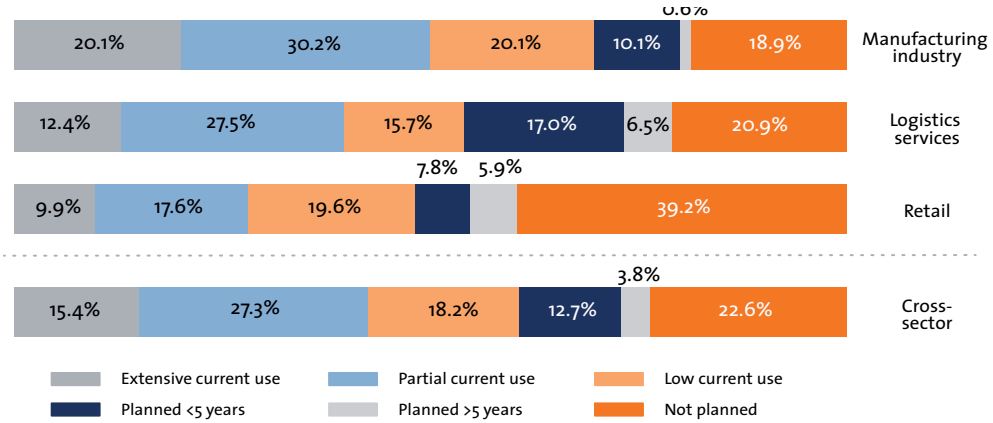
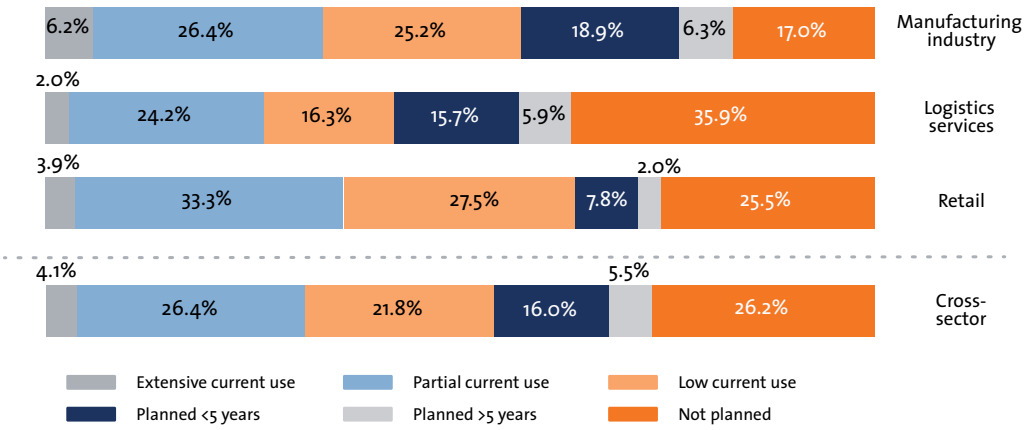


Figure 3-3: Use of predictive analytics in the various sectors



is inclined to a high level of relevance. This is also reflected in the planned implementation: 47.1% of retail companies do not plan to introduce RFID technology. In the expert interviews, this reluctance was substantiated with reference to technical problems. For example, they would claim that interferences and unacceptable scanning error rates at high sensor scanning speeds create problems for the companies. Practical use is often limited to projects – which are limited in extent – such as ones for tracking loading tools or identifying process bottlenecks. At the moment, the vision of a supply chain that uses RFID tagged products is, at least partially, not supported in practice. The logistics service providers also reflect this: 17% of the logistics service providers plan not to introduce RFID, and 5.2% have a planning horizon of more than five years.

The use of sensor technology for containers, loading tools, transport, or in warehouses, is becoming increasingly attractive due to how this reduces costs. These sensors provide a useful data source for capturing information about temperatures, vibration, humidity, etc., during a shipment. In addition, machine or device-specific sensors can be used for monitoring the operating conditions and for triggering appropriate actions such as maintenance, change of operating conditions, or necessary continuation of processing.

Overall, sensor technology is assessed as being moderate to highly relevant. The manufacturing sector evaluated sensor technology as highly relevant, while the retail sector signaled only moderate relevance. In retail, the current use of sensor data is reported as low; accordingly, 39.2% of the retail companies do not plan to introduce sensor technology (see Figure 3-2). In manufacturing, the dissemination is already higher: 30.2% partially use sensor technology, and 20.1% use sensor technology comprehensively. The biggest growth in sensor solutions is expected in the logistics service sector: 17% of the companies plan to implement this within the next five years, and 6.5% have a longer planning horizon.

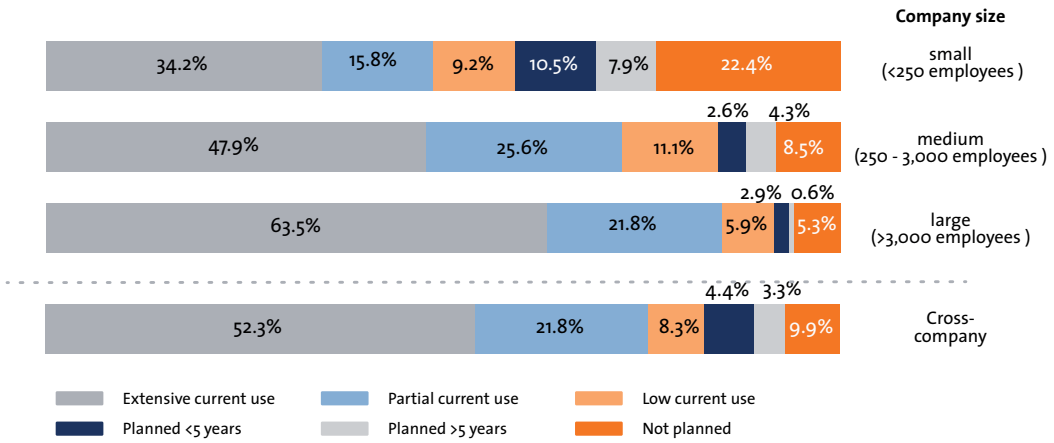
Data analysis

Information on capacity, orders, and customers, has already been evaluated for several years. Particularly in retail, the electronic processing of orders derives suitable measures on the basis of key performance indicators. The predictive analysis and predictive maintenance methods expand the data analysis to find appropriate statistical analyses for predicting and optimizing business processes [5]. The surveyed consultancy companies expect saving opportunities by optimizing transport capacity and order placement.

The logistics service providers' comments were generally more reserved: They reported a moderate relevance regarding the predictive analytics and maintenance concept. Of the logistics service providers, 35.9% (see Figure 3-3), or 44.4% (see Chapter "Appendix") have not planned to introduce predictive analytics or maintenance. The manufacturing and retail industries rate these predictive analytics concepts as highly relevant, thus evaluating them to be significantly more important than the logistics service providers do. On the one hand, this is due to the nature of the business, and on the other hand, the interviews show that logistics service providers have not yet fully tapped into the opportunities.

At the time of the survey, predictive analytics concepts were, however, only used by a small segment of the companies, regardless of the sector: 4.1%, on average, indicated that they have already introduced the concept comprehensively, while half of the companies indicated partial or low introduction. The predictive maintenance concept shows a similar pattern. This, however, is rated

Figure 3-4: Use of ERP in small, medium, and large companies



as highly relevant in the manufacturing industry and, thus, significantly more relevant than in the retail and logistics services sector where its rating is only of moderate relevance.

Similar to the predictive analytics predictive maintenance has not yet been comprehensively implemented (3.6%). However, 12.9% of the businesses plan to introduce predictive maintenance concepts within the next five years. The application of intelligent control concepts in production will also lead to a change in logistics services. On the one hand, an increasing supply of data is expected, and on the other hand, more comprehensive problem reporting, which also implies higher expectations of logistics service providers. A portion of the users of such concepts relies on machine learning and artificial intelligence to improve this reporting even further. Logistics service providers can also use analytical concepts to their advantage: Intelligent prediction can, as elsewhere, increase the utilization of operating resources, as well as support intelligent route planning, and selection of time frames. The surveyed experts believe that data will, in the long term, have to be available across the entire supply chain. The data is not only available for analysis and data-driven decision-making but also allows for optimization of the entire supply chain using artificial intelligence.

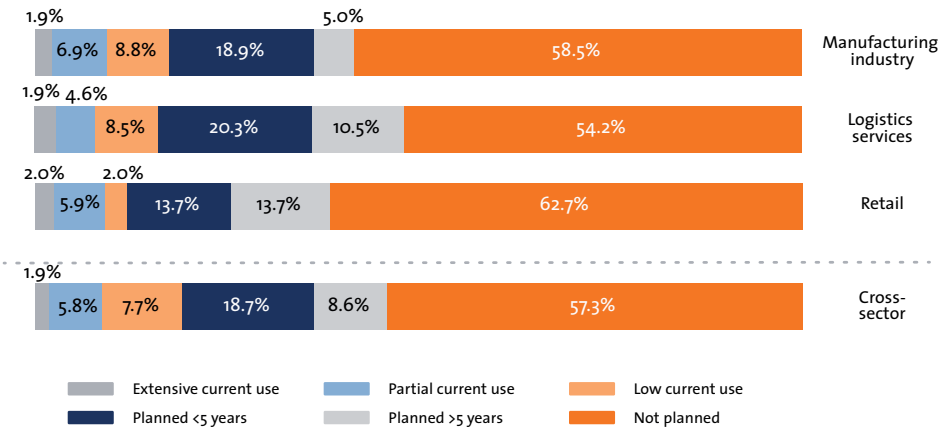
IT services

Businesses often find the necessary adjustments to IT-systems difficult. Legacy systems need to be integrated, productive systems are difficult to replace, or the IT landscape of the company has evolved very differently. This evolutionary adjustment of existing IT-systems in companies represents a disadvantage in comparison to companies that do not have historical restrictions. Changing, as well as solidly integrating IT, are currently necessary actions for efficiently meeting customer demands. In most cases, specifically single-item production or the individualization of products are the causes of high costs.

Service packages can be used to address these challenges on the IT side. The “anything as a service” approach (XaaS) benefits users, because they can flexibly grow with the company, have lower investment costs, and give quicker access to new applications [6]. Considering cloud-based IT services, we specifically studied the areas of software (SaaS), infrastructure (IaaS), and platforms (PaaS). The online survey participants rated the relevance of all three concepts as moderate. Only PaaS showed a significant difference within the sectors: Manufacturing companies deviate here and, in contrast to retail companies and logistics service providers, evaluate this as highly relevant. Currently, very few companies plan to introduce XaaS concepts: Only 9.4%, 8.3%, and 12.1% plan to use IaaS, PaaS, and SaaS within the next five years. In contrast, more than 20% of the participants indicated that they are already using XaaS in their companies: Partial use was indicated by 22.9% for SaaS, 16.8% for IaaS, and for 14.6% PaaS, while comprehensive use was indicated by 11.0% for SaaS, 9.9% for IaaS, and 7.4% for PaaS. In future, particularly logistics service providers will have to deal with cloud-based infrastructure, because of the volume of data to be stored and processed, as well as the service quality required to provide this data, will continue to grow.

All the experts identified warehouse management systems as one of the most relevant technology concepts overall. The degree of dissemination is already very high: 56.7% of the participants comprehensively use such software, and only 3.9% still plan an implementation within the next five years.

Figure 3-5: Use of augmented reality in the various sectors



The mapping of business processes in enterprise resource planning systems (ERP) is highly relevant for retail, as well as for companies in the manufacturing industry. The introduction of ERP systems is associated with considerable effort and correspondingly high costs. Accordingly, such software is particularly widely used in larger companies who rate them as very highly relevant. Companies with less than 250 employees use ERP comprehensively in only 34.2% of the cases, and partially in only 15.8% (see Figure 3-4). Then, 22.4% of these smaller companies have planned not to use ERP systems at all. In contrast, 63.5% of the large companies with more than 30,000 employees use these systems comprehensively, and 21.8% partially. Consistent and rapid availability of data through interfaces which optimize the entire supply chain is essential for manufacturing and retail. Due to this, also smaller companies and logistics service providers are forced to adapt because they have to communicate – largely via ERP data interfaces – with the bigger companies.

Assistance systems

IT services are also required for operating assistance systems which facilitate and improve the work of personnel by making context-dependent information available. This is specifically true of manual activities, such as handling goods or warehousing, because the errors made here, cause considerably more work. In addition, there are new ways of supporting the employees in the field via applications on mobile devices, for example for traffic management or maintenance, as well as to access certain company data and key indicators.

The relevance of mobile data access for employees is regarded as moderately to highly relevant. More than half of the survey participants have already enabled mobile data access for their employees (36.1% partially, and 28.4% comprehensively). Only 9.4% of the respondents have not made plans to enable this for their employees yet. Data can also be accessed via wearables, i.e. through portable computer systems such as smart watches or activity trackers that can show context-sensitive information or give instructions. The relevance of such systems is evaluated as moderate to low, and currently, only a small proportion of the companies use it: 2.5% comprehensively implemented appropriate solutions, 10.5% only partially, 16.3% will implement it within the next five years, and 51.8% do not plan to use it. A similar implementation can be observed with augmented reality solutions (AR), which typically use smart glasses: 18.7% of the companies plan to introduce this within the next five years (see Figure 3-5). The productive usage possibilities of such solutions only recently became available, and accordingly, their relevance rating is low. Extensive use of these solutions is limited to only 1.9% of the companies, of which 5.8% use AR at least partially. More than half of the surveyed participants (57.3%) indicated that they will not use AR, not even in future.

However, despite this attitude, a change can still be expected, because AR solutions cover a very wide spectrum. Recording the real environment and supplementing it with additional information, for example in the form of stationary devices (“smart” mirrors, etc.) or using smartphone apps, can become interesting for retail. The use of smart glasses is, however, the most promising for logistics. The ability to blend in additional context-dependent information or indicators makes this technology particularly useful for handling or maintenance tasks. Practitioners noticed considerably improved

efficiency, as well as lower error rates compared to conventional methods, particularly in the area of order picking [7].

In addition to picking based on printed lists, picking by light and by voice procedures were also studied. For more than ten years logistics companies partially used both these concepts and the practitioners rated their relevance as moderate to low. Nevertheless, 8.8% of the respondents plan to introduce light-based procedures, and 12.9% the language-based ones within the next five years.

Autonomous systems

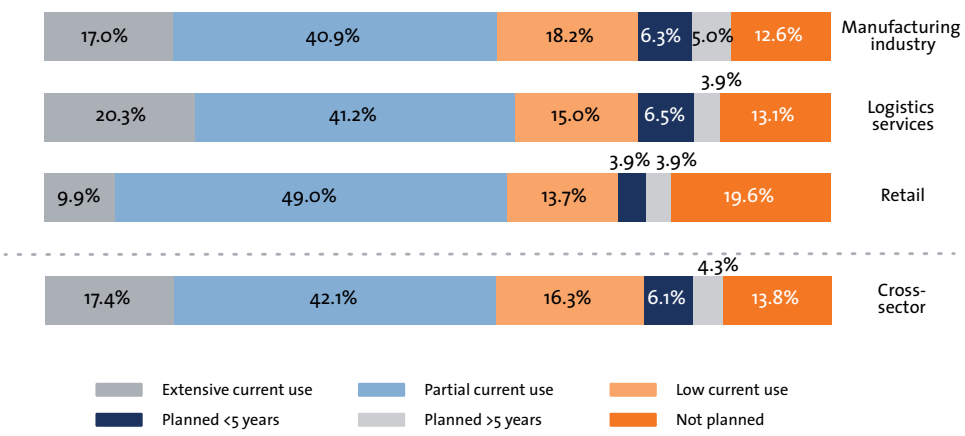
While assistance systems support the staff in their daily work, autonomous systems take over the work automatically. The technologies we studied hold significant potential for change in logistics and supply chain management. Most of the concepts are still in a development stage or can only be limitedly applied. Therefore, unmanned aircraft ("drones") at the moment have low practical relevance; the same applies to unmanned vehicles, such as driverless trucks which are currently rated with moderate relevance.

The exact design of utilization concepts for autonomous systems is currently widely discussed. It represents a field in which many research projects and young companies are participating. Practitioners specifically find delivery concepts of the last mile interesting in the medium term [8]. In the last couple of years, unmanned aircraft ("drones") received considerable media attention. Due to extensive approval procedures, as well as low transport capacity and range, using these concepts is currently limited to certain special cases, such as humanitarian aid projects or transport of medical products [9]. However, early applications of autonomous delivery in the public space already exist in the use of small land/ground-based robots. For example, deliveries have been piloted by the companies Hermes and MediaMarkt, as well as in cooperation between the Swiss postal service and the Estonian manufacturer Starship Technologies, or between the Australian division of Dominos pizza delivery service and the military supplier Marathon Targets.

The logistics service providers specifically count on eventually using driverless trucks. First concepts already exist: Daimler has introduced the first autonomous truck, approved by the Nevada road traffic agency in 2015 [10]; the Uber start-up, Otto, conducted the first fully autonomous test drive with a retrofitted truck in October 2016 [11]. The resulting changes anticipated for the transport sector are considerable since the use of vehicles no longer depends on staff availability. In addition to the remaining technical challenges, the absence of an appropriate legal framework constitutes a further implementation barrier in many countries [12]. The introduction of autonomous trucks is, therefore, more likely in the longer rather than in the shorter term. This is reflected in the moderate relevance that the study participants allocated to this topic. For the medium term, practitioners foresee platooning – a dense unlocked convoy steered by a command vehicle – as a likely precursor to autonomous driving.

Autonomous vehicles have already been used for years in contained areas, such as warehouses and ports. Here, driverless transport systems (DTS) take on a wide range of tasks in supporting the picking up or transporting of containers and generally bringing more automation. Overall, these systems have moderate relevance; they are, however, significantly more relevant for the companies in the manufacturing industry than for those in the retail sector. This is evident since manufacturing companies frequently use DTS in their assembly lines.

Figure 3-6: Use of web-based communication in the various sectors



The same is true of robots. Companies in the manufacturing industry rate these as highly relevant because they are already extensively used in production. This differs significantly from ratings in logistics services and retail where robot support is rated as only moderately relevant. However, the expert interviews indicated that, in the long term, robotics will also be used in warehouses of logistics service providers or retail companies, to automatize simple tasks and, thus, increase handling efficiency.

Information exchange

Considering the identified technology areas, as well as the associated changes in the supply chain (see Section "Changes in the supply chain"), information exchange is of central importance. On the one hand, different communication channels enable exchange within the supply chain and also across all supply chain participants, and on the other hand, it also allows for controlling the supply chain. In the manufacturing sector smooth communication across the entire supply chain should assure cost saving and increase efficiency. In such circumstances, the end customer moves into focus, on the one hand truncating the supply chain, and on the other hand, as a control variable. Customer loyalty programs and analyses of data from social media platforms can be used as control instruments. Both concepts were rated as having moderate relevance; customer loyalty programs were evaluated as significantly more relevant than social media analyses. These channels allow for the derivation of indicators and for being used as a data source; they also allow for active dialog and – to a certain extent – influence the needs of the end customer. Retail companies, in particular, plan to use social media analyses is in the future: 15.7% intend to introduce this within the next five years.

Currently, the development of mobile device software (apps) for customer use is already highly relevant for retail and logistics service providers. Of the logistics service providers, 39.2% already partially use apps and 14.4% use them comprehensively. Customized apps allow for more direct customer contact and possibilities of achieving mutual benefits. In the last few years, CEP service providers introduced innovative apps that enable shipment control to the benefit of customers and the company. Companies in the manufacturing industry do not rate the relevance of apps as highly, therefore 22.6% do not plan to introduce apps, while the logistics and retail sectors rate the relevance of apps at only 13.7% and 7.8%.

Communication via an app is only one way of contacting customers – web-based communication platforms, which not only enable communication with the end user but also with business partners, play an important role. These technological concepts are rated as highly relevant and already have a high degree of dissemination with 42.1% partial and 17.4% comprehensive use (see Figure 3-6). Regarding these systems, retail companies plan to extend the existing end customer self-service functions to a company-to-company communication in the future. This, for example, will allow easy implementation of master data changes or more direct order management. Changes can be processed more efficiently and other delivery concepts that require greater autonomy, such as drop-shipping, can also be implemented. Some companies noted that the respective software solutions significantly reduce the number of emails, thus making this communication channel manageable again.

Machines will use similar interfaces to communicate across companies in the long term. The relevance of this concept is, however, rated as low to moderate. In the manufacturing industry, only 13.2% of the companies use it partially, while 42.8% do not yet plan to introduce such a concept.

Vision and strategy

Disruptive and long-term relevant concepts

Autonomous vehicles will significantly change transport logistics, even if the time horizon for the first productive use of completely autonomous self-driving trucks, will probably exceed five years. Being staff independent will allow the continuous use of the vehicles and increase the available transport capacity. Coupled with a digital, automated allocation of loading space, better vehicle utilization becomes possible. Presently, warehouse operators are already challenged to prepare their locations accordingly. For example, they have to plan journeys and future opening hours correspondingly. Logistics service providers will be forced to diversify independently of the transport business. In the future, vehicle manufacturers will be able to provide transport services by using autonomous vehicles themselves. Automated convoy driving ("platooning") will be a transitional solution until then. At the moment, these systems aim for a driver assistance system with vehicle-to-vehicle communication. Although staff independent transport is not possible yet, it is bound to have efficiency benefits.

Similarly, drones will eventually also take over logistics tasks. Their use will go beyond the unmanned aircraft concept as is illustrated in particular cases where using land-bound vehicles is cost intensive or takes too long, such as in transporting medication [13]. Due to limited legal provisions and spatial conditions, a change to such extensive use cannot be expected in Germany as yet [14]. The disruptive nature of the drones arises from the other innovative uses of these transport units. As an alternative to existing intralogistics solutions, Fraunhofer IML developed a particularly energy-efficient, rolling transport drone, which should support intralogistics processes. The use of commercially available drones for administrative tasks in large warehouses, for example, stock taking or reorganizing, is also comprehensible.

There are also existing concepts, such as the autonomous ground-based robots of Starship Technologies and Marathon Targets. These concepts have developed due to customer demands for deliveries within specified timeframes, which would be too costly using conventional delivery vans. Logistics service providers can especially use these vehicles to expand their offer in the CEP sector. However, due to the technical requirements, these companies become very dependent on technology providers. The deployment locations are a further decision variable. The ground drones used up to now, are battery operated and can, therefore, only cover limited distances. In such instances, a dense location network is required for decentralized deliveries.

Companies in the logistics and manufacturing industries will, in future, implement decentralized concepts for tracking goods and transport containers. Driven by the demand for greater transparency in the supply chain, which allows traceability from start to finish, comprehensive technical solutions are required. This is often a challenge for IT solutions that focus on centralized solutions with complex access rights. Blockchain or derived concepts can provide a remedy because they have already addressed these issues [15]. Such decentralized concepts will also create new opportunities for transparency and easy auditing. However, data confidentiality and the associated inhibition of analysis options can then only be partially addressed and, therefore, it necessitates a change in the contractual design of data use. An agreement on data use, which becomes a necessary part of the offer, will have a competitive advantage in the long run.

Next steps and medium-term relevant concepts

Concepts which companies should understand as digitalization opportunities due to their high relevance and large number of planned launches, are: Predictive analytics through artificial intelligence-based analysis or maintenance (see Figure 3-1 and Section “Data analysis”), the use of sensor technologies (see Section“Data collection”), and the integration of mobile devices (see Section “Assistance systems”).

Predictive analytics can create a competitive advantage for logistics service providers. Particularly transport and goods handling provide a substantial amount of data, such as arrival times, clearance durations, and cargo quantities, which can be used in the analysis. With the use of artificial intelligence and predictive analysis, orders or making available necessary resources can be optimized. Good data collection and storage is indispensable: The quantity of collected data is not necessarily essential in this context, but avoiding interruptions in the continuous data flow or error-prone intermediate manual steps, is more important. Changes to processes or manipulated variables developed by means of algorithms, must then also automatically flow back into the system. The system leverage supported by artificial intelligence can be huge – especially if entrepreneurial decisions are made automatically.

Sensor technology can be a data source for these analyses that support the supply chain. On the one hand, different localization technologies have been available for several years, and on the other hand, they can be much more useful if additional measurement data from sensors is connected to the locations. This measurement data can be used as a basis for intelligent supply chain control and can facilitate predictive decision-making. For example, temperature and humidity monitoring can already indicate whether a food shipment will meet the quality standards of a specific recipient. Deviations can then be directly communicated, for example, to avoid undersupplying the receiver.

Integrated data access and the possibilities of collecting and supplying information through mobile devices are not sufficiently in use yet. Offers which are used on many mobile devices or which can be connected to external IT systems, are very useful for managing external stakeholder groups, thus also reducing the time and effort expended by a company. Here, the ability to obtain timely information on deviations, as well as to provide additional, contextualized information, is a benefit.

The necessary change has many facets: Open software solutions should be preferred to proprietary solutions since this is the only way to avoid being dependent on individual IT service providers. Further, it has also become necessary to enable access to a large number of devices, since this is the only way smart glasses or new data acquisition products such as new handheld scanners, can rapidly be integrated. One possibility to enable this would be the transformation to a web-based user interface: These are available on many devices and the provider can make them available to all users at the same time and timeously. By expanding this web-based interface with programming interfaces, apps can be created for employees and customers. The creation of these interfaces and applications eventually will relocate data maintenance to customers or business partners. This can avoid errors caused by manual transmission and can make changes immediately available.

Business practice example*
Picavi – Controlling/managing the warehouse with data glasses

What was installed?

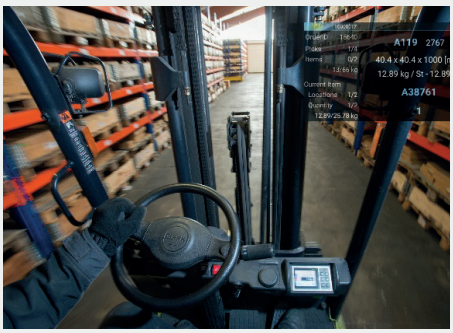
Picavi GmbH connected the intra-logistics processes at the steel supplier, Steel Service Krefeld. As a first step, modern smart glasses were integrated as a pick by vision solution which reduces errors and optimizes the picking process by means of visual process management and by connecting it to the merchandise management system. After the successful integration in the order picking processes, the system was expanded to the incoming goods and inventory areas.

How was the new technology implemented?

The display on the smart glasses helps the warehouse employees by visually guiding them through the picking process. This entails that each pick is requested. Barcoded packaging is verified, confirmed, and documented by the integrated scanner of the smart glasses. The connection to the warehouse management system (WMS) takes place via the system at the incoming goods point. There are also menu buttons on a specifically developed battery that can be used with gloves.

What does this technology enable?

Combining smart glasses with process management, brought down the time used in this process by 40%. Many time-intensive operations, such as the input in the WMS, were automated by the integrated scanner. This assures effective tracking. Additionally, this increases quality and reduces the paper-based error rate.



Company description

Picavi, situated in Herzogenrath near Aachen, is a high-tech start-up founded in 2013 under the name Logcom GmbH, and thus has many years of experience in IT and intra-logistics. This established know-how assured that smart glasses would be practically usable in their internal flow of materials and goods. The innovative warehouse technology, which covers processes from incoming goods through order picking and outgoing goods to the inventory, is increasingly successful, having been in permanent professional use since mid 2015.

* This pratice example was identified as presentable in line with this study for the topic "Innovative technology concepts" and presents a showcase.

Reference: [P1]

Changes in the supply chain

Current fields of action

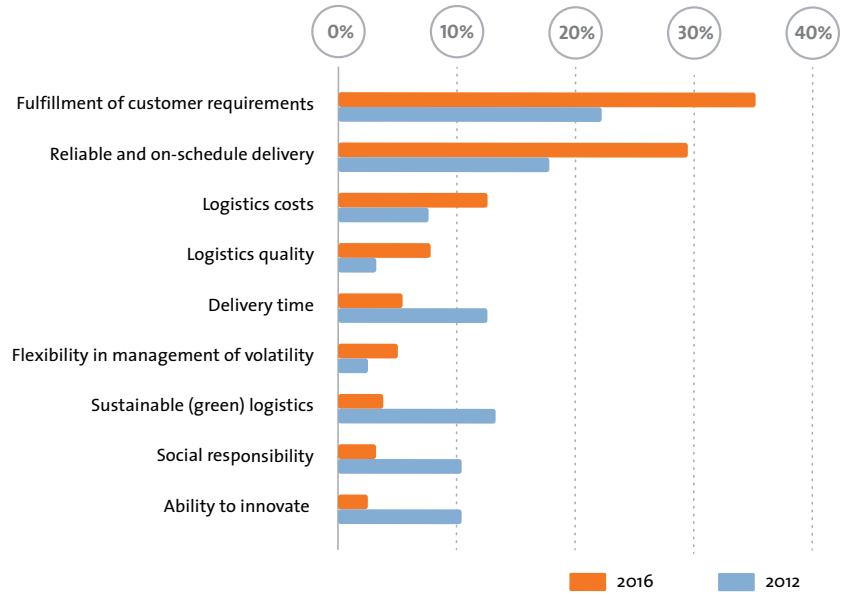
Digitalization also plays a central role in an inter-organizational context. Supply chains can be characterized by the flow of goods, information, and payments across the various supply chain stages to the end customer [16]. The logistics goals of individual companies are a key requirement for strategic orientation. In the 2012 survey, logistics goals with the highest priority were diverse and distributed relatively evenly. Today, in comparison, the selected priorities are concentrated in the following three logistics goals (see Figure 4-1):

- Fulfillment of customer requirements
- Reliable and on-schedule delivery
- Logistics costs

The logistics service sector shows a particularly clear prioritization of fulfilling customer needs (39.1% logistics service providers, 33.1% manufacturing/processing industry, 26.1% retail, see Chapter "Appendix"). Changes in the value chain – especially for logistical services – are, therefore, increasingly customer-driven. Then, reliable and individually designed services at competitive prices become even more visible, and this affects the entire spectrum of distribution, production, and procurement logistics. The resulting complexity is best controlled with (digital) technologies which can establish transparency in the supply chain, and which benefit all participants. Individual customer requirements specifically bring about change regarding the size and nature of product flow, the inter-organizational data exchange, and the supply chain composition. Taking these circumstances into account, the following sections will be structured according to four central questions, namely:

- How will product flows change in the future?
- How will supply chains be controlled in the future?
- How is the composition of the supply chain transformed and how will the actors' roles change?
- Which strategic components of present measures can be derived from the findings?

Figure 4-1: Logistics goals with the highest priority*



*Proportion of companies that rate the logistics goal as priority 1.

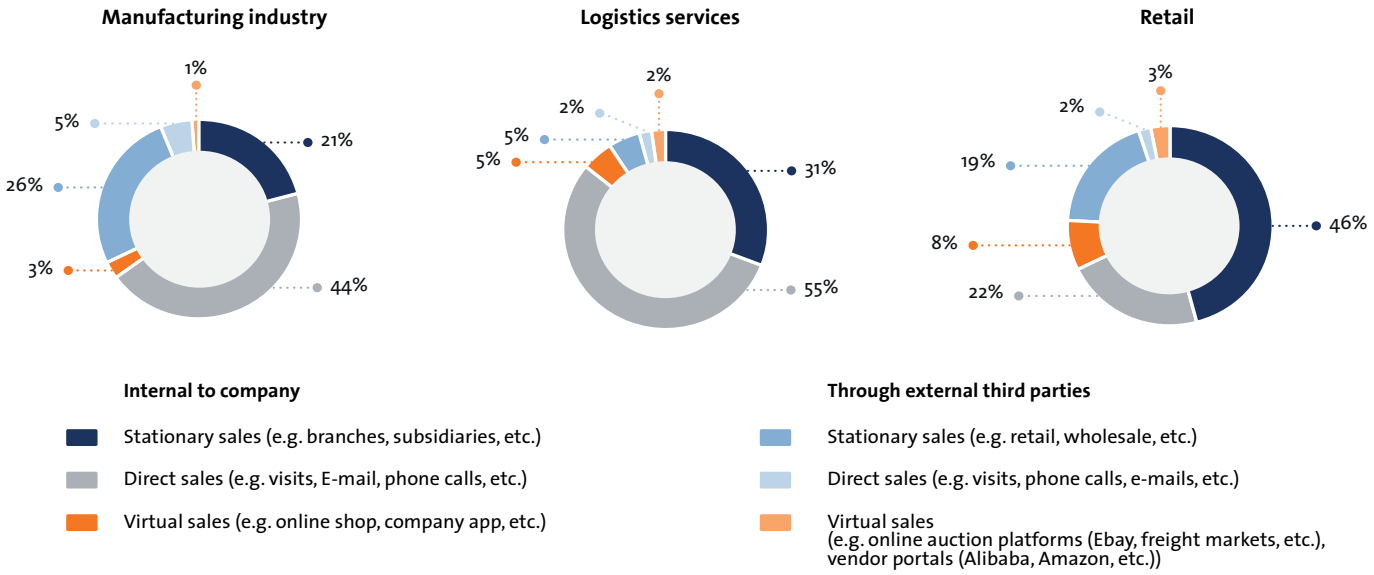
The individualization of the product flow

Driven by changing and increasingly digitally shaped buyer behavior, the physical product flows of finished goods, semi-finished products, and raw materials also change. Customers use a variety of channels to purchase goods and services (see Section "Exogenous trends"). Particularly end customers take advantage of the opportunities their mobile devices make available to them: Products are retrieved and compared online, and the most cost-effective, soonest available product or service offer can be selected quickly. This paradigm shift and its associated requirements recently also changed the business customer field along the supply chain. While sales activities in the logistics services business are still largely shaped by the company's own stationary and direct sales (86%), retail already has a stronger mix of traditional sales channels combined with online shops, apps, seller portals, and online auction platforms – even through third-parties (see Figure 4-2). This matrix becomes increasingly important to maintain market presence and, thus, catalyzes change in distribution logistics that aims for availability and cost minimization.

Decentralized storage concepts and the associated adjustments to infrastructure follow customers' wishes for short delivery times and individual delivery modes both in the B2C and B2B environment. The requested services basically become small-scale and customized, which, at least, requires uniformity of information flow in the supply chain.

In addition to logistics services, the trend of individualization on customer demand also applies to the required products. The customer's request for an individually configured product that meets his requirements thus affects production. Many companies have already adapted to this trend (see Figure 2-1). Companies from the processing industry, for example, offer mass

Figure 4-2: Average distribution of sales channels by sector



customization solutions which, through modularization, enable individualization at low cost. The increasingly important trend of sustainability (see Figure 2-1) goes hand in hand with the pursuit of an efficient and individualized supply chain that allows production even in a batch size of one. This combines the advantages of mass production with that of individual production and is only possible if the process is cost efficient and agile. Companies, therefore, are challenged to develop their existing manufacturing processes, partially making use of existing large equipment and systems, and then transforming them into a smart factory. In this future smart factory, flexible, modular cyber-physical systems will communicate with each other and will allow, without large setup costs, the continuous adaptation of production and operation to serve individual customer wishes. This, however, implies a complete overhaul of IT and internal logistics systems, and also of those across the entire supply chain.

Additive manufacturing is vigorously discussed as a further potential technology for the supply chain management field. In this scenario, the manufacturing of spare parts and customized products is decentralized and made by a 3D printer in close proximity to the customer. This manufacturing, which is oriented to temporal and geographical needs, has a dramatic impact on warehousing, transport, and disposal. The focus is on keeping in stock, supplying raw material, and running trips on the last mile in the delivery areas. Making an overland delivery of partly finished and finished products is virtually unheard of here.

Many companies grapple with questions about the extent to which products and goods will have to be transported in the future. This will have a significant impact on logistics and supply chain management. Disruptive developments, for example in the publishing and music industries, have shown that digitizing established market-related supply and transport chains, can make them obsolete. Therefore, logistics must, at an early stage, engage in dialog that grapples with future products, services, and customer demands.

Data-driven control of the supply chain

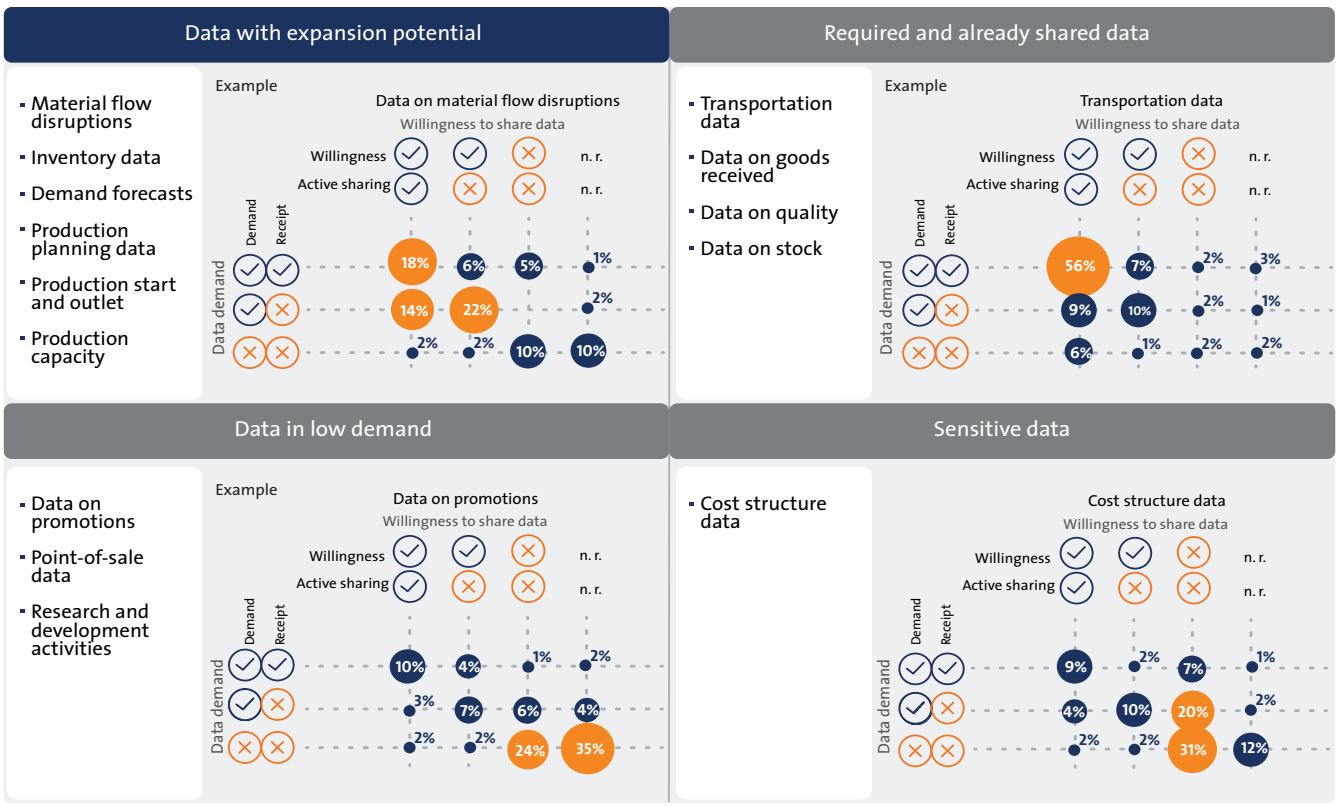
Inter-organizational data exchange still plays a decisive role in the analysis and design of supply chains. This is mainly due to persistent discussions on the bullwhip effect [17]. In the course of digitalization, more information is recorded and processed than before, so that information management, particularly across company borders, plays an even more important role. According to the experts, in the past, many companies were either not willing or not technically able to share data extensively. Digitalization has already brought increased data sharing within the supply chain and will do so even more in the future. In the long term, data sharing can be regarded as a necessary prerequisite to supply chain control. Companies unable or unwilling to provide necessary data in this context will find it difficult to be chosen as a business partner.

Shared data can be used throughout the supply chain to optimize product flow by means of intelligent forecasts and analyses. Based on the experts' answers, this study could identify four different groups of data. These groups are defined by (a) the companies' needs for data, and (b) the companies' willingness to share this data (see Figure 4-3).

Transport data, as well as data on delivered and received goods, is already comprehensively shared. However, companies recognize a growing need for exchanging a larger variety of data, such as inventory data, demand forecasts, or data on material flow disruptions. Such data sharing facilitates market analysis, computes requirements along the entire supply chain, and it also assists in calculating adequate measures in real time. This can lead, in all supply chain stages, to improved service levels and reduced risk of being out-of-stock that would be caused by a lack of transparency.

In view of the competition between value chains instead of companies [18], it seems surprising that according to this study, to this day 61% of the data requirements for addressing material flow disruptions are still unsatisfied. At the same time, 34% of the companies who do not share information yet, are prepared to do so in the future (see Figure 4-4). Despite a lively discussion about the question of data protection and data

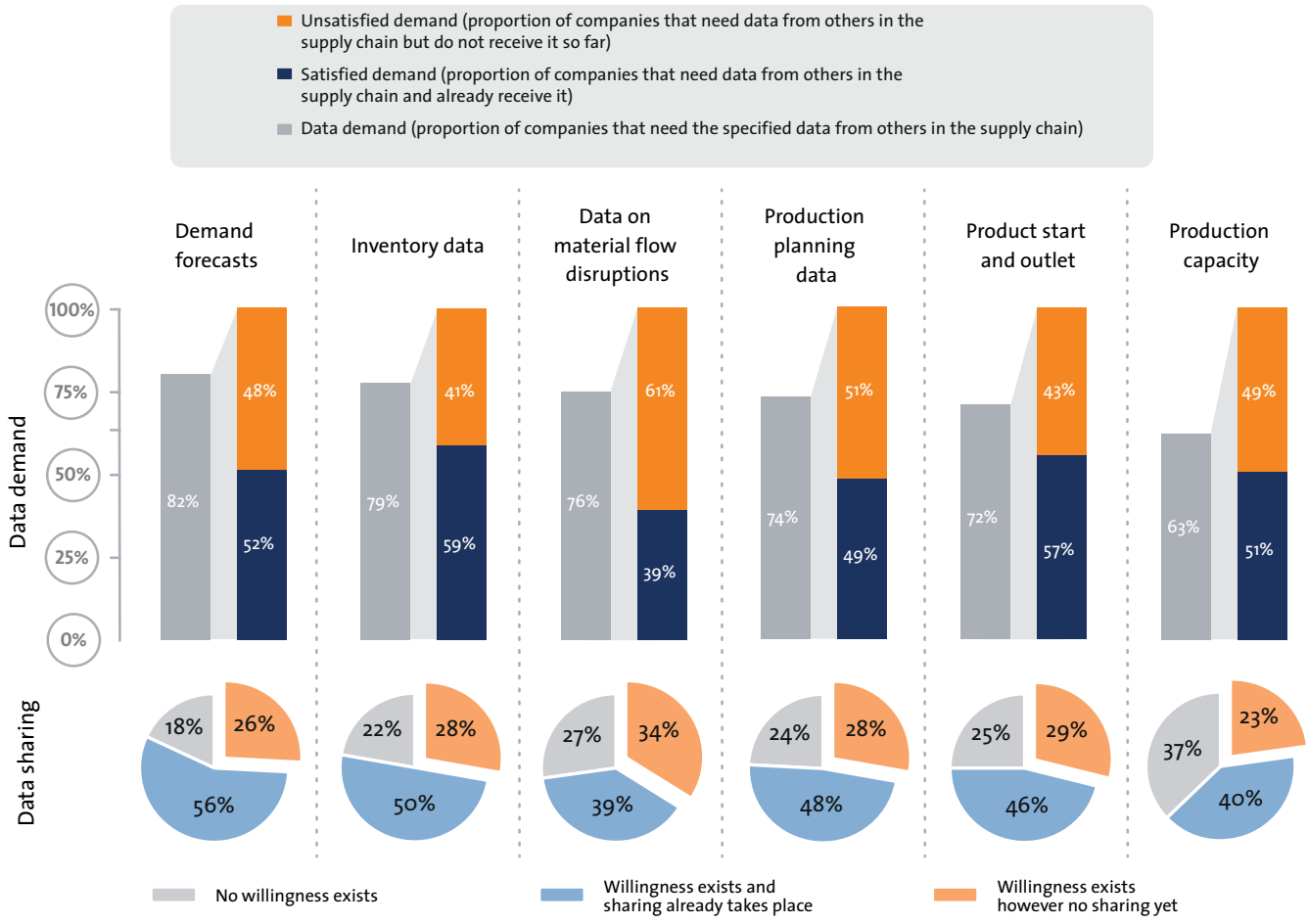
Figure 4-3: Identified data groups and their classification based on the data demand of the companies and their willingness to share



security, companies increasingly distance themselves from rigid security-minded thinking and can identify both the need for and the potential of information sharing along the supply chain. Beyond a willingness to share, the actual data exchange carries challenges of a completely different dimension. Companies often fail, because the required data is not available, interfaces are not defined, or the quality and integrity of the data are inadequate.

Despite these existing shortcomings, companies are already preparing themselves for an information-driven supply chain. Of the quantitative study participants, 79.6% regard a transparent supply chain as relevant or highly relevant (see Section "Exogenous trends"). The interconnectedness of products, machines, production plants, means of transport, and processes is accelerated in the smart supply chain context. Companies hope that this will create an opportunity for fast and dynamic responses to events, and the availability of intelligent design solutions. High-performance IT is generally perceived as a future competitive advantage. This is also urgently required, considering the challenges. IT will help to meet the challenge of increasing complexity caused by growing small-scale services, as well as of highly customized solutions and the associated coordination effort.

Figure 4-4: Data requirements and transfer of the data type „data with expansion potential"



Reorganization of supply chains

Triggered by new technologies and the market entry of companies from outside the industry, the actors, roles, processes, and products of organizations' supply chains undergo change (partially or fundamentally). Therefore, each individual company needs to reevaluate and orientate its role within the supply chain.

In the digital age, rapidity is more important than ever. Technical developments, product life cycles, and customer needs are changing; new competitors, but also potential suppliers and service providers, are starting to penetrate the market. As a result, it becomes necessary for companies to build an agile supply chain network that allows continuous monitoring of developments and enables fast adaptation in this volatile environment. According to the experts, everyone within the supply chain tried, on the basis of the existing lack of data transparency, to optimize themselves – the manufacturing sector, for example, from a production technical point of view, and retail on the basis of the sales data. In the new process, all actors become involved and there is a data-based optimization across the entire supply chain, both in the retail and manufacturing sectors, as well as among the logistics service providers. There is, however, disagreement on the future role of the logistics service provider. While some experts believe that logistics will increasingly take over value-added services in the manufacturing sector, others limit this to the work of smaller suppliers. In larger companies, the trend is towards insourcing.

In the past, and for better control in the manufacturing sector, the rising cost pressure and increasing complexity led, for example, to the outsourcing of individual component production and pre-assembly. Increasing digitalization now helps to reduce complexity and allows for better control of the processes. This has brought a turnaround in that these knowledge-intensive tasks are once again fully performed in-house. In addition, the interviewed experts reported that a concentration of Tier 1 suppliers on a controllable level will lead to better control and reduced administrative costs.

Tabelle 4-1: Average distribution of logistics costs divided according to components*

	Manufacturing industry (n=97)	Logistics services (n=97)	Retail (n=27)
Transportation costs	30.1% →	38.7% →	28.1% →
Inventory costs	20.4% ↓	11.7% ↓	20.5% ↓
Warehousing costs	19.5% ↓	19.1% ↓	22.0% ↗
Administrative / management costs	11.5% ↗	15.4% ↗	11.5% →
Packaging costs	9.4% →	4.6% →	6.2% ↘
Cost of value-added services	5.2% ↘	6.6% ↑	5.6% ↘
Cost of returns / Return shipping	3.9% →	3.9% →	6.1% ↑
Costs of logistics within company	100%	100%	100%

* The arrows indicate a tendency to how the cost of inventory parts are likely to change due to digital transformation.
Cost components likely to go down due to digital transformation
Cost components likely to go up due to digital transformation

The last few years have seen a significant increase in the relevance of sustainability trends (see Figure 2-1). This development has a significant impact on supply chain network structures. Product flow is more regional again, and factories are closer to the market. Procurement decisions often require a balance between the purchase price and the proximity to the fulfillment center, which can be decided by considering a company's various global and regional sourcing strategies, in view also of the associated risks.

Digitalization increases transparency of the existing offer on the market. Buyers are, therefore, more flexible in relation to the supplier, which assures the better availability of parts. During the last few years, a real platform economy has developed. Platforms are, in this context, understood as two-sided, digital marketplaces, on which suppliers and customers can exchange products, services, and technologies against payment. The platform operator collects fees from its users for the provision and organization of a marketplace. Classic examples of such platforms in logistics would be transport and freight markets.
The increasing digital penetration also means that shippers have more flexible access to logistics service providers. The available price transparency increases the cost pressure on each individual logistics service provider (see Section "Exogenous trends"). Many companies risk losing orders due to cheaper alternatives on the spot market – a risk that applies to both logistics service providers and suppliers. This phenomenon is compounded by the standardization of logistics and

increasingly shorter contract periods since customers are able to change service providers faster and more flexibly.

One effect is that the requirements and tenders of customers become more complex; in this context simple standard offers are no longer sufficient. Supplier-service provider relations are no longer restricted to single partners. Digitalization calls for changes, especially in the case of major strategic partnerships. This study shows that too few companies seriously grapple with the issue of how the cooperation and composition of actors in the supply chain will change through digitalization. The respondents are very uncertain about the role of shippers. Some see their role-based interchangeability as particularly under pressure and suspect a strong future consolidation in the shipper market. Others expect a massive expansion and digitalization of the shipper's and logistics service provider's tasks.

Measured in terms of logistics costs, the distribution, transport, inventory, and storage costs make up the largest share across all sectors (see Table 4-1). However, the surveyed companies expect the digital transformation to reduce these cost components. This can be explained by means of the options described earlier, for example, by predictive analysis. The companies recognize that service innovation will become very important. Long-term relationships can be established through differentiation which allows for tailor-made solutions for customers. Then, the scope and use of value-added services will increase and, consequently, also their relative share in the company costs. In comparing the sectors, it is especially noticeable that retail anticipates a lower cost reduction and higher cost increase potential than the manufacturing industry and the logistics service providers.

Vision and strategy

The fields of action defined in the previous section can be brought together to envisage future supply chains. To concretize such a vision, this study formulated strategic action options which companies can use to access the opportunities of digital transformation at the supply chain level.

There are clear differences between the sectors regarding current supply chain challenges. The focus of the manufacturing industries, e.g. mechanical engineering, is on delivery reliability, on-time delivery, and competitive costs against a background of globalization, individualization, and complexity. This requires the identification and consistent use of optimization potential, which previously were hardly economically accessible. Digitalization can contribute to this with a new level of transparency and networking in the supply chain, and also through the development of new service offers. The realization of omni-channel solutions against a background of increasingly far-reaching individualization, as well as a completely new dimension of reaction speed and delivery times, challenges the retail sector, which in turn has to design and orchestrate its global and local supply chains accordingly. Again, digitalization provides real-time visibility and networking, but also the possibility to access optimization potential using predictive analytics. As the central link in the value and supply chain, the logistics service providers must finally use digitalization to offer the transparency and agility that customers require. To use the possibilities of digitalization in addressing this value and supply chain challenge, the following three main strategy components were determined: customer centricity, real-time visibility, and agile supply chain management. These are outlined, with some essential elements, in the following section.

Customer centricity

The strategic focus should always be on the customer – this applies, in particular, to logistics and supply chain management [19]. The end customers drive and determine digitalization through their expectations, and so constitute the cornerstone of every supply chain.

Customer centricity is the core element of digital transformation and is, therefore, regarded as an essential part of the strategy. This approach aims to offer the customer a positive and personalized purchase experience – and not only with or after concluding the sale of a product or service. Much rather, it should accompany the customer on the entire journey, from the identification of needs, the provision of information, and the individual demand satisfaction, to the service in the utilization phase, and then digitally supporting this throughout.

Customer centricity remains in focus

Vision	Strategy components
 The customer can retrieve personalized, cost-effective products with short delivery times.	· Modularization of manufacturing and logistics systems · Manufacturing in batch size 1 · Pursuit of make on demand and late configuration concepts
 Customer demands and needs are anticipated before the intention to buy.	· The use of predictive analytics (see Section “Data analysis”) · The consistent use of customer profiles · Suggesting products and services to customers online even before they intended the purchase (customer profiles) · Forwarding needs along the supply chain to ensure availability · Commissioning before the customer order is triggered
 The customer is offered a clear added value.	· Data-based customization and expansion of the business model · Setting boundaries to the price discussion through differentiation on the basis of digitalization · Design thinking for products and processes in the supply chain · Becoming irreplaceable to the (end-) customer, so that the access is not lost (digital lock-in effect)
 Products and services are available at any place and at short notice.	· Use of an omni-channel concept, branches as a point of contact/interest (flexible opening times) · Expansion of flexible delivery models (time slot deliveries, city logistics concepts, etc.) · Use of fulfillment centers with Europe-wide delivery within a very short period of time
 The supply chain is designed to be customer oriented.	· Inventory reduction through drop shipments · Splitting into branch quantities (two-stage cross docking) · Advance order picking/pre-packing for the customer · Optimizing supply chain costs and services by digitizing the supply chain (lead time, delivery time, quality, and accuracy)

Real-time visibility and accessibility

A digital integrated data exchange will be essential for the future supply chain. This enables the ability to provide real-time information and on-demand control of the supply chain. This necessitates a strategy which not only covers data quality, aggregation, and standards but also data security.

Digital consistency refers to efficient and trusting cooperation, which is IT based and takes place without interruptions, with customers and suppliers. The data can be accessed along the supply chain at any time. The customer can, thus, access real-time information on the delivery status and receive real-time data from the suppliers on material flow problems.

Needs will be reported back, and customers, suppliers, and employees will have direct access to the information that has been evaluated and processed in accordance with the needs (see Section“Data analysis”). This allows production to be adjusted to the actual demand and, thus, increases the efficiency of the supply chain.

Real-time visibility and accessibility remain in focus

Vision	Strategy components
All suppliers are able to provide real-time information.	· Creating a mindset for the importance of data · Using internal representative pilot cases as starting point · Ensuring a data base – creating data structures and guaranteeing data quality · Simple and understandable presentation and evaluation of data
Visibility within the supply chain is ensured.	· Making status data available to customers and partners by using localization and sensor technologies (see Section “Data analysis”)
Information is extensively shared with suppliers, customers, and strategic partners.	· Clarifying the legal framework conditions · Regarding standards as compelling and necessary (agreement on data formats, use of the information) · Showing added value in all stages of the supply chain
Systems communicate with each other across companies and control themselves.	· Resolving media interruptions and IT system diversities · Implementing data standards consistently and across all companies · Expanding the broadband network · Correlating the production requirements and needs of all role players · Using intelligent components by, e.g. identification tags
Platforms are used as a hub.	· Quantified assessment of usefulness of foreign vs. self-built platforms · Simplifying the integration of customers and partners · Evaluating the security of cloud solutions to avoid data loss

Business practice example*
catkin at TX Logistics – Logistics platform increases efficiency

What was installed?

Cooperation partners can exchange specific order information automatically by using a web-based intercompany platform. All relevant companies, divisions and persons can be integrated in this digital communication process at any time. The catkin platform is a technology installed to facilitate direct order placement and tracking, e.g. in a combined transport system that picks up and delivers. catkin digitalized existing processes and implemented paper-free processing to achieve this.

How was the new technology implemented?

This technology allowed for establishing a real-time network of companies that shares order data. The platform supports the operational planning of mobile resources, as well as the transparency of each actual order's status using simple and secure instruments. Additionally, planners now receive all relevant information aided by masks and filter functions.

What does this technology enable?

By switching from paper-based to digital processes, TX Logistik records a 50% error rate reduction in this area, a 12% labor costs reduction, and a 25% lead time reduction. Since all parties involved in this process chain are informed, in real time, about the relevant data, travel times, and damages, they can coordinate appropriate actions like exception handling. New partners can be added easily to the collaborative system within minutes.

Company description

catkin GmbH develops and implements tailor-made communication solutions. The maxim here is to increase process efficiency and reduce costs by facilitating networking between clients and contractors. With catkin, an intercompany and system-dependent communication platform is made available to the transport process. The customer and service provider portal connects companies regarding orders, and supports mobile resource management of staff and of machinery.

* This pratice example was identified as presentable in line with this study for the topic "Changes in the supply chain" and presents a showcase.

Reference: [P2]

Agile supply networks

For companies to stay competitive, the age of digitalization requires quick solutions. The surveyed experts regard the ability to adapt to changing market conditions and performance speed as the two main competitive advantages in the next five years (see Figure 6-1). Agile action within a network can, therefore, be used as a core building block for a strategy. This adaptability refers to partners, services offered, as well as technological systems implemented.

Agile supply networks remain in focus

Vision	Strategy components
Permanent security of supply is guaranteed.	· Actively driving optimization across all companies · Reducing numbers of partners to a controllable level · Implementing supply chain risk management · Regionalizing the product flow
Uniform utilization of the logistics is ensured.	· Compensation for surges in demand using networking concepts · Using flexible cross-docking concepts (seasonal business)
Value chains can be flexibly configured.	· Favoring flexible and adaptable structures and systems · Dynamic reconfiguration of the supply chain · Identifying alternative partners on the spot market · Re-evaluating own value added share vs. those of the partner
Digital service concepts expand the product portfolio.	· Monitoring of start-up solutions · Networking and cooperation · Re-evaluating own business model and analysis of customer needs
Adjust business processes dynamically.	· Developing innovation workshops (Process Lab, Fab Lab, etc.) · Dynamic delivery routing · Using agile project management methods

Changed competence requirements

Current and future changes in the industry and working environment, together with changing consumer behavior, increasing complexity, and cost pressures on companies (see Section "Exogenous trends"), all have an effect on which skills are needed and how the workplace is designed in logistics and supply chain management. Digitalization requires employees and managers with new types of skills [20]. In particular, increasing automation, changing workplace equipment, and new tasks shape the skills profiles and the workplace in logistics [21]. Adapting to these changing skills requirements is a key element of successfully implementing digital transformation and utilizing the associated opportunities. The central questions addressed in this chapter are:

- Which skills do employees in the company already have?
- Which skills will these employees require (more of) in the future?
- What barriers are there to training and qualification?
- In general, which skills should companies have or acquire?
- How can companies acquire these skills?

Current fields of action

The companies that took part in the interviews are aware of the changes expected in the skills profiles of skilled workers and managers in the coming years. These changes will, above all, be necessary as a result of the digital transformation of companies, and are associated with the introduction of new technologies, as well as the use of big data sets (Big Data). Big data and new technologies should both be used to cope with challenges currently facing the industry.

The biggest challenges companies are facing at the moment are associated with changes on the customer side. For future planning, more than 70% of the logistics service providers see individualization of customer expectations as relevant or very relevant. One strategic option for satisfying customized demands that is frequently mentioned in the interviews, is postponement. Here, the customized differentiation of a standard product takes place at one of the later stages in the supply chain. Differentiating the standard variant of a manufactured product to fit customer requirements takes place to order, as does delivery of the products [22]. Planning for manufacturing, as well as storage of the standard variants, is based on sales forecasts. In order to improve forecast accuracy, both manufacturers and logistics service providers can introduce technologies for collecting and analyzing big data sets.

Simply having larger quantities of available data does not represent added value per se. Only by enabling the analysis of that data (e.g. by standardizing different data formats, using structured and unstructured data) can companies actually analyze it meaningfully, to identify patterns (e.g. in customer behavior for customized manufactured products) and then create added value in the form of economic profit (e.g. cost saving by storing the right number of standard variants needed to supply according to order).

To handle the wide range of data sources and formats and to identify patterns and correlations by using statistical methods, forecast models or algorithms, companies need new skills. This is because it is not yet possible to fully automate business analytics, as the algorithms currently available do not provide such capability. In many situations sage decisions still rely on intuition, personal judgment, or discretion. At the moment, the lack of qualified staff who can meet these requirements is one of the biggest challenges for companies and thus one of the Top 5 trends in external influences on digital transformation (see Figure 2-1).

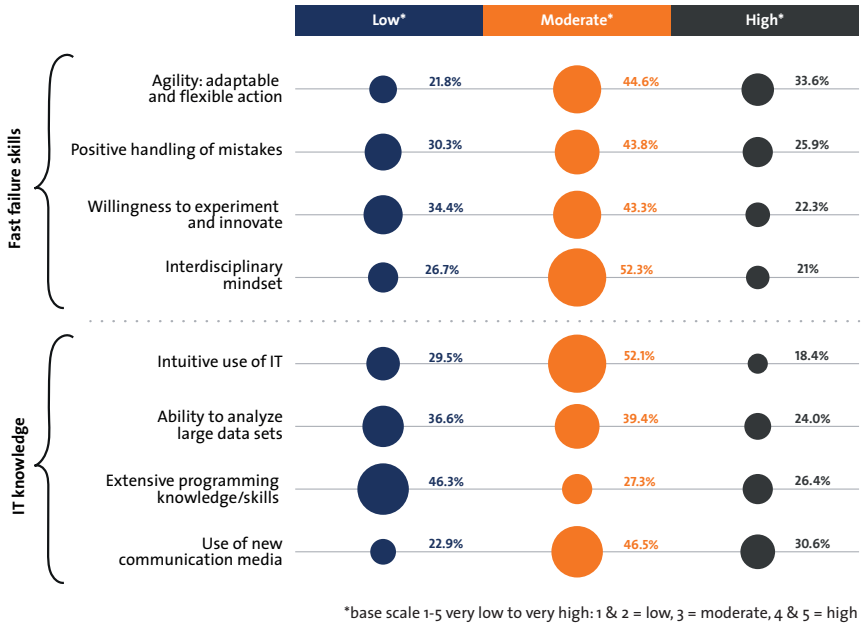
Existing skills and potential for enhancement

The first step in the study was based on interviews with representatives of the participating companies. From these, we preselected skills perceived to be important in the context of digital transformation. The questionnaire-based company survey was then used to elicit which of those preselected skills already exist in the companies. The skills can be categorized into two groups: fast failure skills and IT skills. Agility, positive handling of mistakes, willingness to experiment/innovate, and an interdisciplinary mindset are identified as fast failure skills, while intuitive use of IT, ability to analyze big data sets, to use new communication media, and to program at an advanced level are regarded as IT skills (see Figure 5-1). There are only minor differences between the two groups. We found that 46.3% of the companies stated that they have only a few staff members with extensive programming skills (see Figure 5-1). Merely 26.4% of the companies indicated that such programming skills were represented among their staff to a great extent. In contrast, companies indicated that they have a high representation of using new means of communication (30.6%) and agility (33.6%) among their staff.

Of those participating, 39-53% stated that using new communication media, an interdisciplinary mindset, the ability to analyze big data sets, intuitive use of IT, willingness to experiment/innovate, positive handling of mistakes, and agility were skills represented in their company to a moderate extent. All companies recognized the particular need to develop their ability to analyze data. From the interviews we could deduce that, so far, they have not actively tried to acquire or develop the skills relevant to digital transformation. This is mainly due to uncertainty concerning which skills to prioritize and then to develop their specific content.

Regarding extensive programming skills there are only minimal differences in the industry sector comparison. Of the logistics service providers, 43.1% stated that this skill was represented to a low extent only. For manufacturing and retail, this value was 46.5% and 54.9%, respectively. Greater differences were identified in using new communication media, with 37.3% of logistics service providers already having this represented to a great extent, but only 25.1% and 27.5%, respectively, of manufacturing and retail companies reported this (see Chapter "Appendix").

Figure 5-1: Skills in the companies



*base scale 1-5 very low to very high: 1 & 2 = low, 3 = moderate, 4 & 5 = high

Future developement of skills

Considering the skills that will be required in the future, it is clear that the majority of skilled workers and managers will need the full range (see Figure 5-2) – with the exception of extensive programming skills.

The greatest lack of clarity lies with determining which group of employees (skilled workers or managers) should be required to analyze big data sets. Of the companies surveyed, 37.5% believe skilled workers should have this skill in the future, 20.7% believe managers need it, and 38% think it is a skill both groups should possess. The interviews showed uncertainty regarding analyzing big data sets. In this case, companies are unsure about how best to distribute the responsibilities for data selection, data preparation, data analysis, and performance management among the skilled workers and managers in different sections. This is due to new questions arising, such as "Which data is relevant to quality in the companies and how can we identify it?"

Figure 5-2: Skills required in the future for skilled workers and managers

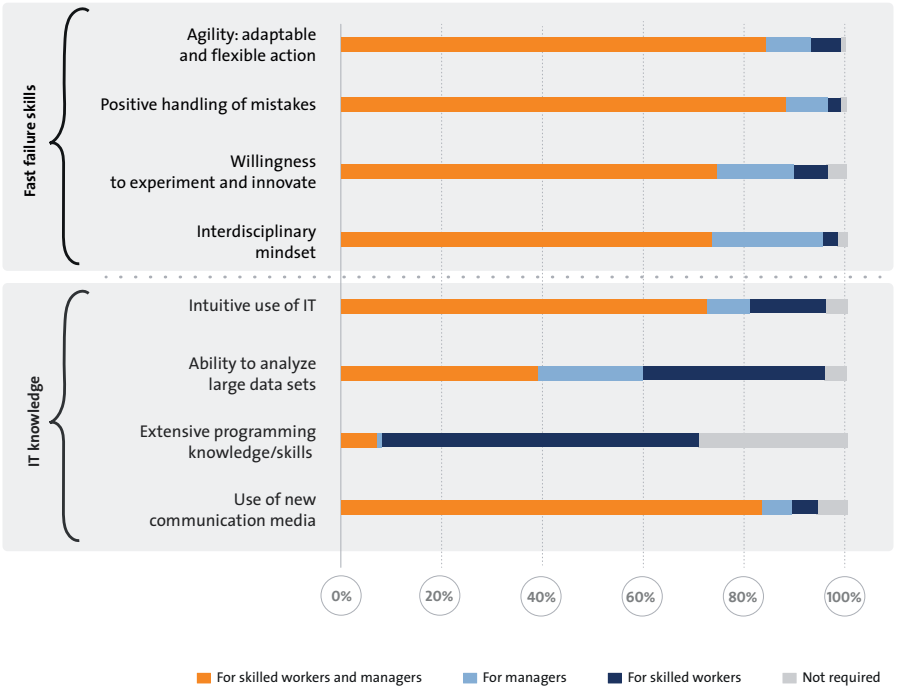
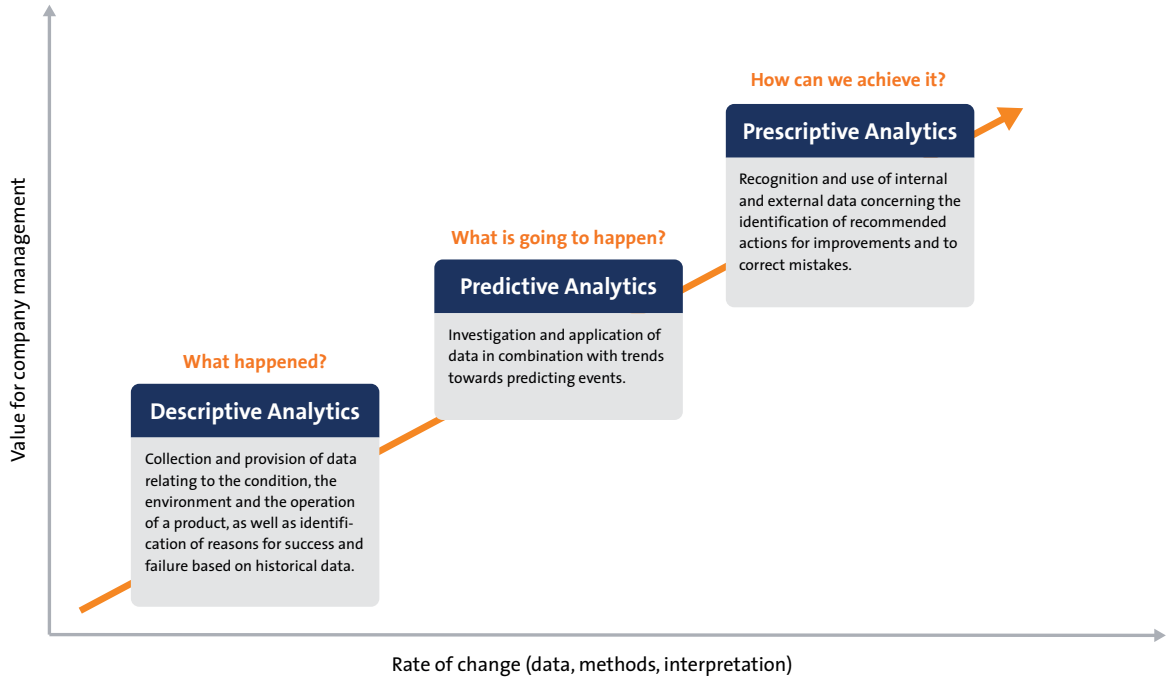


Figure 5-3: Development of data analysis



Ability to analyze big data sets

In this development the focus is no longer on descriptive analytics (e.g. association analyses, cluster analyses, etc.). Instead, predictive analytics (e.g. classification, regression, time series analyses, etc.) is becoming more important. Predictive analytics is used for pattern recognition and evaluating scenarios, which helps in recognizing developments before they become manifest in the KPIs that have been used to date. What is even more valuable for corporate performance management is prescriptive analytics. The simulation and optimization models used in prescriptive analytics serve to recognize correlations that indicate, e.g., what the decisive cost drivers are for production and logistics. This is used as the basis, for example, for enabling productivity increases or for generating new impulses from data for product developments [23].

Of the companies in the survey, 62.5% named programming skills as an important qualification for skilled workers in the future. Regarding programming skills, 29.8% of the companies said those would not be needed in their companies in the next five years. The interviews with the participants showed that the companies are also considering the possibility of sourcing programming services from external service providers.

When comparing the two categories of fast failure skills and IT skills, one recognizes certain tendencies. In the future, the fast failure skills will mostly be needed either simultaneously by both skilled workers and managers, or only by managers. This is because many companies have a top-down mentality which results in skills related to performance management or motivation being required among managers. Thus, for those skills identified as fast failure skills, the values for skilled workers only were between a mere 2.2% and 6.3%, while their values as necessary among both skilled workers and managers ranged between 73% and 86%.

Based on the interviews, companies still have no concrete idea about who would need to have IT skills in the future, although different to the fast failure skills, expectations are that these skills will be required mostly from skilled workers only. Regarding IT skills, the companies said they were necessary for skilled workers as follows: 62.5% found workers should have extensive programming skills, 37.5% voted for them having the ability to analyze big data sets, 16% would require intuitive use of IT, and 4.7% would expect abilities to use new communication media.

The values for the necessity of both skilled workers and managers to have IT skills are slightly lower than those for the fast failure skills (programming skills 6.9%, ability to analyze big data sets 38%, intuitive use of IT 75.2%, and using new communication media 82.9%). For skills such as analyzing big data sets, the companies lack clarity on whether their internal focus should be on performance management or on implementation. As a result, the decision about allocation of competences is also still unclear.

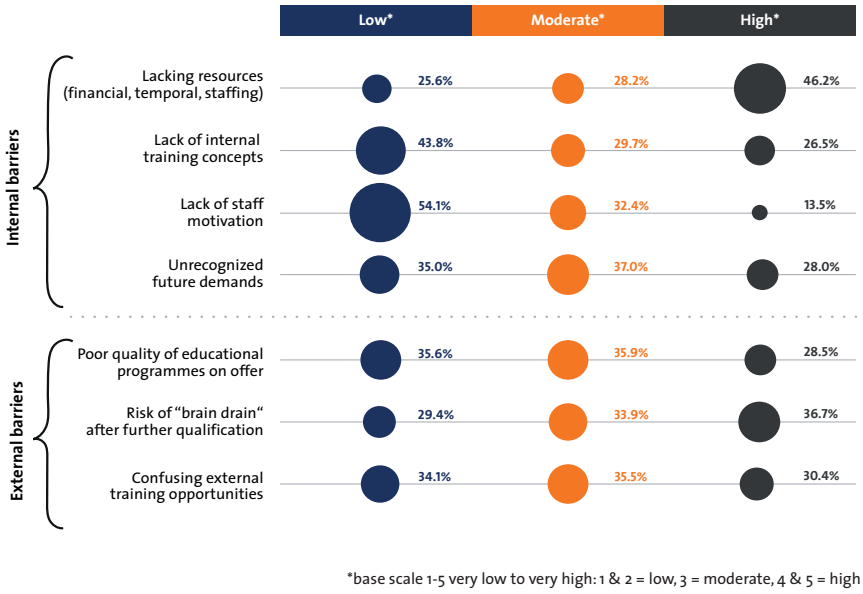
Managers must be able to master fundamental skills such as the intuitive use of IT and communication media, while actual implementation of programming belongs to the remit of skilled workers.

Overall, according to the focus group participants, there is a development towards skilled workers increasingly being confronted with strategic issues in the future, forcing them to assume more responsibility and to act more flexibly. On the one hand, this is because they have to make decisions themselves (development towards decentralizing decision-making) and on the other hand because they have to advise their managers on strategic decisions.

Finally, skilled workers will increasingly have to deal with technology concepts (e.g. web-based platforms). At the same time, numerous operative processes are being automated.

To illustrate, in the context of contact management skilled workers (e.g. buyers) were in charge of maintaining contacts and ensuring trouble-free delivery processes. If buying processes are now executed via a platform, the responsibility for a trouble-free process lies with the platform supplier. Thus, the work of the buyer is first to prepare the decision of whether the company uses a platform and which platform should be integrated. Then, the buyer must check regularly to ensure the integration of the respective platforms meets current internal requirements.

Figure 5-4: Challenges of further qualification



*base scale 1-5 very low to very high: 1 & 2 = low, 3 = moderate, 4 & 5 = high

Challenges of further qualification

There are currently still numerous challenges facing the integration of new skills into a company. On the one hand, there are internal company barriers such as lacking resources, training concepts, information regarding future needs, or simply the employees being unwilling to undertake further training. On the other hand, there are external barriers which include the risk of brain drain after successful training, low-quality programmers, or confusing external training programs. There are minor differences between the two groups.

Roughly half of the companies surveyed (approx. 46.2%) said the lack of resources was a big or very big challenge for internal training (see Figure 5-4), making it the biggest barrier to further qualification. At the same time, 36.7% (big or very big) of the participants said they were worried that on successful completion of the training program, employees would leave the company. The surveyed companies saw a lack of employee motivation to train as the least of their problems. Only 13.5% regarded this barrier as big or very big, while over 54% counted it as low or very low.

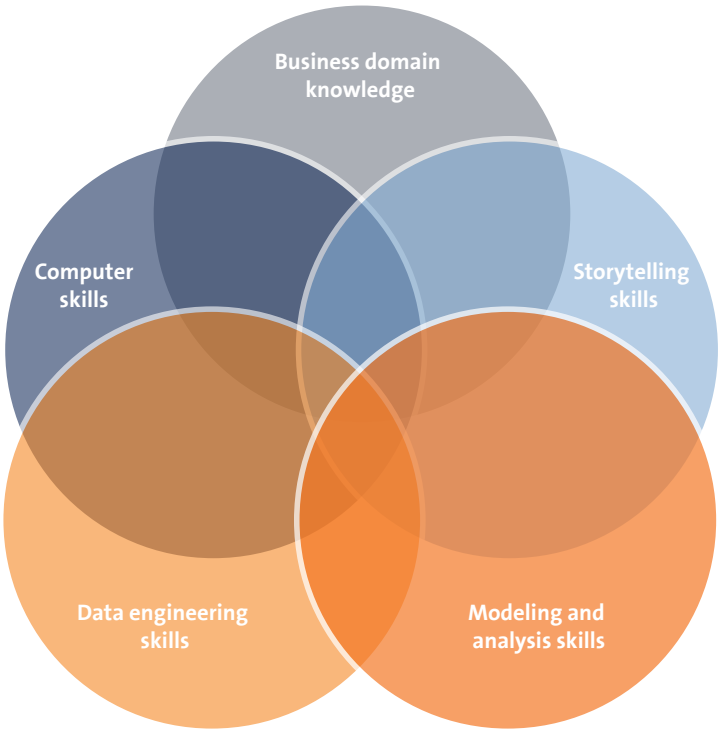
Vision and strategy

Looking ahead, companies developing skills are likely to face challenges which include changes to their existing profiles. As described in Section "Autonomous systems", in the long run, logistics service providers expect driverless trucks to be introduced; this would mean the use of vehicles no longer depends on the availability of employees. Correspondingly, the tasks and required skillset of truck drivers will change.

Individual operative activities are developing into collaborative processes with shared responsibility. As a result, in the medium term, the activities of for example truck drivers will become more complex. Their tasks will develop from those of a simple "performer" of operative transportation to a "transport manager" who is involved in the planning of routes, in order processing, and in taking software-based optimization decisions relating to such tasks. For the long term, this profile will continue to change until employees will no longer carry out the operative execution. They will be taking decisions concerning the optimization of transportation based on technologies.

The first step is to identify which skills will be needed in the future and where to start developing such skills within the company (i.e. which employees or functions). Even the question of where to start, is difficult. For the most part, we have to decide on a case-by-case basis whether to expand and develop skills internally or whether to acquire skills by hiring new staff. One reason for this is that new job profiles are not merely results of shuffling and combining existing profiles (e.g. supply chain manager and mathematician); that, in fact, would diminish existing interface know-how within the company.

Figure 5-5: Data scientist skills [26]



Data scientist skills

One possible orientation concerning the major skill requirements of the future (especially considering the increasing use of big data sets) would be for companies to take a look at the skillset of a data scientist (see Figure 5-5). The task of the data scientist is the structured identification and analysis of data. Data analysis focuses on gaining insight into commercial and business management issues, aiming to deriving impacts on the company and ultimately finding solutions [24]. To some extent the different skills areas of the data scientist overlap (see Figure 5-5). In general, companies see a great need for extending skills concerning data analysis and consolidation (for more on data mining activities, see [25]).

Business domain knowledge is seen as specialist know-how concerning those business areas for which the data is collected and analyzed. This includes thorough knowledge of the industry or specialization area, several years of work experience, detailed or specialized knowledge of the business and a solid understanding of correlations within the respective functions of logistics, supply chain management, marketing & CRM, engineering, and performance management [27].

Storytelling consists of several skills [28]: Presentation and communication are important skills for preparing and communicating results to decision-makers. Data visualization comprises skills for the graphic presentation of abstract data and correlations.

Business intelligence reporting comprises a set of skills necessary for executing the process from the point of receiving data through to providing information for end-user reports or other software products. The software is used to support implementation. The following specifications can be used to outline modeling and analysis skills [29]. Analytical modeling design describes the ability to model existing data for specific analytical purposes. Here, data scientists have different tools they can use. On the one hand, they can use multivariate statistics, where we differentiate between analytical methods which test structures and those which discover structures. The focus here is on methods which analyze a number of statistical variables. On the other hand, they can use data mining and machine learning. Data mining refers to the ability to apply statistical methods to big data sets in order to discover new patterns, correlations or trends. Machine learning refers to the ability to develop or use algorithms which enable the "artificial" generation of knowledge during a learning phase through the recognition and learning of patterns. Further tools are text mining, which is the ability to apply methods for analyzing text-based data, and computer linguistics, which deals with machine-based processing of natural language. Next, data scientists can use econometrics and time series modeling. Here they apply methods which combine economic theory, empirical data and statistical methods. This includes, for example, time series modeling (auto-regression), regressions, or Monte Carlo simulations for the empirical testing of economic models. Finally, data scientists can use simulation and system dynamics. These describe the holistic analysis and simulation of complex and dynamic systems to investigate decisions and their ramifications.

Data engineering skills consist of the following individual aspects [30]: Data quality management, which is the ability to carry out measures to ensure data quality meets DIN EN ISO 9001 and other requirements; data integration, which describes the ability to integrate different datasets (e.g. from different divisions) with different data structures into one uniform data structure. In data warehousing, optimized central databases are set up and utilized for different analytical purposes. Additionally, data engineering skills include aspects such as IT infrastructure, IT architecture, database modeling and programming.

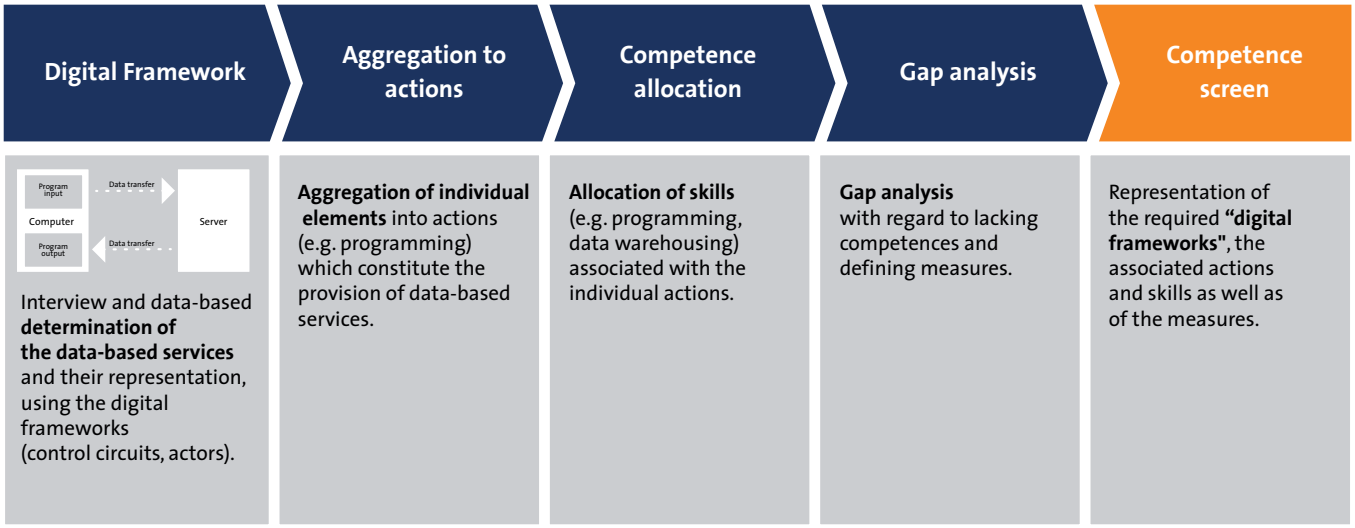
The necessary informatics skills can be broken down into [31] Software service engineering, Cloud and Web applications and the design and provision of distributed systems. Software service engineering describes the ability to design and develop software based on other solutions. Cloud and Web applications involve the design and use of those applications that facilitate the provision of software across different platforms. In the context of distributed systems the design and provision for implementing data science lies at the heart of developing distributed systems. In the context of informatics skills further important aspects are the security of distributed systems, databases and web technologies.

Digital competence screening

As has been indicated, one possibility for answering the earlier question of which skills will be required in the future is to consider the skills of a data scientist. The issue of how to integrate those competences into the company remains, and leads to further questions: How should we describe the digitalized procedures (in the context of creating a digital service), how do we identify the specific skills we need, and then allocate those skills to different specialist functions and areas of responsibility?

Competence screening is one possible approach to integrating these skills [32]. To satisfy the requirements for digitalization, skills integration can be expanded into digital competence screening. A first step would entail mapping the data-based activities of the company. This is done in a digital framework which shows control loops, players and data transfers, with individual elements being aggregated into actions. Then, competences (e.g. programming) are allocated to the individual actions before a gap analysis can be used to identify the remaining required skills. Finally, it must be decided where and how to integrate these competences into the company.

Figure 5-6: Actions in digital competence screening [33]



Step 1: Digital framework

The digital framework (see Figure 5-7) provides a structured approach to mapping and showing all the control loops which have to be carried out by hardware and software in order to offer the data-based service.

The data-based services a company offers can be seen as automated systems. The "machinery" is a combination of hardware and software which automatically carries out defined control loops [34]. The underlying control loops here are data input, the subsequent processing, and data output. Data transfers in the form of uploads and downloads take place between the control loops [35]. Different players can be involved in data input and output. Thus, employees or customers can carry out data input and receive the output. Additionally, it is possible for specially designed programs to carry out these tasks automatically as software agents.

Step 2: Aggregation of actions

Once the digital framework of the data-based service has been set up, the next step is to aggregate the different elements into the actions which constitute the provision of that service (see Figure 5-8). This is done by analyzing the individual elements to answer the question "What action is required for each element?" Additionally, the actions have to be arranged chronologically by evaluating which action must be carried out first and which will follow.

In this example, the following actions can be identified:

1 Provide software or app

2 Provide application server and program application software

Figure 5-7: Exemplary model of a digital framework

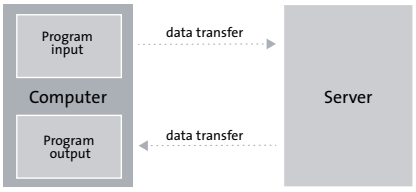


Figure 5-8: Exemplary aggregation of actions

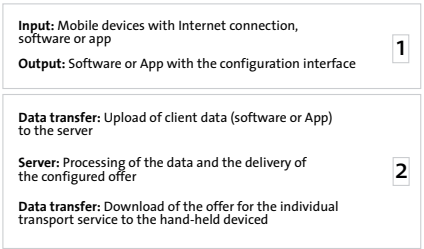


Figure 5-9: Overview of measures to integrate necessary skills

Competence screen

Representation of the required "digital framework", the associated actions and skills as well as of the measures.

Step 3: Competence allocation

In order to assign competences to individual actions it is necessary to refer to the previously described data scientist skills, as these should be integrated into the company. The requisite skills for software service engineering to implement the action "provide software or app", while the actions "provide application software" and "program application software" are IT infrastructure skills and those pertaining to databases and web technologies. Based on the allocation of the necessary competences, the final step is to carry out a gap analysis.

Step 4: Gap analysis

The first step in gap analysis is to document all the identified competences and then to analyze their status. This provides information about whether the skillset already exists in the company or whether it is a target competence. Then, the company needs to decide which specific measures should be taken to further develop existing skillsets and integrate new ones [36].

Step 5: Development of measures

There are different possibilities for integrating the necessary skills in a short-term, resource-friendly way, for example by purchasing cloud solutions such as "software as a service," internal measures like pilot projects for digitalization, or cooperation with external partners (see Figure 5-9).

Purchasing competences – Cloud solutions

When buying in skills, we have the possibility of using cloud solutions that are known as "as-a-service" concepts. These concepts are often based on pay-per-use models, and SMEs, in particular, can use these concepts to gain access to IT structures or IT services which they would otherwise have to integrate into their companies at great expense. Such pay-per-use models save SMEs from having to invest in hard- and software. Also, such models have lower operating and maintenance costs as software updates or repairs are usually included in the package [37].

Alongside these services to resolve IT issues, there is another possible "as-a-service" concept which focuses on providing the skills of a data scientist: Data science as a service. Here, specific services are carried out by companies that specialize in data science. Such service providers, when commissioned, importantly have to guarantee a transparent approach. These companies have specialized employees and can be commissioned especially to carry out modeling and analytical activities (e.g. data mining, machine learning, econometrics, or system dynamics). Completely automated services cannot be used yet for modeling and analysing.

Internal measures

Alongside paying external providers for their skills, another possibility especially suitable for SMEs is to look at the strengths and preferences of their own employees. Often, the skills they need already exist in the company, waiting to be discovered as employees with the required abilities are deployed in another field. During the focus group part of this study, the participants indicated that companies need to alter their mindset in order to focus more heavily on the strengths of their employees. Those strengths should be identified and fostered independent of the activities or functions employees already perform, but this is only possible if the company also focuses on employee work preferences. Companies can carry out tests to identify their employees' work preferences. Such tests should be designed and carried out in collaboration with the HR development department. There is also the possibility of cooperating with initiatives like the Initiative New Quality of Work (INQA) which have already developed such tools.

Pilot digitalization projects are another way of developing skills. Here, processes or interfaces in a specific, pre-defined work area (e.g. logistics in plant A) are digitalized and new technologies (e.g. smart glasses, RFID, or similar) are used for a specific period. Target values have to be defined in advance to measure the success of the pilot project. It is important to ensure that the chosen target values are both valid and useful in measuring success over the limited time frame of the project. Within these fixed times, the employees must come to terms with the new technologies, their implementation, and the new tasks and problems associated with them. This provides the employees with the direct possibility of establishing whether their individual strengths and preferences fit the new activities. In addition, during the pilot project they learn new things which can be further developed or passed on internally after the project ends.

A further way of disseminating and expanding skills in the company could be to put together teams spanning generations. Different generations often deal with new technologies in remarkably different ways, especially when it comes to digitalization in the company. Young employees or "digital natives" work intuitively with new technologies and can adapt quickly to changes. In multi-generation teams younger and older employees can complement one another. Older employees receive support from the younger ones how to use the new technologies, while younger employees, for example, learn how to question the validity of data consistently and are then able to profit from the professional expertise and experience of the older generation.

Yet another means of promoting skills development is to foster the concept of "intrapreneurship". This happens, e.g., by temporarily releasing people from daily operations, and so encourages employees to develop and implement their own ideas, which in turn enables them to acquire new knowledge and learn new skills. However, it must be remembered that this approach does not allow for direct management of skills development.

Finally, the implementation of learning factories is also a possibility for internal development of new skills and competences. Here, both trainees and longer-serving employees develop specific application-based skills; content and know-how are implemented directly in the form of case-based real-life scenarios in an environment which mirrors reality. Accordingly, it is also possible to test new technologies and train people how to use them. Content is not limited to product-specific subjects (e.g. the application of a new technology in manufacturing and assembly), but can also include logistics topics (designing material and information flows).

Similar to learning factories, it is also possible to set up so-called LearnLabs. The internal driving force in companies here is HR development, but there are also possibilities for cooperation, e.g. with trade and commerce chambers. The aim of LearnLabs is to teach both specialist know-how and social skills. Training takes the form of different modules which use a step-by-step, topic-based approach (e.g. the production workers' ability to recognize errors).

Cooperation

Beyond internal skills development, companies have the possibility of cooperating with external partners. The focus groups also identified possibilities for cooperation with colleges and universities, and specifically, two fundamental options: First, the company can support research towards a degree. By suggesting themes and supervising content, companies can guide students towards resolving individual issues and thereby develop new solutions. Additionally, talented students who get to know the company working towards their degree can be recruited directly. This could enable companies to fill open positions with candidates whose profiles fit previously unavailable skill sets.

Second, joint projects can be initiated and executed. SMEs receive support to solve problems for which they lack the required resources. They are involved in developing the results and are able to develop skills and acquire knowledge. Before starting up such cooperation it is important to check existing connections to universities and research facilities, and to find out whether these institutions have already done work in areas relevant to the specific problem (e.g. business analytics). Additionally, there are already (part-time) courses with relevant digitalization content. Where collaboration with universities or colleges and in relevant study programs already exist, it is possible to establish early contact with students who achieve appropriate (data scientist) qualifications. This, in turn, can facilitate subsequent recruiting.

Finally, companies could also become involved in research projects resulting from diverse funding initiatives (e.g. from the Federal Ministry for Economic Affairs and Energy). Cooperation with other project partners generally provides a good platform for exchanging ideas and experiences. Such exchange and the associated discussion of problems can create impulses for future problem-solving and enable companies to acquire new knowledge.

New and adjusted business models

Developments in the corporate world and changing production conditions are increasingly creating opportunities for adapted and new business models. The use of new technologies, e.g. sensors, provides greater possibilities for collecting production, product, and application data [38]. Additionally, trends (see Chapter "Trends and opportunities in logistics and supply chain management") such as individualization, business analytics, the digitalization of business processes, or cost pressures are changing the relevance of a range of competitive advantages (see Section "Competitive advantages"). This leads to the core challenge of adapting existing business models and developing new ones [39].

Current fields of action

There are many different uses of the term business model in business practice. The focus group discussions disclosed that there is no precise and uniform understanding among companies about what a business model actually is and how it should be described.
For the purposes of this study, the Business Model Canvas [40] gives a suitable description of the contents of a business model. It outlines the main questions that must be answered to define a business model:

- What is the value proposition of the services which are performed (or products manufactured) for the customer?
- Who is the intended user of the specific service, what type of customer relationship exists, and which channels are used to reach the customer?
- How is value created for the customer and which key activities, resources, and partnerships are necessary?
- What are the sources of income and the underlying cost structures?

According to Wirtz [41], a **"[...] business model [...] is a heavily simplified and aggregated illustration of the relevant activities of an enterprise. It explains how the components of value creation in an enterprise are used to create marketable information, products and/or services. Alongside the architecture of value creation, both strategic and customer and market components are considered in order to achieve the paramount objective of creating or securing the competitive advantage of the enterprise."**

The core questions for this chapter are:

- Which competitive advantages will be relevant in the future?
- What is the current state of digitalization in business models?
- Why should companies digitalize and adapt their business models?
- What are the starting points for digitalizing business models?

Competitive advantages

Asked about factors which will still be major competitive advantages in five years' time, the survey participants most frequently named those factors which are already important today. For example, they mentioned flexibility regarding customer demands, quality of services/products, adaptability to changing market conditions, prompt service fulfillment, as well as value for money for products and services.

Flexibility regarding customer demands is seen as the most important factor. Nearly 44.4% of the logistics service providers in the survey regard the competitive advantage of flexibility as relevant for the future (see Figure 6-1). The quality (32.2%) and cost-effectiveness (29.4%) of products/services are both seen as very important for logistics service providers in the future. Of the manufacturing companies, 45.9% feel flexibility is important, while 39.2% of the retail companies feel the same. Generally, there are only slight differences between the industry sectors. In relative terms, the aspect of data (end-to-end data transparency and ownership of end-customer data) is the most important to retail companies, while manufacturers rank the ability to innovate as the most important.

However, companies should not only consider future competitive advantages during the process of digital transformation. They also have to think about who they aim to gain as users of their services, and which players within the supply chain are driving digitalization in companies. The major drivers of digitalization which inspire companies to digitalize their processes are end-users and retail (see Section "Digital transformation opportunities").

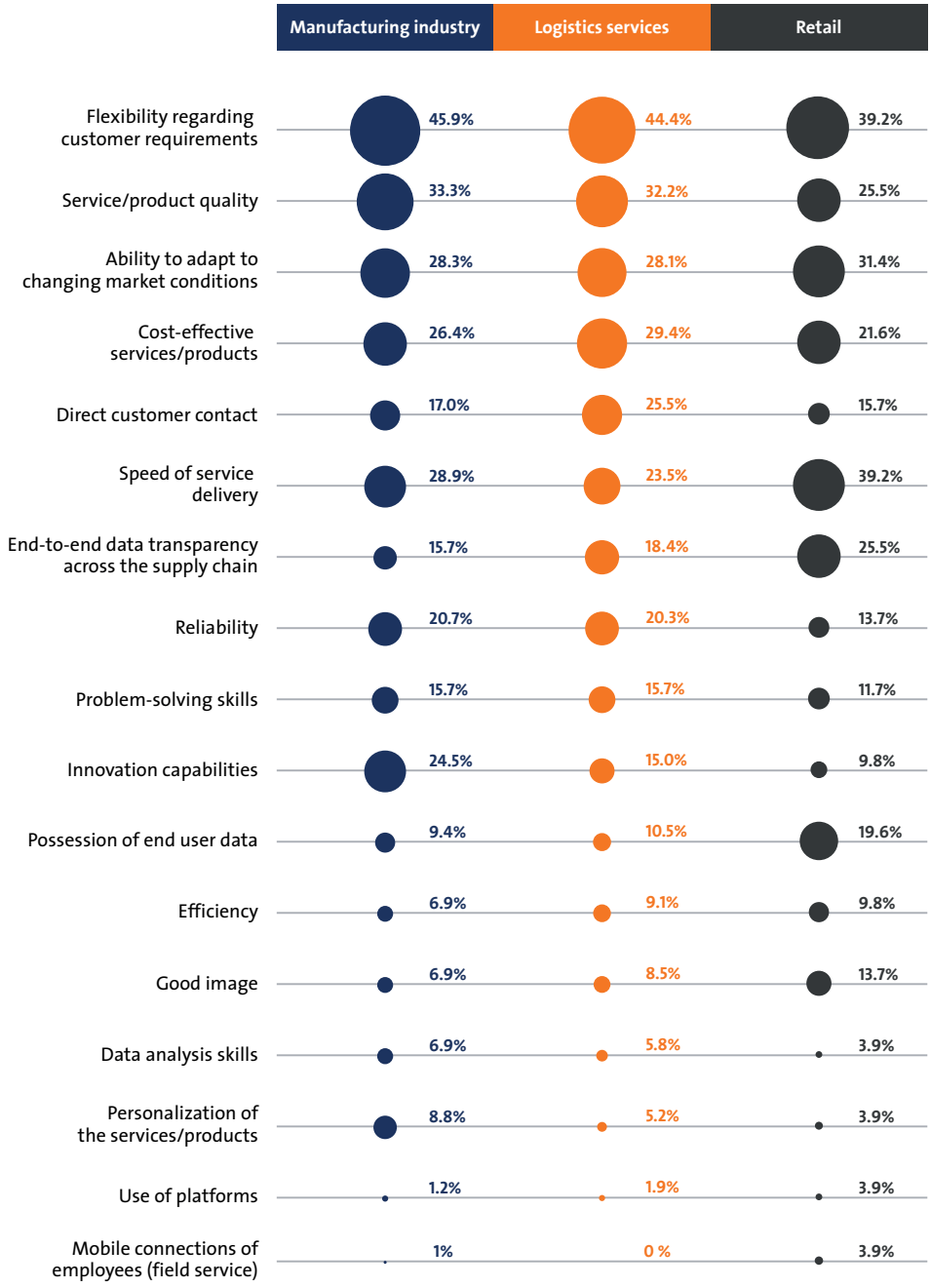
In the manufacturing industry 66% of the companies regard the end-user as a relevant driver of change. For logistics service providers, besides the end-user, retail is a very important driver, with 44% of logistics service providers regarding it as relevant. In the manufacturing sector, end-product manufacturers are significantly more often seen as relevant drivers than in the logistics or retail sections. However, it is important to differentiate here as different factors underlie the drivers that trigger digitalization in companies. The focus group discussions highlighted different reasons for the (end-) customer drives towards digitalization in companies.

Increasing transparency concerning the products and services companies offer, or also in general across the entire supply chain, is prompting dynamic customer requirements. The customer demands comfortable, simple, and transparent provision of service, for example via an omni-channel solution, or customized, individual products and services via a product configurator.

Transparency also enables customers to compare products and services, which leads to greater pressure on the provider (e.g. concerning price or delivery time). To satisfy these customer demands, companies have to create, among other things, mobile solutions for omni-channel communication with customers and for the creation of individual

products and services. Additionally, the digital transformation of business processes can lead to increases in the tempo at which products are manufactured and services are performed. The focus group discussions highlighted the growing importance of time and technological possibilities as factors in considering the future (end-) user's demands.

Figure 6-1: Relevant competitive advantages* for the next five years according to sector



* Participants were asked to name the top 3 competitive advantages relevant in the future.

Digital transformation of business models

One of the main reasons why companies are hesitant to digitalize their business models is that they cannot visualize how they should describe and shape their own digitalized business model.

To date, 46.8% of all companies have not planned to transform their business model. Even so, 35% have already undertaken a minor or partial transformation of their existing business model into a digital one. Only 2.5% have already carried out a broad transformation (see Figure 6-2). Currently, the companies surveyed prefer to expand their business models by including digital services.

For logistics companies, the picture looks similar, with 43.8% not having planned to digitalize their business models, while 3.3% have already carried out a broad digital transformation. The industry sectors however, differs considerably concerning the partial digitalization of business models. In comparison, 45.1% of retail companies have already digitalized smaller or larger parts of their business models, while the corresponding value for logistics companies is 37.2%, and for companies from the manufacturing industry it is only 29.6% (see Figure 6-3).

Figure 6-2: Digitalizing business models

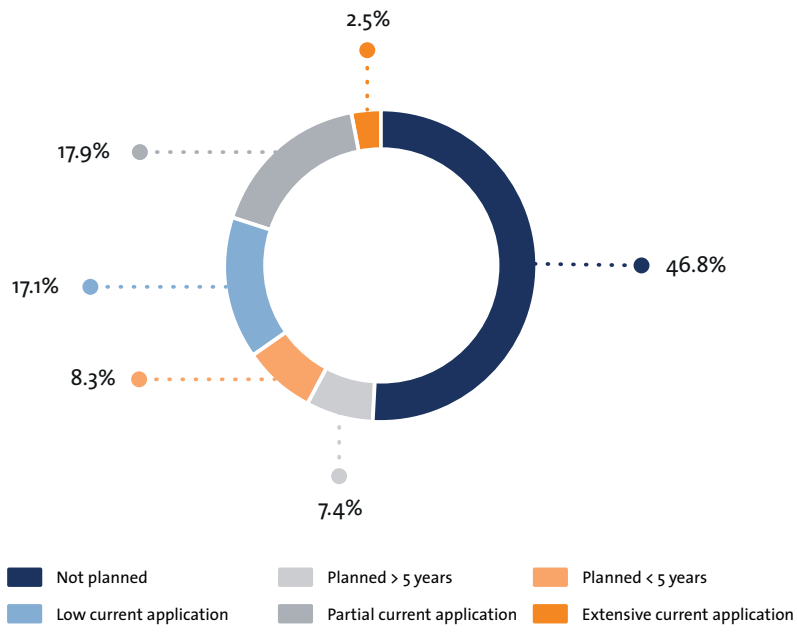
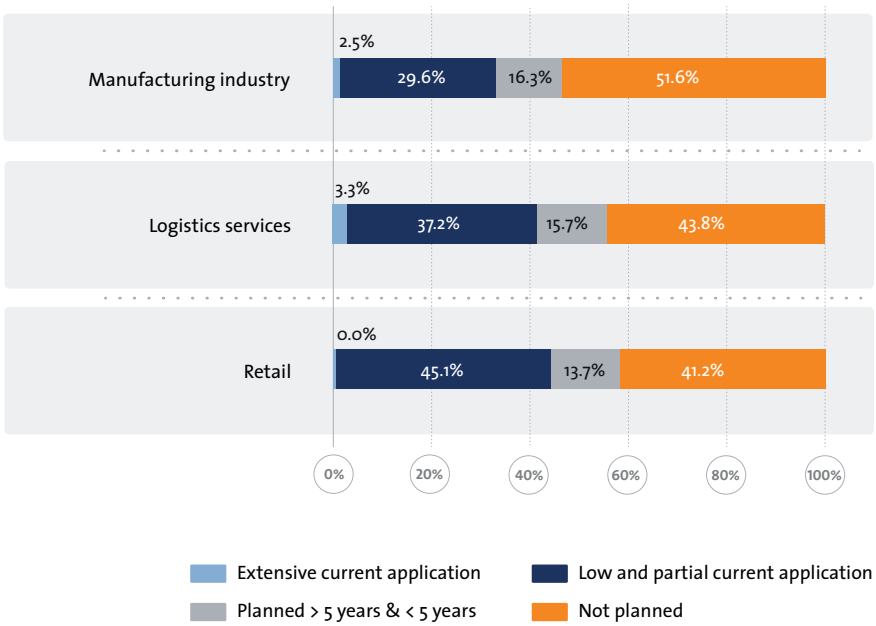


Figure 6-3: Digitalizing business models according to sectors



Vision and strategy

Focus group participants expect that, in future, competition will become increasingly important – in all sectors, but especially in logistics. For this reason, companies across all sectors will be obliged to increase their flexibility concerning customer wishes, to reduce their costs, or to improve the quality of their services, in order to remain competitive. The companies see possibilities for optimizing flexibility, costs, and quality in the digitalization of their business models so as to use new technology concepts (see Section "Innovative technology concepts") or big data sets (see Section "Real-time visibility and accessibility"). Examples here are the use of different technology concepts (e.g. software) to optimize information flows at interfaces, or the use of assistance systems (e.g. smart glasses) to optimize processes.

Although, in general, companies are still hesitant about digitalizing their business models to create competitive advantages, many new business models are appearing – mainly in the business-to-consumer (B2C) field. Here, the main focus is on attempts to increase service levels for the customer and to collect and use data that will enable greater individualization of products and services.

Data availability as a point of departure

As more and more information becomes available, data becomes one of the key resources of the future. If data is available, it can be used to create competitive advantages. Companies with large volumes of data have an information edge over their competition, as such data can be used to generate different types of valuable information.

Information about the behavior of customers and competitors can be generated from data from external sources (e.g. social media data, point-of-sale data), together with information about customer needs, or market demand. Internal data (e.g. data from ERP systems or from sensors on the company's production machinery) can be used to find information on the behavior of employees or on the performance of in-house processes.

However, companies still lack the knowledge of how they can use data to generate this information and how they can adapt the business model accordingly.

For companies, the problem associated with this issue is exacerbated by the pressure to find the fastest possible adaptations to the business model in order to avoid any competitive disadvantages. Any transparency created by providing data within the supply chain, provides other players both inside and outside of the supply chain with the opportunity to use that data. Three fundamental scenarios are:

- A player within the supply chain, or a competitor, analyzes the data of your company's customers. Then the findings generated from the data are sold to your company. This brings about high costs and possibly a competitive disadvantage.
- A player within the supply chain, or a competitor, analyzes the data of your company's customers and sells the findings generated from the analysis to a competitor who will, thus, gain a competitive advantage from the information.
- Your company can suffer a loss of value added share due to players who position themselves between your company and the customer.

Possible changes for logistics service provider

Necessary specialization of the logistics service provider

The tasks carried out by logistics service providers are being taken over by large international logistics companies. Smaller transport firms and freight companies will have to concentrate more on specific niches within the market where it is possible to offer specific services and related services (e.g. route optimization) [42].

Logistics service providers are at risk of losing direct contact with the customer

Platforms can change the traditional logistics business significantly: They can be seen as marketplaces which provide infrastructure and rules for both suppliers and buyers. Online platforms can form the basis for carrying out simple shipments more efficiently by bringing customers and logistics service providers together in a network and optimizing transport capacities [43]. The inherent risk is that logistics service providers lose direct contact with their customers and are left with only carrying out the operative execution of the actual shipment.
We see new market players emerging in the business-to-business (B2B) segment. They focus on brokering freight prices and the organization of transport chains via their own platforms. In doing so, they position themselves between the logistics service provider and their customers. They allow the customer (B2B and B2C) to manage the transport routes directly on the basis of direct contact with the new market player [44], thus there is no longer any contact with the logistics service provider who now carries out only the actual transportation service.

Challenge: Fragmentation of shipment

The customers of logistics service providers demand the fastest possible availability of individualized products. This can lead to the fragmentation of shipments and increased transport volume of the last mile as the quantities per order become smaller, but the order frequency increases. This results in lower values per order on the one hand and higher processing costs on the other. Thus, it becomes necessary to take measures to increase efficiency [45].
In the generation of real-time data, logistics companies do have an opportunity, also concerning the purchasing and consumption behavior of customers, to use such data as the basis for increasing efficiency within the supply chain. Specifically, central materials planning and transport scheduling from supplier to end-user can profit in this way. This also requires increased networking of companies and the provision of interfaces to the IT systems of other companies. Here, ideally one would need a data standard, as sometimes the number of interfaces can be very high.

Business model innovations

In companies, individual measures in the form of digitalization projects are often driven by an area-specific function which could mean that possible synergies are not utilized. For example, interactive assistance systems might be introduced without the collected data being further processed for other uses. Such individual measures need to be integrated into a framework. A digitalization strategy can constitute such a framework. Thus, rather than independently digitalizing individual aspects of the company, it is recommended that a digitalization strategy is developed first.

Here it would be helpful to set up a dedicated team for digitalization of with membership of (at least) one corporate management representative, selected other management representatives from different management levels associated with different functions, as well as employee representatives and thought leaders from different departments and professions.

The first step in developing a digitalization strategy should be to analyze the current state of the company's business model and that of the competition (e.g. Uber). Additionally, further instruments for internal or environmental analysis can be used (e.g. SWOT or PESTEL). Then, strategic digitalization options should be developed and assessed [46].

In order to carry out digital adaptations to business models, companies can take data availability as a starting point. All the elements of the business model (generation of income, cost structures, products/services provided, customer relationships and channels, key resources/core activities) [47] should be checked to establish their potential for digitalization.

Only a combination of the elements of a business model can really create added value for the customer, and thus also competitive advantages for the company. There are three main approaches to the data-based adaptation of the business model which are based on the questions raised at the beginning of this chapter (see Section "Current fields of action"), namely:

- Analytics-driven business model innovation
- Customer-driven business model innovation
- Payment-driven business model innovation

The following section presents the three approaches to business model innovation, including a more detailed explanation of the associated templates for business models in each approach.

Analytics-driven business model innovations

The first possible type of business model innovation is driven by analytics. Findings generated from data and then used to find different answers to the questions posed in Section "Current fields of action" provide the starting point for adapting the business model. A schematic overview of the business analytics process [48] is given in Figure 6-4.

The objectives of the sub-process "Framing" are to define the business problem clearly and then to derive the associated analytics problems.

In order to understand business analytics, it is important to know the difference between a business problem and an analytics problem: As the term implies, the former represents a real problem within a company, while the latter, the analytics problem, already contains an idea for a solution to the business problem; the analytics problem is one that will use analytics algorithms as a possible means of solving the business problem. It is derived from the business problem, but it does not address the same issue, as the following example shows:

There are many different reasons why management will focus on a specific business problem. For example, management's own first-hand analyses or customer feedback could alert them to particular issues. The first, rudimentary version of the problem requires further elaboration; this is described as operationalization (allocation of quantitative measuring instruments). These measured values must satisfy three quality criteria: validity, being completely up-to-date and economic efficiency. Failure to satisfy these criteria leads to specific errors in the business analytics process.

To derive the analytics problem in a given context it is necessary to have an underlying possible solution for the issue to hand. Three modes of business analytics have become established in published literature on business analytics and data mining: Descriptive analytics, predictive analytics, and prescriptive analytics (see Section "Future development of skills"). Depending on the mode, the analytics problem is formulated differently, as the following indicates.

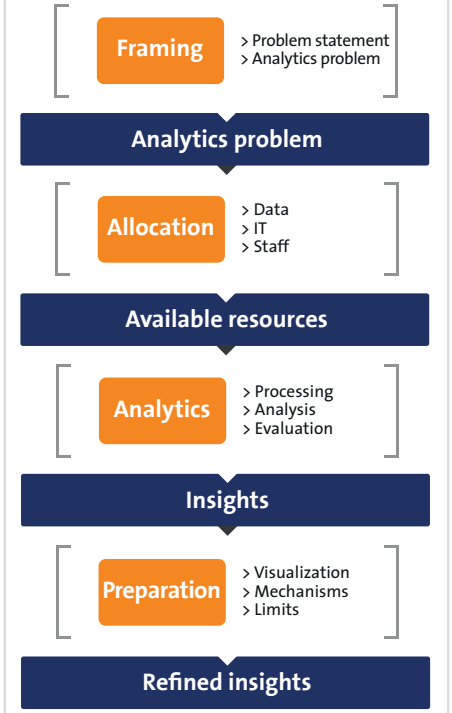
Descriptive analytics addresses exploration problems of which the underlying potential solution is to identify patterns, clusters for example.

In contrast, predictive analytics addresses forecasting problems. It focuses on problems of which the underlying potential solution is the construction of models for predicting an unknown attribute [49]. Examples of this are:

- Predicting when the machines being sold will break down
- Predicting how often a specific customer will require services from their service contract in the coming year.

Finally, prescriptive analytics addresses optimization problems. Here, the focus is on problems whose underlying potential solution is the construction of optimization models. The objective of the sub-process "Allocation" is to provide the resources necessary for solving the analytics problem. The resources relevant to business analytics can be broken down into three groups: data, IT and personnel.

Figure 6-4: Business analytics process



Data has to be provided in a specific quantity and a specific quality. The quantity and quality requirements must be derived from the analytics algorithms intended for use. However, under certain circumstances these might not be fully determined at the point in time when the business analytics process begins. As a result, the sub-processes allocation and analytics are generally iterative for two reasons. First, although the requirements concerning data quantity and quality might be satisfied, it is possible the analytics sub-process will yield no results if, for example, it was not possible to develop a predictive model based on the available data. Second, it will be necessary to run the subprocess allocation a second time if the

data analysis shows the need for stricter requirements concerning data quantity and quality.

Let us look at data. Structured data is particularly suited to business analytics. Data does not always come in a structured form; it can be semi-structured (e.g. in websites), or unstructured (e.g. in simple text) [50]. These forms must first be converted to structured data. While it is comparatively simple to define data quantity using the two dimensions of attributes and instances, the demands on data quality are more complex. In literature there are a number of approaches which differ based on the number and the content of the quality dimensions. Examples of quality dimensions include completeness, correctness, reliability, and consistency.

Regarding IT as a resource, we distinguish between the two classical categories of hardware and software. However, this differentiation is becoming increasingly irrelevant due to the significant increase in business analytics cloud solutions that provide a combination of both of these resources.
Personnel is the embodiment of the human skills required for business analytics. Regarding personnel, or human resources, there are three primary tasks: Determination of the qualitative needs, determination of the quantitative needs, and their organization in terms of location.
The objective of the sub-process "Analytics" is to acquire insights based on data in order to be able to solve a pre-determined analytics problem. This sub-process is broken down into data preparation, data analysis and evaluation of the results.
Data preparation comprises all the activities which transform the data into a state in which it satisfies the requirements for the intended analytics algorithm.

Data analysis consists of those activities in which the insights needed to solve the problem is extracted from the data available. Generally, these are the activities most closely associated with the term "business analytics" although they actually constitute only one of several steps. At the heart of data analysis lie the algorithms.
The final step of the sub-process analytics is an evaluation of the results, during which the quality of the output of the application of the analytics algorithms is tested. An example of this is checking the predictive value (quality) of a decision tree using ROC curves.

The objective of the sub-process "Preparation" is to prepare the insights compiled using the analytics algorithms so that they can be used in the best possible way. Preparation is made up of three aspects: Visualization, clarification of the mechanisms, and determination of the application limits. Visualization aims to show the insights in a form which the recipient of the results can understand and hence use. In essence, it is about creating graphic or numeric representations of the results. Besides visualization, in order to best use the results of the applied algorithms, the user needs to understand the mechanisms which underpin them. Thus, a correlation can only be interpreted causally if the mechanism for that causality is known.
As a rule, it is not possible to assume the acquired insights can be generalized in terms of absolute area, time or content. As a result, the optimal use of the results requires a detailed understanding of their limitations. If the limits are not known, there is a risk of negative effects outweighing the positive ones. Thus, the final step of the sub-process preparation is to identify the limits which derive from, among other things, the available data and the analytics algorithms used.

Model example: Analytics for optimization

Analytics for logistics optimization can be used to develop a business model template: This template enables data (e.g. transport or traffic data) to be used in a logistics service provider's business analytics process, for example, to optimize route planning or improve workforce planning at a customer's warehouse. In essence, the data is used to enhance the provision of a transportation service by means of a data-based service. What has been changed in the process, is the business model elements of the value proposition, the relationship with the customer, and the core activities.

Customer-driven business model innovation

The second type of business model innovation is one driven by customers. In contrast to analytics-driven business model innovation, customer needs shape these models. They are intended to provide new answers to questions posed in Section „Current fields of actions", and to adapt the business model accordingly. The business analytics process can then be used to satisfy specific customer needs. The following exemplifies one kind of customer-driven business model innovations.

Model example: Object self-service

The object self-service model describes the possibility of physical objects triggering autonomous orders. For example, machinery can be automated to order replacement materials (e.g. filters). Then, in logistics it would be possible for a company to install a weight measuring technology in their customers' storage facilities which would prompt automatic ordering of new parts for restocking when the weight of any given set of parts falls below a specific level. This changes the value proposition and, thus, also the relationship to the customer. The customer no longer needs to be concerned about checking stock levels and ordering stock. Besides the core service (delivery of goods), this creates additional value for the customer, which in turn could increase customer loyalty and make them reluctant to change to another service provider.

Business practice example*
Bossard Deutschland GmbH

BOSSARD
Proven Productivity

What was installed?

Many manufacturing companies continue to waste large amounts of time ordering B- and C-parts on their own, stocking up the warehouse, and organizing the procurement processes of the different suppliers. It is only possible to reduce total costs and increase productivity in these areas if the production facility is lean and, above all, smart.

How was the new technology implemented?

Bossard's smart factory approach consists of comprehensively assessing the entire logistics management system of a company, from delivery, through consolidation of suppliers, to operations and systems maintenance. This makes labor-intensive steps redundant, allowing employees to carry out more productive tasks. If a product already comes with information which can be machine-read, its path through the production facility, as well as the necessary individual production steps, can also be optimized and better managed.

What does this technology enable?

Smart factories have technically highly developed systems which interact between the production and supply chains. For example, in the production hall, bins with specially developed weight sensors continuously check current stock levels. The supplier receives this data in an intelligent form, enabling them to replenish stocks automatically when necessary; depending on the level of service, the parts are forwarded to the warehouse or directly to the point of use. If "smart labels" are attached to conventional bins, the display on the electronic label shows an image of the product and product information together with the item number. This ensures process transparency and trust across the whole supply chain. The savings this generates, raise competitiveness and flexibility, and increases the company's ability to plan in the framework of Big Data analyses.

Company description

The Bossard Group is a family-run business, now in the hands of the seventh generation. It has a history of 185 years of experience in industrial fastening and assembly technology. With a comprehensive product portfolio of over one million articles, technical consulting in application engineering, and smart factory logistics, Bossard has positioned itself as a full-service industrial provider and partner. As the leading global provider of intelligent product solutions and services, its customers include local and multinational industrial companies whom they have helped to become more productive through their products and services. With more than 2,000 employees at over 70 locations around the world, the Group generated revenues of CHF 695 million in 2016. Bossard is listed on the SIX Swiss stock exchange.

* This pratice example was identified as presentable in line with this study for the topic "New and adjusted business models" and presents a showcase.

Reference: [P3]

Business practice example*
Albert Craiss GmbH & Co. KG International Haulage Firm

What was installed?

This company's digitalization project aims to design and implement a highly automated end-to-end digital SCM process linked to a dynamic pricing module in the field of transport management.

How was the new technology implemented?

Their approach is to develop and build a network of all relevant IT systems integrated into one process.
This enables:

- Order transmission by the customer via EDI or web order management
- Automated transmission to an e-bidding tool for verified suppliers
- Awarding an order to the optimum partner, and automated processing of relevant vehicle data by the service provider
- Intelligent transport management and monitoring via an end-to-end telematics app with an automated notification function for customers
- A document management system that ensures 24/7 online access to transport and billing documents for all involved parties.

What does this technology enable?

This digital SCM process has been in operation with a number of CRAISS customers since Q4 2016.
The effects have been maximum process transparency for the customer with the shortest possible order processing time and optimum production costs.

Company description

The Craiss Group is a family business which focuses on the European logistics market with a broad spectrum of services in the fields of transport and logistics. Their growth is based on 85 years of experience in customized solutions for industry. With nearly 500 employees at 13 locations in Germany and Eastern Europe, they are one of Germany's leading medium-sized logistics companies.

* This pratice example was identified as presentable in line with this study for the topic "New and adjusted business models" and presents a showcase.

Reference: [P4]

Payment-driven business model innovations

The third type of business model innovation refers to those models driven by payments. The data itself is the starting point; such data serves as the means of payment. The business model is adapted accordingly.

The way in which income is generated (e.g. data as a payment), determines this type of business model. As the data itself is the means of payment, it constitutes the added value without requiring further analysis. This principle often applies in the B2C field. There, the data which Internet users disclose (e.g. from their use of social media) is used (also commercially) in particular to place individualized advertisements.

One possible example of this in the logistics B2B field, would be a shipper sending its own data (e.g. loading frequencies, loading times) to the logistics service provider, who can then use this data to optimize its own order planning, thereby improving its ability to predict and satisfy demand. In return, the shipper receives a price reduction. Primarily, this changes the way in which income is generated, but it also affects the customer relationship, core activities and key resources.

Strategy map

In many respects, the impact of digitalization on logistics and supply chain management is still difficult to visualize. Therefore, the consequences for a company are hardly conceivable, particularly as the process of digital transformation has made limited progress so far. In such a confusing context, this study has been able to find reference points for strategic business direction.

Following the objectives of this study, we derived strategy components for the four thematic blocks, innovative technology concepts, changes in the value creation chain, new competence requirements, as well as new and adapted business models, and assigned them to strategic focal points. These are described in detail in the following section and aggregated in a strategy map.

Strategic focus: Company transformation

Digital transformation requires a consistent and actively designed alteration of the business. The objective should, therefore, be to anchor the digital transformation as an integral part of the overall strategy (see Figure 7-1). This transformation of business models can be expanded across all sectors (see Figure 6-3). Keeping a clear focus on an integrated digitalization strategy can prevent inefficient moves due to selective individual initiatives (see Section "Business model innovations"). A company-specific technology calendar or schedule [51] helps to (a) capture and monitor current and future developments in a structured manner (see Chapter "Innovative technology concepts"), and to (b) systematically initiate the introduction of relevant technology concepts. In reflecting on future business models and technology concepts, it is necessary to consider these across all supply chain stages. The (end) customers and their future needs should be a central element of this consideration (see Figure 2-5, Figure 4-1 and Figure 6-1). In order to internally promote digital transformation, new competences have to be developed and existing skills have to be disclosed. A structured identification of skill requirements (e.g. digital competence screening) for the planned and actual state is essential (see Section "Digital competence screening").

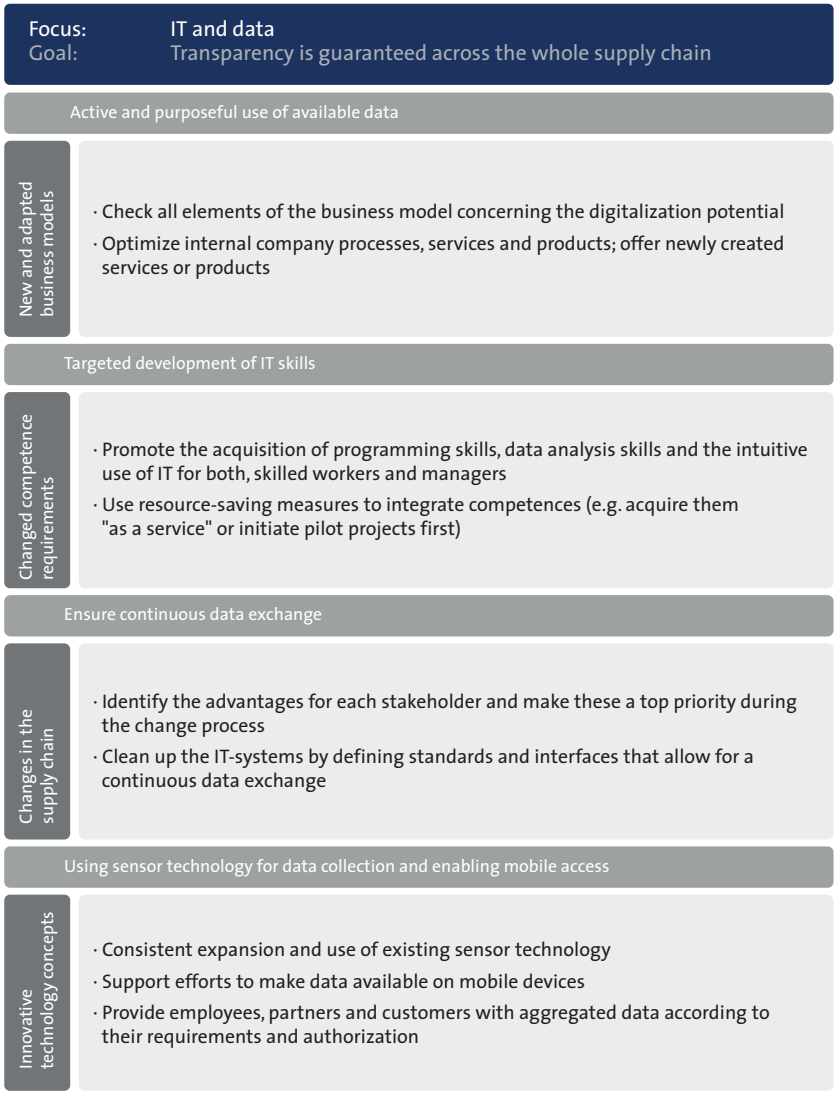
Figure 7-1: Strategic components regarding company transformation

Strategic focus: IT and data

The digitalization of business processes and transparency in the supply chain are regarded as some of the most important trends in logistics and supply chain management (see Figure 2-1). IT and data topics play a central role in digital transformation and should be anchored strategically. The objective is to create a suitable level of transparency along the supply chain (see Figure 7-2). Omnipresent sensor technology and mobile data access options are identified as the future key technology concepts (see Figure 3-1). Sensor technology is an essential basis for data collection. Employees, partners, and customers can receive aggregated data that suit their requirements, as well as getting authorization via mobile devices (see Section "Real-time visibility and accessibility"). Here, it is important to identify the concrete benefits of these technologies for all parties and to consistently keep this in focus during the process of change. All actors within the supply chain are required to "clean up" their IT systems and to enable consistent data exchange via jointly defined standards and interfaces.

Data availability can be used as a starting point for the adaptation of business models. All business model elements (see Chapter "New and adjusted business models") should be examined to determine their digitalization potential. There are two basic ways for a data-based adjustment of a business model: One can optimize internal company processes or improve the performance/product, on the one hand, or offer new services/products, on the other hand. As a result, value can be added for the customer. It is clear, however, that logistics and supply chain management experts and executives need to catch up regarding the necessary IT skills, such as programming knowledge, data analysis skills, and the intuitive handling with IT (see Figure 5-1 and Figure 5-2). In order to benefit from digital transformation opportunities, these shortcomings should be overcome by means of appropriate strategy and congruent measures (see Figure 5-9). To achieve this, a range of resource-conserving measures for integrating competences are available across the corporate sector (e.g. acquisition of skills in the form of "as a service" concepts, or launching pilot projects for digitalization).

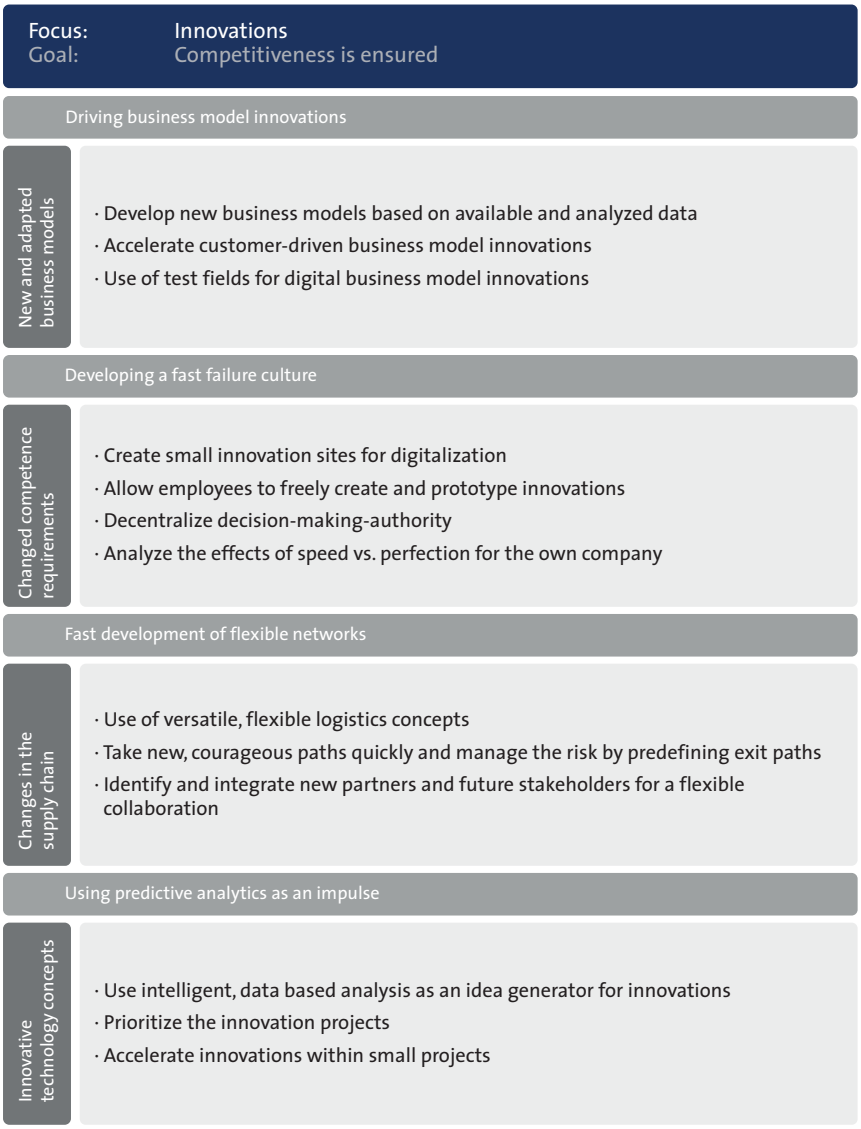
Figure 7-2: Strategic components regarding IT and data



Strategic focus: Innovations

The cost pressure, individualization, and complexity trends continue to shape logistics and supply chain management (see Figure 2-1). There is considerable competition, therefore it is essential to strategically prioritize innovation to differentiate oneself within the market and, thus, secure own competitiveness (see Figure 7-3). Predictive analytics should be used to stimulate innovation. Not only does it allow for optimizing product flow and improving the availability of goods across all value creation stages, but it also provides the basis for new business models. These are necessary innovations during digital transformation in logistics and supply chain management. Versatile and flexible logistics concepts are advantageous in this highly competitive environment. This applies to the technical, as well as the organizational structures of the cooperation.
In future, they have to be adjusted even more for faster adaptability (see Section "Agile supply networks"). To position oneself in a fast-changing environment, a fast failure culture is advantageous in one's own company (see Figure 5-2). This opens the possibility to take courageous new directions rapidly, and still manage the risk through existing predefined paths.

Figure 7-3: Strategic components regarding innovations

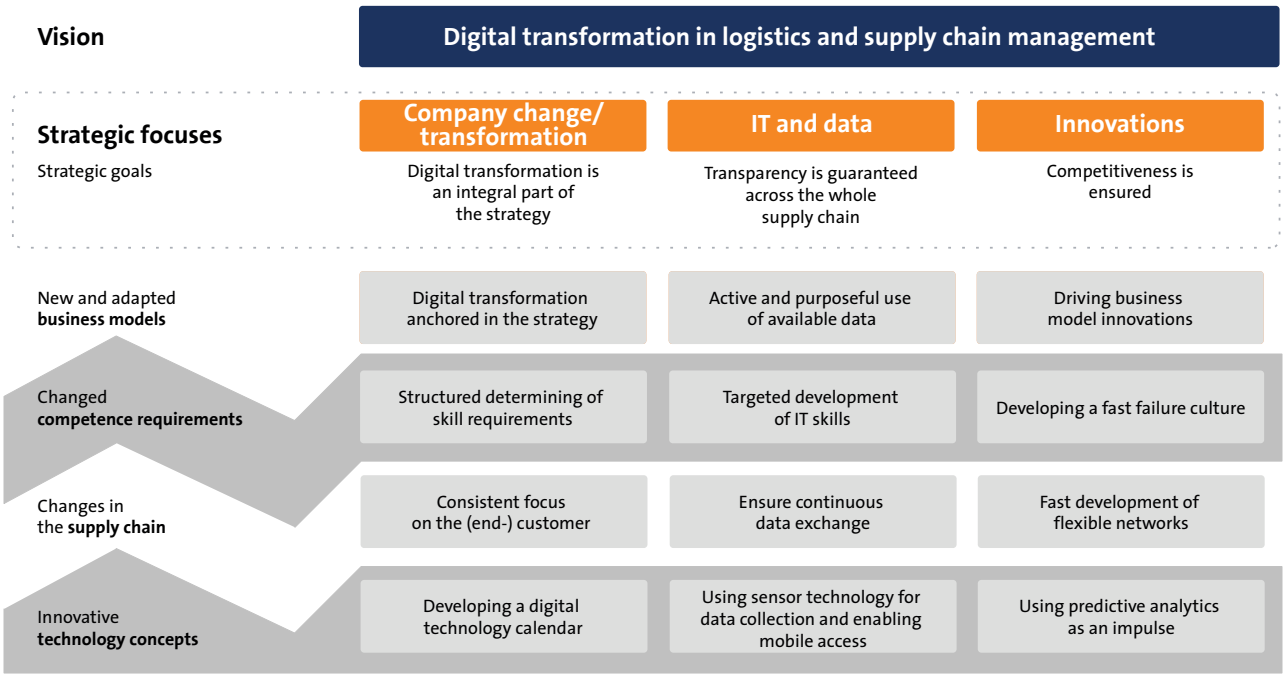


Strategy map for digital transformation of logistics and supply chains

A consolidated overview of the strategic components merged in a strategic map is shown in Figure 7-4. This overview provides a link between strategy formulation and its operationalization [52]. The map, therefore, is intended to help organizations to move towards the vision of digital transformation in logistics and supply chain management.

Within the strategic focal points, the implementation can be both top-down and bottom-up.

Figure 7-4: Strategy map for digital transformation of logistics and supply chain management



Conclusion: The way to digitally transformed logistics and supply chains

Our analyses have shown that understanding digital transformation and companies' current efforts to pursue it, vary greatly. Digitalization efforts are often pursued in small individual projects, with varying intention and intensity, but a basic digitalization strategy is often still missing. To profit from the opportunities of digital transformation, it is essential to first create a private, internal, agreed understanding, and to make the topic a strategic anchor, thereby laying the foundation for the necessary business change (see Figure 7-4). A first contextual analysis helps to anticipate new technologies, as well as strategic partner and customer needs. The next step should entail competency matching, as well as analyzing the business model and the impact of digitalization on precisely this. On this basis, first pilot projects can be determined, from which lessons learned can be transferred to a broad selection of follow-up projects.

The current status is as follows: In retail, digitalization projects focus on the relationship to end customers and how to satisfy their needs. In the manufacturing sector, the focus is on making data available and on integrated planning with suppliers and customers. In logistics services, digitalization projects reach across all areas from digitizing documents to planning with partners. Data plays a crucial role and offers a tremendous opportunity in all sectors. This study convincingly shows that standardizing data and interfaces is an important first step – internally and across all stages of the value creation. Only a "clean" IT system will enable efficient (and predictive) analysis of product flow requirements and optimization. For this, and for the digitalization projects, appropriate IT skills must be developed timeously. In small projects innovations have to be advanced rapidly. The operational implementation focus should be on the expansion of agile structures. For each scenario, intelligent existing paths should be defined in conjunction with alternative paths in order to minimize exhausting staff resources and risk, but still enabling innovation through fast experimenting.

In this case, all the actors – regardless of whether they are in the manufacturing industry, retail, logistics service providers, politics, associations, as well as research and educational institutions – are asked to join forces so that companies and business locations can successfully position themselves in the digital competition.

Appendix

Dear Readers,

A full appendix featuring results detailed by sectors, branches and company sizes can be found on the homepage of the study. Please use the following link for more information.

We are looking forward to your visit on the “Trends and Strategies” website.

https://logistiktrends.bvl.de/study/results/additional_data

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[P3] Bossard Deutschland GmbH

[P4] Albert Craiss GmbH & Co. KG Internationale Spedition

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