

Digitalisation tools in Logistics: application potential, levels of maturity and value contribution

Impulses for investment decisions in digitalisation –
success stories and relevant challenges

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The study “Digitalisation tools in Logistics: application potential, levels of maturity and value contribution” contains extensive analysis and evaluations as well as a detailed profile on 22 digitalisation tools. It can be downloaded free of charge at <http://www.logistik-digitalisierung.de>. The study was carried out by Prof. Dr. Wolfgang Stölzle (Institute of Supply Chain Management at the University of St. Gallen), Prof. Dr. Thorsten Schmidt (Institute of Material Handling and Industrial Engineering at the Technische Universität Dresden), Prof. Dr. Christian Kille (Institute for Applied Logistics at the University of Applied Sciences Würzburg-Schweinfurt), Dr. Frank Schulze (also from the Technische Universität Dresden) and Victor Wildhaber (also from the University of St. Gallen).

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Foreword from the Authors

As with all important issues within an era, the associations and convictions rarely correspond to the true substance, developmental focus and potential of the leitmotifs. Digitalisation is, of course, currently one such leitmotif. An intensive discussion with decision makers in logistics quickly proves that even experts have a very heterogeneous understanding of the topic. This, then, is a suitable starting point for examining this question more intensely.

Of course, examining the topic of digitalisation quickly leads to broader questions, i.e. for logistics: a vision of primary planning and control of the flow of goods in a highly networked world full of autonomous and decentralised entities. Suitable integration of individual, powerful digital technologies in a transparently networked process landscape (transparent because it is digital); customer needs can be recorded, system statuses determined in real time and optimal decisions can be made ad hoc.

But of course, it is not that simple. Even a more exact definition of digitalisation is, after careful consideration, not a simple matter. And it is often unclear which of the many initiatives will be useful, and at what point in time they should be implemented. In particular, there is the question as to which of the many solutions is actually ready for implementation. Based on these realisations, the authors decided to examine individual elements of digitalisation, hereafter referred to more specifically as tools, in depth.

This study intends to aid future digitalisation in logistics. The focus is on those logistics digitalisation tools currently in use within the industry. The central goal is to examine and analyse these tools with as much detail as possible. The goal is not just to evaluate their readiness for use, but also their reliability and their development potential in a methodologically sound manner. Our goal in this study is to deliver the facts to leading logistics decision makers, and provide a solid foundation for making digitalisation investment decisions.

The authors, September 2018



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Management Summary

Goal setting and focus

This study was motivated by the broadly diversified and rarely specific discussion on the potential of digitalisation. In short, one gets the impression: everyone believes they can contribute to the topic many people have noticed a lack of transparency nobody is willing to admit to uncertainty or lack of knowledge

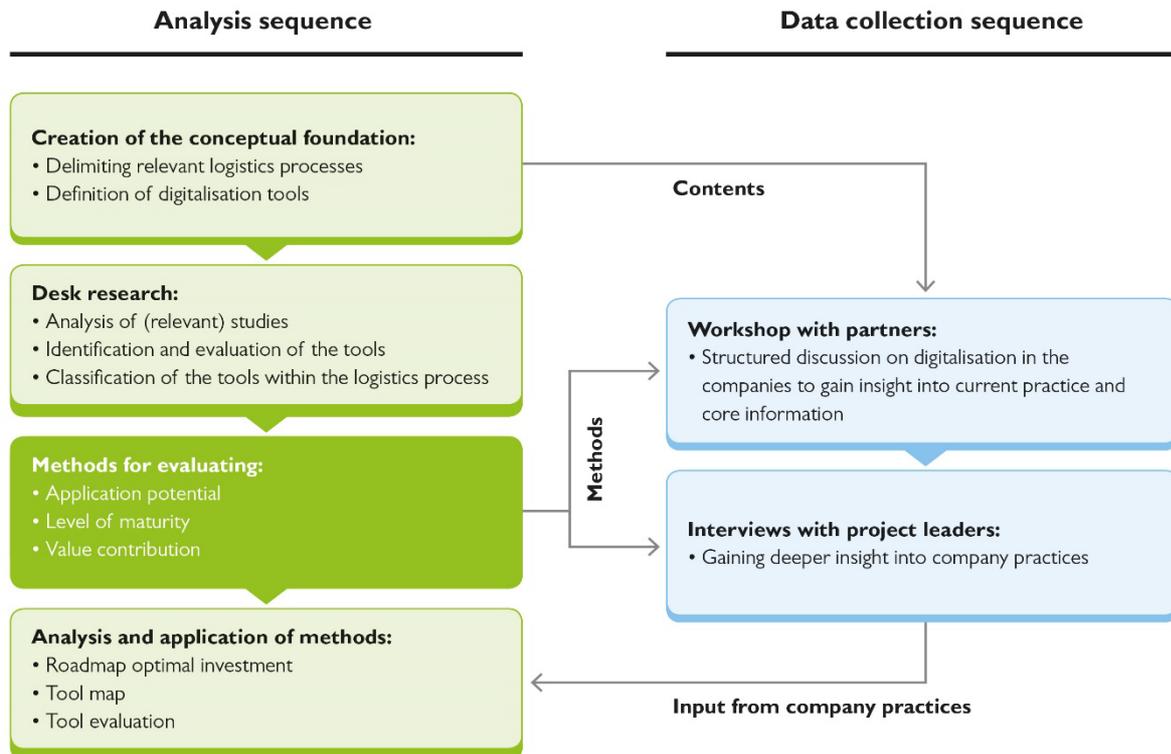
Even the understanding of the term 'digitalisation' varies wildly. One peculiarity is that, depending on the point of view, digitalisation either encompasses use of digital tools within the company. Or, it is considered the (digital) transformation of the company itself, for example its business processes, that is the 'modern' changes and reorientations within the company. To exaggerate slightly, this could be understood as the difference between "USE DIGITAL" and "GO DIGITAL".

This study focuses on "USE DIGITAL" and provides detailed information on application potential, level of maturity and value contributions for each tool. Therefore, specifics are the central topic of the study. The investigation focuses on logistics processes and associated services, and

the digitalisation tools that can be used to facilitate them. The overarching issues regarding general development of digitalisation in logistics are addressed at the end of the study. The long-term business transformations within logistics, which may take place as part of digitalisation, are of minor importance within the study.

Therefore, this paper is designed to do more than just improve understanding of the potential and opportunities provided by digital tools used for logistics processes. It also aims to provide decision making help regarding which digitalisation tool should be invested in at which point.

In aid of this, in addition to analysing many sources from the literature and already published studies, the authors carried out a total of three workshops and 27 interviews with company representatives. The results of these interviews and the exchange of practical experiences were used to formulate specific Good Practice recommendations for company solutions and to provide evaluation profiles of 22 digital tools, from which the results of the study are derived.



Research design: a summary

Delimiting the characteristics of a digitalisation tool

For this study, eight characteristics were defined, of which several had to be present in order for a tool to be designated a digitalisation tool:

1. ability to network
2. use of open networks
3. use of decentralised data collection
4. data can be varied
5. independent decision making
6. provision and use of shared resources
7. interaction between people and machines
8. relevance for logistics

Using these criteria, the authors identified or differentiated 22 digitalisation tools and eight basic tools from one another.

Finally, the study offers the opportunity to identify digitalisation tools relevant to a company and to use this as the basis for investment decisions via the following steps:

1. Step: location on the logistics map
2. Step: filter according to implementation potential
3. Step: evaluate the level of maturity
4. Step: select based on value contribution

		digitalisation tools																						
		hybrid					physical				virtual													
Tool categories		chat bots	shared logistics resources	matching platform	estimated time of arrival	digital freight forwarder	anticipatory logistics	wearables	drones	telematic platforms	platooning	mobile robotics	intelligent containers	flexconveyers	autonomous driving (internal)	autonomous driving (external)	supply chain event management	smart contracts	predictive analytics	logistics control tower	E-payment	E-document management	dynamic pricing	
Phases	Planning	•	•	•	•	•				•									•	•	•	•	•	
	Control	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
	Monitoring	•	•	•	•	•			•	•		•				•	•	•		•	•	•	•	
Process	Storage and handling		•				•	•				•	•	•					•	•				
	Acceptance and handover				•			•		•					•			•			•			
	Transportation	•	•	•		•	•		•	•	•					•	•		•	•		•	•	
Added value services	Procurement/provision			•		•							•						•	•				
	Maintenance/repair																		•					
	Assembly/packaging		•																•					
	Shelf service						•												•					
	Customer communication	•	•	•	•	•				•							•	•	•			•	•	•
	Quality management	•			•						•	•							•			•	•	•
	Planning/consultation services	•		•	•						•						•			•			•	
	IT services	•	•	•		•					•						•					•		
	Personnel services		•																		•			
	Financial services																		•			•		
Logistics services	Order management									•						•	•		•	•	•	•	•	
	Inventory management		•				•		•			•							•	•			•	
	Commissioning		•					•				•		•	•									
	Preparation for packaging and shipping		•					•						•	•									
	Shipment allocation		•		•	•	•	•	•		•			•	•				•					
	Disposition			•	•	•	•				•	•							•	•		•	•	
	Shipment tracking	•	•	•	•	•					•	•				•	•	•		•		•	•	
	Customs services																		•			•		

Locating the digitalisation tool on the logistics map

Locating the digitalisation tool on the logistics map

Analysis shows that the majority of digitalisation tools are closely connected to the control stage, and have less to do with planning and monitoring. This extensive connection to the

control phase has to do with the fact that the majority of the observed digitalisation tools over the last few years have been heavily (further) developed, or new tools have been introduced, and the control processes have changed significantly.

	Analysis and algorithms	Augmented reality	Image and environmental sensors	Cloud services	Distributed ledger (blockchain)	AI based procedures and machine learning	Networks	V2V and V2I communication	wearables	drones	telematic platforms	platooning	mobile robotics
Analysis and algorithms											↑	↑	
Augmented reality									↑		↑	↑	
Image and environmental sensors									↑	↑	↑	↑	↑
Cloud services									↑		↑	↑	
Distributed ledger (blockchain)											↑	↑	
AI based procedures and machine learning									↑	↑		↑	↑
Networks									↑		↑	↑	
V2V and V2I communication											↑	↑	
wearables		←	←	←		←	←						
drones			←			↑							
telematic platforms	←	←	←	←	←		←	←				←	
platooning	←	←	←	←	←	←	←	←			↑		
mobile robotics			←			↑							
intelligent containers	←		←	←							←	↑	
flexconveyers	←												
autonomous driving (internal)			←			←							←
autonomous driving (external)	←		←	←		←	←				↑	↑	
SCEM	←						←				←		
smart contracts			←	←	←		←						
predictive analytics	←		←			←					←	↑	↑
logistics control tower	←		←								←		
E-payment	←			←									
E-document management	←			←	←		←				←		
dynamic pricing	←					←	←						
chat bots	←			←		←	←		↑				
sharing logistics resources				←			←				←		
matching platform	←	←		←	←	←	←				←	↑	
estimated time of arrival	←			←							←	↑	
digital freight forwarder	←			←		←	←				←	↑	
anticipatory logistics	←			←		←	←						
←	16	4	11	14	5	12	13	2	0	0	9	1	0
↑	0	0	0	0	0	0	0	0	6	2	14	10	2

intelligent containers	flexconveyers	autonomous driving (internal)	autonomous driving (external)	SCEM	smart contracts	predictive analytics	logistics control tower	E-payment	E-document management	dynamic pricing	chat bots	sharing logistics resources	matching platform	estimated time of arrival	digital freight forwarder	anticipatory logistics
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4	1	2	8	11	7	9	13	5	11	10	8	3	11	10	10	8

Basics

physical

virtual

hybrid

Relationship between digital tools

Please note: the arrows point from support (basic) tools to more complex ones

The overview also shows differentiation between eight logistics and ten added value services. These are all supported by at least one, but usually by several digitalisation tools. This also has an effect on logistics services and their quality. For example, the relevant digitalisation tools can be selected in a targeted manner and then evaluated in another step.

The interaction between digitalisation tools is another important aspect here. It is rare that a single tool can fulfil its potential alone, or that it is intended to act in isolation to other tools. This networking potential with other basic or digitalisation tools may be low (flexconveyor with a single input) or complex (telematics platform with 14 inputs and 9 outputs).

Evaluation summary: application potential, levels of maturity and value contribution

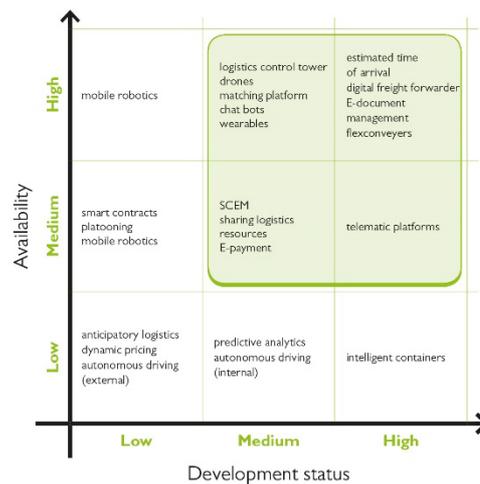
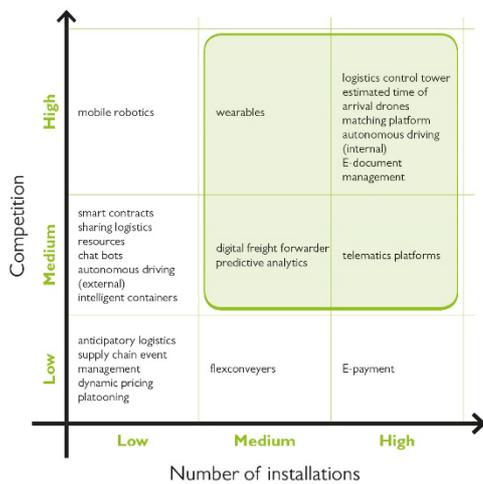
In addition to the location on the logistics map, digitalisation processes can be differentiated in regards to four process and three product related application potentials. The majority of

digitalisation tools have many application potentials well beyond classic cost reduction. They support a paradigm shift from a cost-focused view to a service-focused view. This is reflected in the application potential rankings:

1. Improves efficiency/productivity (19 tools)
1. Improves quality/service level (19 tools)
2. Improves flexibility (18 tools)
3. Expands existing products/services (16 tools)
4. Reduces costs (15 tools)
5. Offers new products/services (7 tools)
6. Creates disruptive effects (6 tools)

It is therefore obvious that digitalisation tools are much more than just a means of cost reduction.

However, the level of maturity also needs to be taken into account. Here, it is not just technological maturity that plays a role, but also market readiness. There are two portfolios which provide results from both perspectives on the level of maturity, and show, overall, an extremely heterogeneous spectrum.



Market situation portfolios

Please note: on the left, the competitive situation is compared to frequency of installation, and on the right the availability is compared to the level of development

Overall, the level of maturity is distributed as seen in the following table.

Level of Maturity	Number of digitalisation tools
High	6
Medium	7
Low	9

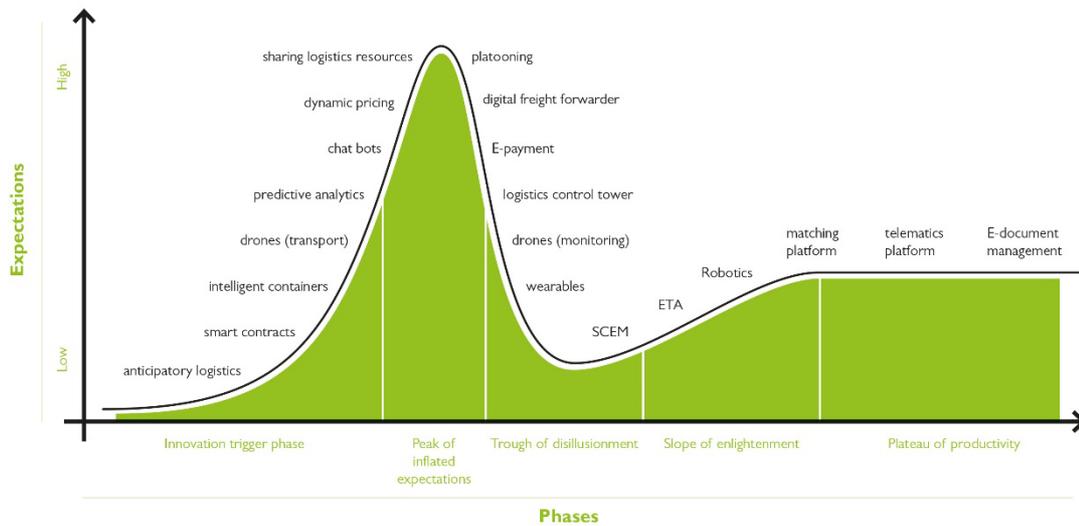
Distribution of digitalisation tools in accordance with level of maturity

The analysis of possible value contributions underlines the focus of the study, that is the specific use in day to day business. Only four digitalisation tools promise new business models, and two introduce the possibility of new fields of business. The primary value contribution lies in optimisation of business processes, a promise made by all 22 digitalisation tools. In addition, 17 digitalisation tools offer an improved information situation, as well as cost savings in operative processes, while 16 offer cost savings in support processes. This makes it clear that it is not just investment in digitalisation tools undergoing a paradigm shift, but rather that practical use of these investments is, generally speaking, rewarded via classic quantitative savings.

Innovation in logistics

The 22 digitalisation tools can be classified within the Gartner hype cycle. This cycle evaluates both the degree of innovation for a tool as well as the expectations. Six tools proved to be in the “innovation trigger” phase, five could be sorted into the “peak of inflated expectations”, four into the “trough of disillusionment”, three into the “slope of enlightenment” and two into the “plateau of productivity”. The analysis of the specialised media landscape together with expert interviews maps the result: digitalisation tools that still display a low degree of maturity are nevertheless the subject of very high expectations.

It might be assumed that start-ups, in particular, engage with highly innovative tools. Astonishingly enough, however, an analysis of 78 start-ups from Germany, Austria and Switzerland did not confirm this assumption. Instead, it was found that 37 of these start-ups use or develop tools relating to this study. Of these 37, 21 (that is, the majority) are using tools that have either already reached the “plateau of productivity” or at the very least the “slope of enlightenment.” Only five were making use of tools that could be considered innovation triggers.



Locating the digitalisation tools within the hype cycle

In contrast, the 27 interview partners and their Good Practices, as well as the analysis of numerous case studies, showed that the established logistics companies are much more courageous and innovative than is generally recognised or thought.

Development path of digitalisation in logistics

The focus on individual digitalisation tools is important for logistics service providers in order to plan their investments over a longer period of time. In addition,

identification of **sustainable** technologies is fundamentally important, in order to remain competitive in the long term.

There is already a great deal of activity in this area, as demonstrated by the fact that the majority of digitalisation tools are already in use for practical applications. In particular those with a strong relationship to physical objects are currently in use daily. In the future, in regards to digitalisation tools, the key words 'data', 'networking' and 'communication' will play a significant role.

Profile of basic and digitalisation tools as well as Good Practices

The analysis, interpretation and deduced implications create the basis for the evaluation of digitalisation tools. The results of the evaluations can be found in the following profiles. Two types of profiles were created: the profile for general evaluation of the digitalisation tool and the description of a related Good Practice (if possible). The input for this was the 27 interviews, the workshops with study partners, academic and industry publications and the expertise of the authors of this paper. The evaluations and interpretations developed from this have been objectified, but in each case should be individually and specifically analysed in regards to the application case background, the predominant framework conditions within the company and additional technological developments. The study creates a basis for supporting investment decisions in digitalisation tools and for developing a digitalisation strategy.

Each profile (both digitalisation tool and Good Practice) has the same structure. The profile for general evaluation of a digitalisation tool consists of three pages (general description, application potential and level of maturity, as well as performance assessment and value contribution) and is explained in the following table (explanations in grey cursive print). Only the basic tools, which are upstream of the physical, virtual and hybrid digitalisation tools, are described solely by the first page. Additional evaluation did not seem practical, as these tools are not useful and do not have value contribution when used on their own.

Name of the tool	
Summary	
Function	<i>What other digitalisation tools does it interact with?</i>
<i>What does the digitalisation tool do?</i>	<i>The representation takes the form of a networking graphic.</i>
<i>The function is described in order to achieve clarity regarding the understanding within the study.</i>	
Relationship to logistics:	Relationship to digitalisation:
<i>Why is the digitalisation tool relevant for logistics?</i>	<i>Which digitalisation criteria apply to the digitalisation tool?</i>
<i>Many digitalisation tools exist, but not all are relevant to logistics.</i>	<i>The introductory chapter highlights the characteristics of digitalisation tools.</i>
<i>Where is the digitalisation tool on the logistics map?</i>	
<i>The representation takes the form of a two-dimensional logistics map. It clarifies which services are supported in which logistics processes.</i>	
Development path/claim to innovation:	
<i>What are the origins of this digitalisation tool and how is it going to develop?</i>	
<i>A look at the past helps to classify technologies already in use, as in many cases a new word has been selected for further developments. An analysis of future development is carried out in the final chapter.</i>	

Application potential

What is the application potential for the digitalisation tool?

Here, a line is drawn between process, product and strategy related potential, marked by a tick (as shown in the following example). The strategy related observations clarify degree of innovation into three levels:

Process related:	<input checked="" type="checkbox"/> Cost reduction	<input checked="" type="checkbox"/> Improvement quality / level of service
	<input checked="" type="checkbox"/> Increased flexibility	<input checked="" type="checkbox"/> Increased efficiency / productivity
Product related:	<input type="checkbox"/> Offers new products / services	
	<input checked="" type="checkbox"/> Expands existing products / services	
	<input type="checkbox"/> Development leads to disruptive effects	
Strategy related:	<input checked="" type="checkbox"/> Improvement (new to the company)	
	<input checked="" type="checkbox"/> Innovation (new to the market)	
	<input type="checkbox"/> Disruption (new to the world)	

How can the digitalisation tool be deployed?

Most digitalisation tools cannot be used in isolation. The networking graphic makes this clear. Which is why the digitalisation tool is evaluated in regards to whether it can be used directly ('off the rack'), needs adjustments ('individualised based on predominant framework conditions') or is still in development.

Usability:	<input checked="" type="checkbox"/> Can be used directly	<input type="checkbox"/> Usable, adjustments required
	<input type="checkbox"/> Not yet usable, in development	

In which way/with what prerequisites it is possible to use the tool, as an example?

Level of Maturity

Which level of maturity does the digitalisation tool have?

A summary of the following description of the level of maturity takes place using the steps 'high', 'middle' and 'low'. This is applied to the four criteria 'availability', 'number of installations', 'development status' and 'competition'.

Maturity level	<input checked="" type="checkbox"/> High	<input type="checkbox"/> Middle	<input type="checkbox"/> Low
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Explanation:

How is the level of maturity of a digitalisation tool described?

Four criteria represent the view of the market and technology. The market side can be evaluated using the number of installations and the number of competitors, the technology side by using the availability and development status. In doing so, the four criteria are evaluated as follows:

High (technology can be purchased) / middle (pilot applications) / low (vision)

Availability

High (>10) / middle (2 to 10) / low (none or one test) Number of installations

High (established components and technologies) / middle (components and technologies in use) / low (components and technologies in testing) Development status

High (more than 4 providers) / middle (2 to 3 providers) / low (1 provider) Competition

The category and evaluation are printed in **bold** in the text in each case, so it is easier to see the results. This information is used to determine the level of maturity of the digitalisation tool.

For most digitalisation tools, a typical application case (Good Practice) is described after the three page profile. The contents of this are largely drawn from interviews with company representatives. Therefore the focus is on describing the Good Practice, expanded by additional information from other practical examples:

1. description of the core good practice performance
2. basic information on the application
3. location on the logistics map
4. desired use and challenges
5. (additional) practical examples

This compilation is intended to specify the general evaluation of the digitalisation profile and expand the study to contain relevant practical information. Differences between the descriptions or evaluations in the digitalisation tool profiles and in the Good Practice examples are explained by the practical implementation within the company taking framework conditions mentioned in the profiles into consideration. It is important, at this point, to emphasise once more that the general evaluation of the digitalisation tools is intended to provide orientation. The potential gained by practical implementation is limited by the framework conditions within the company and in the market environment, which is emphasised in the Good Practice examples.

Authors

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Prof. Dr. Wolfgang Stölzle has held the Chair in Logistics Management at the University of St. Gallen from Autumn of 2004, and has been the Director of Studies for the part-time diploma course in Logistics Management since 2008. His areas of research include business logistics, supply chain management, traffic management, controlling and procurement management.

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Dr.-Ing. Frank Schulze has been a research associate at the Technischen Universität Dresden since 1996, and is in charge of the AG material flow planning for the Chair of Technical Logistics. His key activities are modelling material flow systems, developing controlling strategies, rough design of material flow systems and dimensioning material flow components, as well as visualisation of material flow systems.

Victor Wildhaber

Victor Wildhaber has been a research associate at the Institute of Supply Chain Management at the University of St. Gallen since 2017. Previously, Mr. Wildhaber completed his Business Management degree at the University of St. Gallen, as well as a Masters in same at the University of St. Gallen.

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