Application of agile methods in traditional logistics companies and logistics startups☆

Results from a German Delphi Study

Malena Zielske [a,b,*], Tobias Held [a]

[a] *Hamburg University of Applied Sciences, Hamburg, Germany*
[b] *Lufthansa Industry Solutions GmbH & Co. KG, Norderstedt, Germany*

ARTICLE INFO

ABSTRACT

To meet changing requirements and rising product complexity, a growing number of traditional logistics companies and logistics startups are increasing their agility through the use of progressively agile methods. The objective of the Delphi Study is to assess how traditional logistics companies and logistics startups use agile methods in their IT departments, what benefits they realise and what challenges they face introducing and using agile methods.

A modified Delphi Study was conducted over three complementary rounds as an iterative expert judgment process. After the analysis of the results, insights were gained on the following points covering traditional logistics companies and logistics startups: (a) used agile methods and practices, (b) perceived benefits that these methods offer and (c) challenges of applying these methods.

The results of the Delphi Study show that traditional logistics companies as well as logistics startups chose similar agile methods and practices. Both company types aim to realise mainly the same benefits but face different challenges regarding the introduction of agile methods.

The Delphi Study's originality lies in its contribution to the largely unexplored area of agility in the field of logistics.

1. Introduction

Digitisation raises the demand for software products such as platforms and (mobile) applications, and also for sectors that have not (predominantly) made money with software products in the traditional sense. The aim is to look at how other industries, such as the logistics industry, deal with this demand for software products and whether logistics companies use agile methods originating from software development in order to digitise their products and match them up in the best possible way with the needs of the customer.

Over the last few years the use of agile methods and practices has increased in importance, having started in software companies, but now catching on in other industries as well (Laanti et al., 2011; Schön et al., 2017a; Bernal et al., 2019). Agile methods and practices are used to cope with up-and-coming product development and project complexity, rapidly changing customer expectations, business model insecurities, complex technological decisions or other altering external influences (Cockburn and Highsmith, 2001; Beck, 2000). Agile methods and practices promise to deliver business value consistently and in short iterations, by adapting and improving the product and the work process incrementally and empirically (Abbas et al., 2008; Larman and Basili, 2003). Since the level of agility is based on humans and their interactions, it depends heavily on the mindset of all of the employees within a company or organisation and promotes the rapid implementation of customer-centric solutions (Beck et al., 2001).

Since the 1980's, the concept of agility itself has evolved from a concept that encompasses flexibility and leanness to a value-based concept (Conboy, 2009). Agility focuses not only on customer value, but also on individuals, cooperation, and interaction to achieve flexibility and leanness (Conboy, 2009) and depends strongly on the way employees think (Beck et al., 2001). The concept of agility is still a complex concept today and is interpreted in many ways in both research and practice (Conboy, 2009).

This study focuses on how the conservative logistics industry — known as a "slow adapter" (Kupp et al., 2017) - deals

---

with agility, and how established logistics companies and logistics startups use agility to deliver innovative products that are appreciated by customers (Vogel and Lasch, 2018). Many logistics companies seem to have difficulties in delivering the right customer value, and this gives the impression that they cannot keep up with startups or the speed of innovation within the industry (Beck et al., 2001; Delfmann et al., 2018; Newkirk, 2002). There is however an increasing number of partnerships to promote the exchange between traditional logistics companies, logistics startups, and IT consultancies. One example is the Digital Logistics Hub, of which Lufthansa Industry Solutions GmbH & Co. KG is a partner. The goal of this Delphi Study is to identify agile methods and practices used in traditional logistics companies and logistics startups. The objective is to understand the advantages logistics companies gain from the use of agile methods, but also the difficulties they face when using them.

The Research Questions (RQ) answered are listed below:

- RQ1: Which agile methods and practices do traditional logistics companies and logistics startups use?
- RQ2: How do traditional logistics companies and logistics startups benefit from the use of agile methods?
- RQ3: What difficulties do traditional logistics companies and logistics startups face concerning the adoption of agile methods and practices?

A modified Delphi Study is conducted based on established guidelines (Dalkey and Helmer, 1963; Linstone and Turoff, 2002; Diamond et al., 2014). The modified Delphi approach allows deepening results of previous rounds (Schön et al., 2017b). These results are used to adopt the questionnaire from round to round to answer the RQ in the best way possible. Therefore an iterative expert judgment process is performed.

This Delphi study is based on previous results from a multiple case study and a systematic literature review (SLR) which have already been published. An exploratory multiple case study with 12 interviews has been conducted (Zielske and Held, 2020b). In comparison to this Delphi study, the explorative study was based on guided face-to-face interviews with participants from logistics start-ups. No participants from traditional logistics companies were interviewed and there were no multiple rounds of interviews. Subsequently, a SLR has been performed to gather already published results on the use of agile methods in logistics startups (Zielske and Held, 2020a). The SLR was used to identify the research gap that this Delphi study aims to reduce. Knowledge used for the design of the questionnaire used during this Delphi study has been collected during the explanatory multiple case study and through the SLR. Therefore, partially results from previous studies have been used to prepare this Delphi study.

The paper is structured as follows:

Section 2 gives a brief overview of the underlying definitions of agile methods and practices as well as an overview of related work. Section 3 presents the applied research method and describes the study design of the iterative judgment process. Section 4 summarises the findings of the three rounds of the Delphi Study and discusses both their results and limitations. Finally, Section 5 concludes this study and provides some perspective for future research.

2. Background

2.1. Agile methodologies

Since the 1980's, the concept of agility has evolved from comprising flexibility and leanness to a value-driven concept (Conboy, 2009; Stavru, 2014). Agility focuses not only on customer value, but also on people, communication, and collaboration in order to achieve flexibility and leanness (Conboy, 2009). Today, the concept of agility still is a multifaceted concept and is interpreted in research and practice in many different ways (Conboy, 2009; Jalali et al., 2014). Conboy and Fitzgerald provide a general definition of the term and describe agility as "the ability of an entity to proactively, reactively or inherently embrace change in a timely manner, through its internal components and its relationships with its environment" (Conboy and Fitzgerald, 2004, p. 39), (Sarker and Sarker, 2009; Lindsjørn et al., 2016; Pikkarainen and Wang, 2011; Dikert et al., 2016). They thus describe the basic values of agile process models, above all, willingness to change and cooperation (Cohn, 2009). Qumer and Henderson-Sellers deepen this definition with facets of agility such as, "nimbleness, suppleness, alertness, responsiveness, swiftness and activeness" (Qumer and Henderson-Sellers, 2006, p. 122). Different other authors use the attributes flexibility, speed, leanness, learning and responsiveness (Conboy and Fitzgerald, 2004; Wong and Whitman, 1999; Boehm and Turner, 2003). In this work, agility will be understood as a concept that aims to achieve flexibility, speed, leanness, learning, and responsiveness through the ability to proactively, reactively, or inherently deal with change quickly.

Agility is not exclusive to one functional area but "can be addressed in different business competence areas", such as (see also Fig. 1) (Kettunen, 2009):

- Agile business models
- Enterprise agility
- Organisational agility
- Agile manufacturing
- Agile supply chains
- Agile software development.

Fig. 1 shows the relation between the functional areas of agility mentioned above. The origin of the agile areas lies in the common goal to create added value for the customer through the right product and the ability to react to changes at short notice. The needs of the team working on the product are as much in focus as the satisfaction of the customer. This agile methodology has given origin to various functional areas where these values are the basis for collaboration. These include, for example, the agile supply chain, which tries to respond to customer requirements as flexibly and promptly as possible. Another example is enterprise agility, which describes whether a company can handle change and fulfill customer requirements across all departments. The focus of this paper is agile software development, which will be discussed in detail below. First, however, the history of agility will be described.

The concept of agility was first introduced in organisational theory and social science as corporate agility in order for business entities to respond to changes in an uncertain world. Brown and Agnew described agility as "the capacity to react quickly to changing circumstances" in 1982 (Brown and Agnew, 1982). They mention not only flexibility but also the commitment of key resources, mainly human resources, to output-oriented goals (Schirrmacher and Schoop, 2018). The application of agility was concretised in the Lehigh Report describing agile manufacturing, which was published in 1991 (Hooper et al., 2001; Nagel and Dove, 1991). Hooper describes agile manufacturing as a "manufacturing system with extraordinary capabilities (internal capabilities: hard and soft technologies, human resources, educated management, information) to meet the rapidly changing needs of the marketplace (speed, flexibility, customers, competitors, suppliers, infrastructure, responsiveness)" (Yusuf et al., 1999; Davarzani and Norrman, 2015; Mourtzis, 2016). In 1995, Goldman et al. expanded upon the Lehigh Report and stated that agility is relevant for other organisational units as well, such as marketing, production, design, organisation, and management.
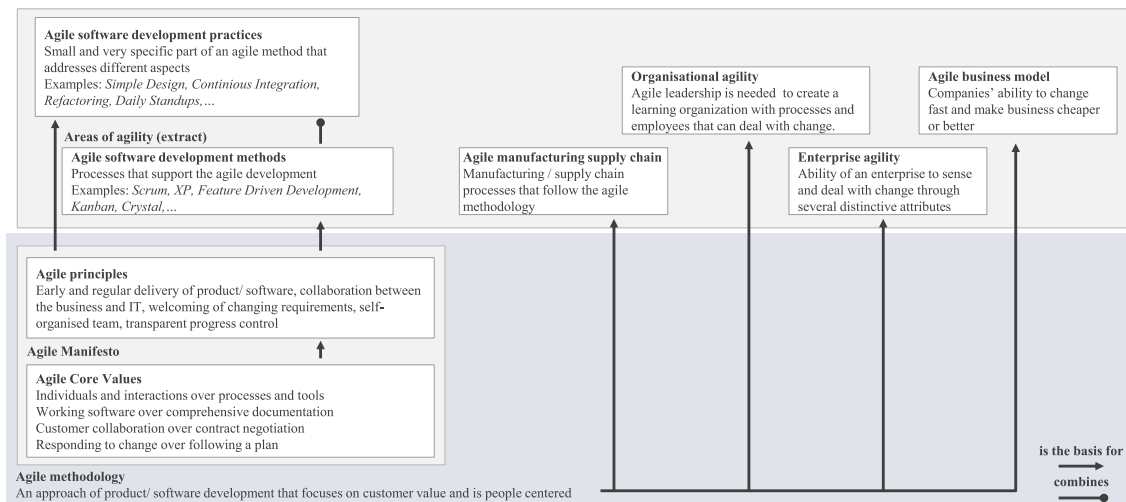
Fig. 1. Agile business competence areas and their relationship (Own representation based on Kettunen (2009), Diebold et al. (2016), Helaakoski et al. (2006), Daniels (2014), van Oosterhout et al. (2005)).

Goldman et al. describe agility as "a comprehensive response to the business challenges of profiting from the rapidly changing, continually fragmenting global markets for high-quality, high-performance, customer-configured goods and services" (Goldman et al., 1995). The uncertainty of changing requirements also affects IT and software development, where the need for agility also increases due to the dynamic circumstances of the other business and technological areas mentioned previously. In 2001 the so-called "Agile Manifesto" of software development projects was introduced (Beck et al., 2001), after agile and iterative process models like Rational Unified Process and methodologies like Scrum and Extreme Programming (XP), Feature-Driven-Development (FDD) and Kanban were developed starting in the 1980's (Beck, 2000; Takeuchi and Nonaka, 1986; Schwaber, 1997; Kruchten, 1998; Palmer and Felsing, 2002; Anderson, 2004; Schwaber, 2004).

The Agile Manifesto is based on four values and twelve principles with the goal of optimising the software development process and collaboration within teams. Focusing on the development of customer value, many agile methods and practices that can also be applied in other non-IT related domains (Highsmith, 2010; Parente, 2015) have been developed as well (see Table 1). Practices are associated with one method, but can also be partially applied in combination with other methods.

The use of agile methods is particularly suitable for complex product development or project situations characterised by rapid and frequent changes (Kurtz and Snowden, 2003; Stacey and Mowles, 2015). Agile methods aim to reduce this complexity through accelerated reaction speed, improved collaboration (Kaim et al., 2019), and higher levels of trust between team members, but also with the customer. Additionally, simpler processes, reduced change costs, and less time spent on changes result in increased productivity and a lower defect rate (Shah and Nies, 2008; Baig et al., 2017; Prater et al., 2001). This increases the quality of the product and reduces complexity (Anwer et al., 2017) (see Table 2).

The most widely used agile methods are Scrum, Kanban, XP, FDD and Crystal (VersionOne CollabNet, 2019). According to Schwaber and Sutherland, the creators of Scrum, Scrum is a framework for people to address complex adaptive problems while productively delivering creative products of the highest possible value (Schwaber, 2004). Through the application of an iterative approach using a combination of sprints, synchronisation meetings (such as Daily Standups, Sprint Plannings and Reviews),

and Retrospectives, various improvements are achieved through the Scrum team. The Scrum team consists of the Product Owner, who is responsible for the vision and backlog prioritisation, the Scrum Master who is responsible for the optimisation of the Scrum process and the development team (Ashraf and Aftab, 2017).

Kanban aims to adopt the lean principles from manufacturing such as the elimination of waste, the amplification of learning, and making decisions as late as possible. A core idea of the Kanban method is to use a signboard to visualise the current tasks. Different columns are used to present the status of the individual tasks, which are displayed on Kanban cards. Additionally, the aim of this visualisation of the workflow is a limitation of work in progress. Kanban encourages continuous improvement to realise an efficient workflow (Ahmad et al., 2018; Anderson, 2010).

A "lightweight" method is how the creator of XP, Beck, describes his agile method of software development that is based on simplicity, communication, courage, feedback and respect (Beck, 2000). It is a process of trial, error, and continuous improvement, without a "given software process that can be pointed to as the one and only definition of Extreme Programming" (Keenan and Bustard, 2006, p. 1). The core of XP is the cyclical approach at all levels. For example, two developers can coordinate their work permanently (every second) through the agile practice Pair Programming. During software development, the new software is checked in every minute through Test-Driven Development. In XP, the software is integrated continuously into the overall system once every hour to enable regular software builds. At least once a day, the entire team synchronises during a Daily Standup Meeting. XP is a very technical method that uses methods such as refactoring, continuous integration of the software, and Test-Driven Development.

FDD is also a "lightweight" and model-driven software development process. The goal is the frequent delivery of tangible work results so called features. FDD consists of five activities. The first three activities ("Develop overall system model", "Build feature list", "Plan by feature") are performed at the beginning of the project. After the overall system model is developed, the required features are collected in a list and planned in a sequential order. Afterwards, the remaining two activities ("Design Feature" and "Build Feature") are performed in iterations, as a feature is defined as "a customer-evaluated functionality that can be implemented in two weeks or less" (Pang and Blair, 2004, p. 86). Feature teams, that work together on related features inspect

Table 1

Overview of the most common agile methods and associated agile practices (Beck, 2000; Palmer and Felsing, 2002; Schwaber, 2004; VersionOne CollabNet, 2019; Cockburn, 1998; Abrahamsson et al., 2003).

Agile method	Agile practices
Scrum	Sprint, Planning, Daily Standups, Retrospectives, Product Owner, Scrum Master, etc.
Kanban	Visualisation, Limit Work in Progress, Feedback Cycles, etc.
XP	Regular Software Builds, Continuous Integration, Test-driven Development, Pair Programming, etc.
FDD	Feature Teams, Code Inspections, Code Ownership, Regular Builds of the Software, etc.
Crystal	Frequent Delivery, Reflective Improvement, Close Communication, High User Involvement, etc.
Scaled Agile Framework (SAFe)	Product Increment Planning, Inspect & Adapt Event, Agile Release Train, etc.
Large Scale Scrum (LeSS)	Overall Retrospectives, Sprint Planning 1 & 2, Lean Thinking, etc.

Table 2

Overview of studies examining the use of agile methods in logistics companies.

Paper	Aim of the study	Method used	Agile methods found in publication
Perego et al. (2011)	Analysis the use of IT in logistics companies	Systematic literature review	Agile project management
Holcomb and Gligor (2012)	Development of a framework that describes agility of logistics companies	Systematic literature review	manufacturing flexibility, supply chain speed, or lean manufacturing to explain supply chain agility
Gunasekaran et al. (2016)	Review of Information Technology for competitive advantage within logistics and supply chains	Systematic literature review	Supply chain agility, competitive advantage through adaption, alignment and agility, quick response to short term changes in the up- and downstream supply chain, impact of IT performance, agility is linked to business performance, to become agile, firms need to invest in IT
Paternoster et al. (2014)	Examine how software is developed in startups	Systematic Mapping Study	Agile methodologies are the most viable processes for start-ups, embrace change, lightweight processes iterative, incremental approach, fast releases, IT follows the business strategy, Lean Start-up, minimum viable product (MVP), evolutionary workflows, eXtreme Programming (XP), Scrumban, pair-programming, culture that embraces failure
Nirwan and Dhewanto (2015)	Understand the use of Lean Startup in a B2B startup	Case study	Lean start-up, agile testing, learning cycles, early customer interaction, pivot, MVP, iterations, customer testing
Daniels (2014)	Evaluate the impact of agile methods on new ventures success	Systematic literature review	Acceptance of uncertainty, consistent communication, collaborative teams, lean organisation, and iterative development
Zielske and Held (2020b)	Explore the use of agile methods in logistics startups	Multiple-case study	Lean Startup, Prioritised Backlog, Selforganised teams, Regular Software Delivery, Hypothesis testing, Short iterations

the team members' software code and own it together so that they take responsibility for the software code. Through the short development cycles, regular software builds can be guaranteed.

The Crystal method family comprises a number of different methods e.g. Crystal Clear, Crystal Yellow, Crystal Orange. For each individual project, depending on the size of the team and the criticality of the project, the most appropriate method should be chosen (Cockburn, 2005). Criticality is assessed according to criteria such as satisfaction of the customer and loss of money. However, certain rules, characteristics, and values are common to all methods in the Crystal family. These include the incremental approach, focus on human communication and collaboration, frequent software delivery, involvement of the user and reflective improvement meetings.

The agile methods described above (Scrum, Kanban, XP, FDD, Crystal) were developed for organisations consisting of only one team per software product. The subsequent agile methods (SAFe, LeSS) were developed later, when the collaboration of several teams on one product increased the dependencies between the teams and the need for agile scaling methods (Ebert and Paasivaara, 2017; Larman and Vodde, 2016).

The Scaled Agile Framework (SAFe) is a collection of organisational and workflow patterns for multiple teams. Many of them are based on Scrum. The goal is to support companies in scaling teams with more than 100 people with lean and agile approaches (Ebert and Paasivaara, 2017). SAFe considers not only the team level, but also the overarching project program and organisational level, so that governance and product management are also included. An iterative approach is taken and realised through the Increment Planning. After completion of several sprints, the results of the teams are integrated in the overall system through the Agile Release Train and the development process itself is reflected in Inspect and Adapt events.

Large-Scale Scrum (LeSS) is a product development framework for multiple teams. It extends the agile method Scrum and its associated practices with scaling rules and guidelines. Nevertheless, the focus remains on the original goals of Scrum (Larman and Vodde, 2016). LeSS is more lightweight than SAFe and does not include guidelines regarding the program and the overall organisation. It shows how up to eight teams can work together with Scrum without introducing many further practices. If more than eight teams work together, LeSS Huge is available. LeSS Huge hardly introduces any additional roles and practices compared to Scrum. LeSS uses overall Retrospectives to reflect the collaboration between the teams, Sprint Plannings (1) for all

teams together before the individual teams perform a separate Sprint Planning (2) and encourages creatives methods such as Lean Thinking.

2.2. Related work

There are related studies in the literature that examine the use of agile methods in startups. Only one study that explicitly explores the use of agile methods in logistics startups could be found (Zielske and Held, 2020b). Related work was identified by searching in search engines such as ScienceDirect, SpringerLink and Google Scholar using the keywords "agile methods" and "logistic". Below the studies published on agile methods used in logistics companies are presented.

Analyzing the related work, it is revealed that two different kinds of research approaches are used. On the one hand five publications use SLRs to describe the use of agile methods by logistics companies based on available evidence in existing research (Daniels, 2014; Perego et al., 2011; Holcomb and Gligor, 2012; Gunasekaran et al., 2016; Paternoster et al., 2014). On the other hand two studies by Nirwan and Dhewanto and Zielske and Held use (multiple) case studies to investigate the use of agile methods (Zielske and Held, 2020b; Nirwan and Dhewanto, 2015).

Perego, Perotti and Mangiaracina classified 44 studies on information and communication technology (ICT) for logistics and freight transportation. They found relatively few, but primarily recent studies. The authors discovered that ICT adoption in the logistics industry and the organisation of IT, through agile project management for example, are still underrepresented in literature. The review showed that many of the studies examined are either conceptual papers or empirical studies — that is, mostly based on case studies, surveys, or interviews (Perego et al., 2011).

In 2012 Gligor and Holcomb published their SLR with the purpose of providing a conceptual framework that explains the relationships between the capabilities of logistics enterprises in terms of their ability to achieve manufacturing, organisational and supply chain agility. The authors found that the literature mainly focuses on manufacturing flexibility, supply chain speed, or lean manufacturing to explain supply chain agility, but logistics capabilities have not been taken into account to achieve a more holistic view. The study of Gligor and Holcomb has practical relevance, because the level of agility in a supply chain influences the efficiency and effectiveness of the collective efforts (Holcomb and Gligor, 2012).

A SLR by Gunasekaran et al. (2016) presented publications dealing with the role of IT in realising competitive advantages within logistics and supply chains. The authors conclude based on the SLR that competitive advantages though IT is based on the achievement of 'adaptation', 'alignment', and 'agility'. Gunasekaran et al. support Gligor's and Holcomb's argument that more research is needed on supply chain agility (Gunasekaran et al., 2016).

In 2014, Paternoster et al. published their SLR describing the use of agile methods in software startups. 43 studies were extracted and analyzed covering 213 software development practices with a high proportion of agile practices. Results show that in startups software development practices are chosen opportunistically. The overall goal of the startups is to provide value under the constrains imposed by the startup context quickly (Paternoster et al., 2014).

Nirwan and Dhewanto conducted a case study on the impact of the use of Lean Startup in a B2B startup in Indonesia. They identified the key barriers of the implementation of Lean Startup and provide managerial implications (Nirwan and Dhewanto, 2015).

In 2014, Daniels published his Ph.D. study focusing on characteristics of the agile methodology and its contribution to the success of new ventures within an entrepreneurial orientation. A literature review on agile characteristics and strategic management has been conducted as basis for qualitative data collection from agile experts within IT functions, and entrepreneurial professors. Daniels found that agile methodologies can go beyond software development and foster the sustainability and success of start-ups. Acceptance of uncertainty, consistent communication, collaborative teams, lean organisation, and iterative development are especially helpful for start-ups (Daniels, 2014).

In comparison, only one publication from Zielske and Held especially designed for logistic start-ups has been found. Published in 2020 this research article shows that also in the logistic industry agility and the use of agile methods is beneficial even though logistics startups have to deal with a lot of time pressure (Zielske and Held, 2020b). Especially young startups are under a lot of time pressure and lack resources, which means that often only some practices are used instead of the complete methods, as startups lack the time to implement the complete agile method.

To the best of our knowledge only few publications on the use of agile methods in logistics companies, especially in logistics startups, exist. The aim of this study was to reduce the research gap identified through the gathering of opinions from experts. For this purpose expert judgment techniques can be used. They allow a certain numbers of experts to articulate and develop a shared opinion on the research topic. Expert judgment techniques are for example the Delphi method, nominal group techniques and brainstorming.

Brainstorming is a creative method used to gather new and different views on a certain topic. It is therefore less applicable for a general gathering of views on a research topic (Diehl and Stroebe, 1987). Nominal group technique and the Delphi approach seem more suitable. Nominal group technique is used to gather a group of experts physically. The discussion of the expert group is structured through a facilitator to find a solution for the problem to be analyzed (Torrecilla-Salinas et al., 2019; Carney et al., 1996). The Delphi approach uses questionnaires over several rounds and feedback loops to determine the experts' opinion. As nominal group technique requires the physical presence of the experts, it is less suitable especially during the covid-19 pandemic. Compared the other expert judgment techniques, the Delphi approach has the advantage that it can be used when the sample is too small to use statistical methods to assess the validity of the results (Rowe and Wright, 2001). Through the appropriate choice of the expert panel (see Section 3.3) and the data gathering within several rounds valid results can be derived. Additionally, the use of structured questionnaires during the Delphi study facilitates the analysis of the results by providing the possibility to define possible answers and can thus increase validity.

To verify that the Delphi approach is an appropriate method to answer the research questions of this study publications in the field of logistics using the Delphi approach were gathered to assess the characteristics of the Delphi approach more deeply. Related work was identified by searching in search engines such as ScienceDirect, SpringerLink and Google Scholar using the keywords "Delphi study" and "logistic" or "agile method". Table 3 shows an overview of the studied published on reported benefits of the Delphi approach.

Analyzing the related work, it can be stated that the Delphi approach seems to be applied especially in cases when anonymous and iterative research is needed to address complex problems.

Akkermans et al. use the Delphi approach in their study on future supply chain management, as it enables them to structure a group communication process, so that experts can give their assessments of complex problems and receive feedback from other experts during the study, for example via comments (Akkermans et al., 2003). It is also a theory-building research method.

Table 3
Overview of Delphi Studies in the field of agile methods and the field of logistics.

Paper	Aim of the study	Reason for the selection of the Delphi approach	Adaptions proposed
Akkermans et al. (2003)	Identify supply chain management trends	Structured group communication process: individuals express effectively views on complex issues Theory-building research method that allows receiving feedback on comments of other experts	None
Conboy and Fitzgerald (2007)	Review the current state of agile method tailoring	Reliable consensus obtained from an expert group Combining the knowledge of a large expert group to have a better chance of getting closer to the truth Complex problems can often only be solved by pooling opinions Flexible in its design	None
von der Gracht et al. (2009)	Energy efficiency and speed in the supply chain	Overcome the 'bandwagon' and 'halo' effects High inclusion of expertise to systematically develop a consensus of expert opinion on future trends Experts can look at the views of their colleagues (anonymously) and possibly rethink their own answers	None
Deschene et al. (2016)	Identify agile methods to increase acceptance of software security considerations	Separate questioning of selected experts Segregation of experts to ensure anonymity, reduce the risk of group opinion and limit the influence of dominant experts Structured, guided, iterative approach that seeks to arrive at a consensus on a particular research topic	None
Schön et al. (2017b)	Identify most important challenges in "Agile Requirements Engineering"	Anonymity prevents the influence of other experts Iterative approach with controlled feedback Use learnings from previous rounds to carry out the following ones	Modification of the questionnaire between the rounds to clarify and refine results Reaching consensus was not the overall goal as this studied aimed at finding valuable insights
Torrecilla-Salinas et al. (2019)	Validation of an agile framework for Web development projects	Suitable for small groups of relevant experts No physical presence needed, experts can be geographically distributed Controlled feedback after every round of data gathering Anonymity of experts is secured	Modification of the questionnaire between the rounds to clarify and refine results

Conboy and Fritzgerald seek to benefit from the fact that combining the answers of a large number of people gives a better chance to come closer to "the truth" (Conboy and Fitzgerald, 2007).

Von der Gracht et al. have designed their Delphi Study in such a way that surveyed experts can immediately identify data trends and thus take into account the views of their colleagues (anonymously) to possibly rethink their own answers (von der Gracht et al., 2009).

Deschene has chosen the Delphi method for her study on agile methods in relation to software security policies because it offers a qualitative, guided, and iterative approach to bring experts to a consensus (Deschene et al., 2016).

Schön et al. have also chosen the Delphi approach in order to be able to proceed in an iterative way and to use the learnings from previous rounds (Schön et al., 2017b).

Torrecilla-Salinas et al. use a modified Delphi study to deepen results found in the previous rounds to clarify and refine those findings iteratively.

These Delphi studies conducted in the areas of logistics and agile methods show that the Delphi approach can be used to gather the opinion of experts iteratively. Benefits such as anonymity, controlled feedback between the rounds and the use of learnings from the previous rounds are the reasons the Delphi approach has been chosen.

To this end, the aim of this study is to find out which agile methods and practices are used by traditional logistics companies and logistics startups, why they are used, and what difficulties they encounter. To the best of our knowledge, there is currently no qualitative study that examines this topic.

3. Research method

Originally, the Delphi method was used to reach a consensus within an expert group on the research topic. Various metrics such as Fleiss' Kappa (Fleiss, 1971) or Kendall's concordance coefficient (Legendre, 2005) are used for this purpose. However, recent studies show that even the definition of consensus is ambiguous (Diamond et al., 2014). Therefore, the ultimate goal of this Delphi Study is not to reach consensus but to find valuable insights on the current use of agile methods and practices. The aim is to explore the rather unexplored research field of agile methods in logistics industry. For this purpose, the characteristics of the Delphi approach such as being based on a multi round survey, the controlled feedback loop and the possibility to ask similar questions throughout the rounds are helpful. The authors modified the Delphi approach (Dalkey and Helmer, 1963; Linstone and Turoff, 2002; Diamond et al., 2014) and carried out an iterative expert assessment process (Dalkey, 1969) to evaluate the use of agile methods and practices in traditional logistics companies and logistics startups in four stages (see Fig. 2). The goal of the first stage is to explore the discussed topic through mostly qualitative questions. Afterwards first insights of the experts are used to deepen the understanding of the topic under discussion in the second stage. In the second stage qualitative as well as quantitative questions are combined. In the third stage, the central theses of the expert group are generalised and clustered. Conclusively, a final evaluation of core findings takes place after the overall analysis has been completed.

Within the questionnaire, qualitative questions are combined with quantitative ones. In-depth insights can be gained through
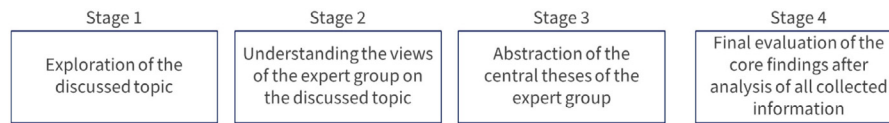
Stage 1	Stage 2	Stage 3	Stage 4
Exploration of the discussed topic	Understanding the views of the expert group on the discussed topic	Abstraction of the central theses of the expert group	Final evaluation of the core findings after analysis of all collected information

Fig. 2. Stages of the conducted modified Delphi study.

qualitative, controlled opinion feedback (Dalkey and Helmer, 1963; Fletcher and Marchildon, 2014), which can be quantified in the following rounds of quantitative questions and evaluated without distortion. Providing feedback on the results of the preliminary rounds enables the experts' opinions to be honed (Vijayasarathy and Turk, 2012).

3.1. Objective and research questions

The goal of this Delphi Study was to gather data on the current use of agile methods by questioning established logistics companies as well as logistics startups. The gathered data was used to address the research questions. They are specified below.

Research Question 1: Which agile methods and practices do traditional logistics companies and logistics startups use?

This question is about finding out which agile methods and practices are actually used by traditional logistics companies and logistics startups. One main goal is to compare agile methods used in traditional logistics companies and startup and the other goal is to analyze criteria used for the selection of agile methods.

Research Question 2: What benefits do traditional logistics companies and logistics startups want to realise using agile methods?

The goal is to find out which benefits traditional companies and startups want to achieve using agile methods and practices and how effective these agile methods and practices are in achieving these benefits.

Research Question 3: What difficulties do traditional logistics companies and logistics startups face concerning the adoption of agile methods and practices?

For this question, the obstacles traditional logistics companies as well as logistics startups encounter when introducing and using agile methods and practices are consolidated.

3.2. Description of the study design

The study was conducted in several successive rounds. Fig. 3 gives an overview of the procedure. In each round, a questionnaire was created and optimised through several pretests with academic and industrial experts. Afterwards, an e-mail with an invitation and link to the online questionnaire was sent to the participating experts. Results of the previous rounds were used to develop the subsequent questionnaires. The participants had two weeks to answer the questionnaire. Afterwards, the results were evaluated with two other researchers. The study was conducted with questionnaires in German and English. These were checked in advance for consistency.

Google Forms was used for all rounds of the Delphi Study. In general, it was decided to use qualitative questions and 7-point Likert items for quantitative questions because it has been proven to be the best choice to avoid interpolation (Finstad, 2010). In some cases a 5-point Likert item was used to reduce complexity for the experts in the answer choices (Cummins and Gullone, 2000). In addition, the quality criteria proposed by Diamond et al. were considered (Diamond et al., 2014) to ensure the quality of this study.

In the first round, invitations were sent out to 37 experts who work in traditional German logistics companies and German logistics startups. 29 experts participated in the study. In the second round, 25 participants completed the questionnaire, and in the third round, 22 questionnaires were finished. For reliable results, the literature recommends a minimum number of at least 10–15 panelists (Dalkey, 1969; Lilja et al., 2011).

3.3. Selection of experts

For the pretests, knowledge and views of academic and industrial experts were used. These experts qualified to perform the pretests as they either conducted Delphi studies on the use of agile methods themselves in an academic context, worked as professor in the field of logistics or because they conducted agile transformation projects in logistics companies.

For this Delphi Study participants are expected to have deep expert knowledge on the use of agile methods and practices in the IT departments of traditional logistics companies and logistics startups (Okoli and Pawlowski, 2004). As expertise is difficult to assess, a systematic classification was conducted (Clayton, 1997; Sackman, 1975). Participants were selected based on their expertise in the specific field of logistics and, more specifically, for their experience with agile methods and practices. All experts who participated in the Delphi Study are professionals currently working in the areas of logistics and IT consultation, in the area of logistics, with many years of professional experience. In total, the panel consisted of 29 experts working in 29 different companies headquartered in Germany.

Approximately 45% of the companies of the participants were founded within the last 10 years and are therefore classified as startups (see Fig. 4). In total, 14 out of 29 participants were from traditional logistics companies. More than 25% of all participating companies were founded within the last three years. The details can be found in the following diagram:

About 50% of the participants come from companies with more than 500 employees. In comparison, about 30% of the participants come from companies with fewer than 30 employees (see Fig. 5). All companies older than 10 years have more than 500 employees. Even though all startups have fewer than 500 employees, this study is not about comparing large and small companies. In addition to age, the startups considered also have the characteristics of being (highly) innovative in terms of their technology and/or their business model.

For the team organisation, participants chose between three predetermined project management approaches to describe their team's organisation: "Agile", "Classical approach" and "Hybrid form". Additionally, the participants had the possibility to add another form of team organisation in a free text field. Participants stated that only a little work is done purely according to the conventional waterfall model; often the hybrid approach is followed, or they even work in a completely agile manner. For all three project management approaches no supporting explanation was given to the participants (see Fig. 6).

In the Delphi Study, mainly members of top management, project leaders, and agile coaches/ scrum masters took part. Other participants work as head of departments, software developers, product leads and business analysts. As a broad selection of experts participated, a variety of different views can be included (Okoli and Pawlowski, 2004). In Fig. 7, the distribution of different
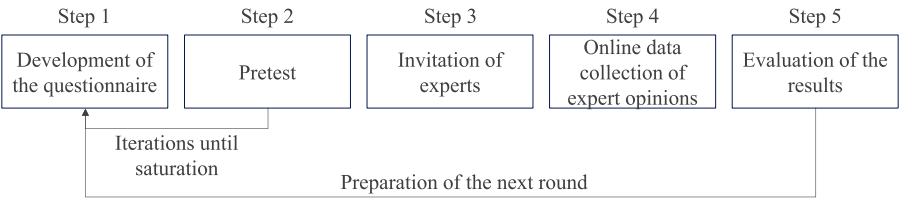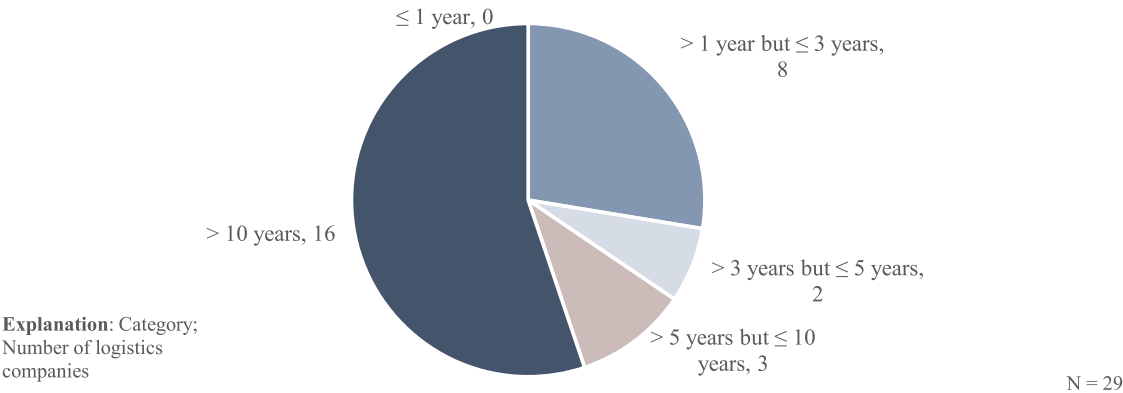
Fig. 3. Process of the Delphi Study.

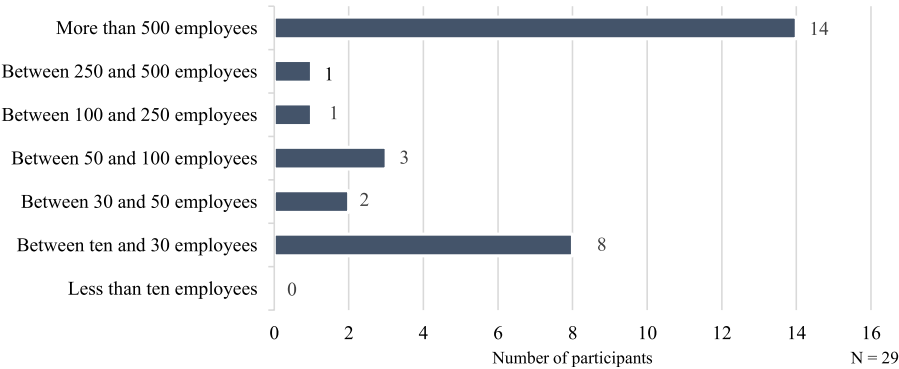**Fig. 4.** Age of the logistics companies.

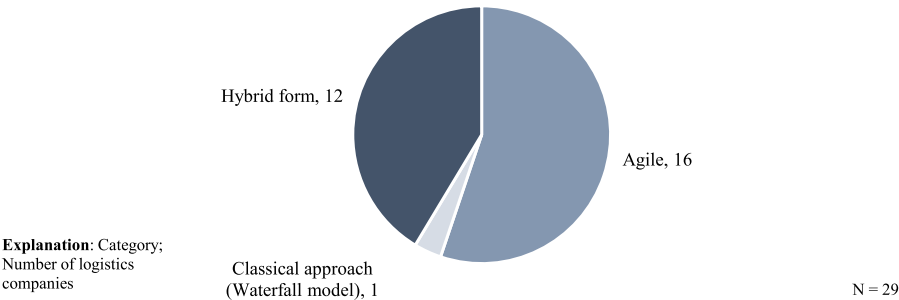**Fig. 5.** Number of employees in logistics companies.

Fig. 6. Team organisation.

roles can be seen. Fig. 7 represents the participants of the first round.

The participating experts were also asked to assess their prior knowledge with regard to agile methods. 20 out of 29 participants, close to 70%, rated their prior knowledge on a scale from one to seven as five or higher (see Table 4). 16 of the 29 participants have three or more years of experience with the use of agile methods and practices.

Table 4
Expertise of experts ($N = 29$) in agile methods rated by themselves ($1 = $ No know-how, $7 = $ Very extensive know-how)

Scale	1	2	3	4	5	6	7
Number of participants	0	1	2	6	6	13	1

Experts are aware of the type of the employing company (traditional logistics company; logistics startup) of other panel
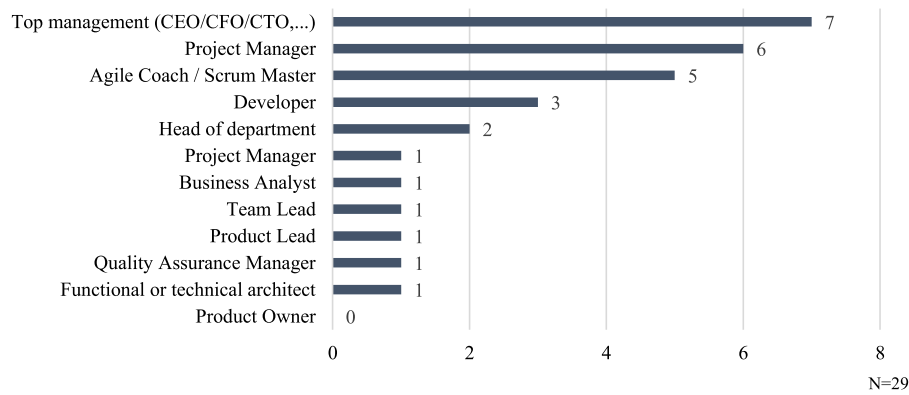
Fig. 7. Roles of the experts in their organisations.

members. This is necessary to prevent that experts have the feeling that they can say anything as accountability is removed due to anonymity of experts in this study (Sackman, 1975).

3.4. Delphi process

Three complementary rounds were conducted. The questionnaires for round 2 and 3 was designed after the results of the previous rounds were analyzed. The data from the individual rounds was evaluated statistically but also qualitatively due to the rather small number of participants. By filtering the data according to certain clusters such as type of company, role in the company, experience with agile methods, it was possible to uncover particularities. Details are described below.

Round 1

The questionnaire for the first round was comprised of two sections. The first section asked for information of a personal nature, which was used for the assessment of the individual participants (summarised in Section 3.3). Additionally, more formal information such as the size and age of the employing company was recorded.

The second section was comprised of nine questions, some of which were open questions and some of which were multiple choice questions. The following topics were covered:

- Agile methods and practices used (multiple choice)
- Way of using agile methods (e.g. in "pure form" or with many adaptations) (multiple choice)
- Frequency of use of agile practices (multiple choice)
- Initiator of and decision maker(s) on or for the use of agile methods and practices (multiple choice)
- Advantages of using agile methods and practices (open question)
- Challenges in using agile methods and practices (open question).

Learnings from Round 1

The results of the first round showed that especially in logistics startups some agile methods, which are not as popular as Scrum or Kanban, are used more often than described, e.g., in the State of Agile Report (VersionOne CollabNet, 2019). In order expand further on this point, the second round was devoted to the question of which practice is used for which purpose and how the methods are selected for their application.

Results of the first round also showed that agile methods are frequently adapted to the needs of companies. According to the results, this adaptation of agile methods to one's own company-specific circumstances is stronger than described in the literature (Kähkönen, 2004; Fuchs, 2019). Fig. 8 shows the level of adaptions to company specifics.

In order to understand how agile methods are introduced and how traditional logistics companies and logistics startups establish their use, the process of agile transformation has been increasingly addressed in the following rounds. These learnings show that subsequent rounds are necessary to react and expand on findings from the first rounds.

Round 2

The following topics were covered in the second round:

- Criteria used for the selection of agile methods (multiple choice)
- Practices used to deal with challenges ranked most important (described below) during round 1 and efficiency of those practices
  - Changing internal and external requirements
  - Changing priorities
  - Acceleration of product delivery
  - Improvement of communication between the customer and the IT department
  - Increasing transparency on project risks and impediments
  - Increasing product quality
  - Decreasing project risk
  - Increasing productivity of the team.

- Approach chosen for the agile transformation if applicable (multiple choice)
- Factors influencing the successful use of agile methods (multiple choice).

Even though each question was a designed as a multiple-choice question, participants had the possibility to deepen their answers after each question in a free text field that followed every question.

Learnings from Round 2

In the second round, the participants were asked to describe which agile practice they use to deal with certain challenges. In addition, the participants were also asked to evaluate the effectiveness of the practices. The results show that even though the effectiveness of the practices used is not high for all practices, they are still used to deal with the challenges. For this aspect, clarification was needed in the third round. Based on these rather unexpected findings, questions in the third round asked whether participants think they use the agile practice chosen in the best way possible and if they plan to use other or additional agile methods and practices. Qualitative answers given in free text fields by the participants were structured and included in the reports. Through these reports, the communication process between the participants could be structured by a qualitative
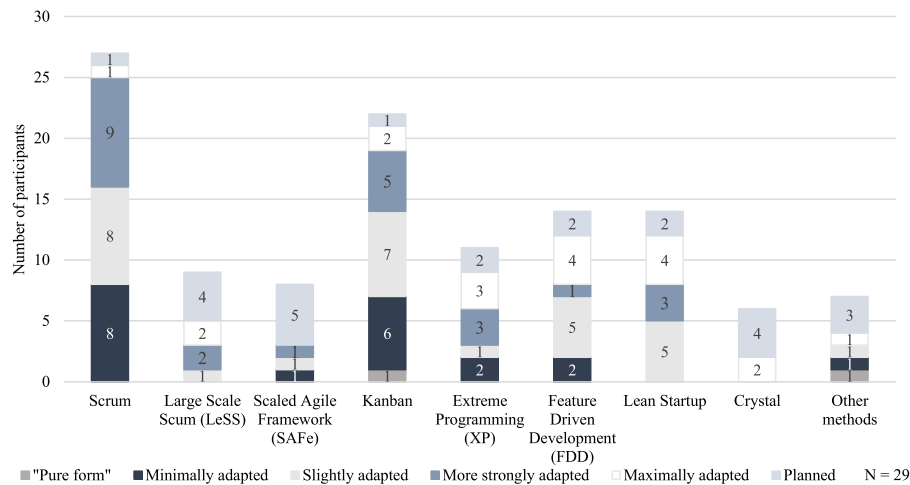
Fig. 8. Level of adaption of agile methods to company specifics.

evaluation of the free text answers. Theses structured answers were sent to the participants in a report that presented results from the second round together with the link to the third questionnaire.

Round 3

To augment the results of the second round the following points were inquired after.

- Rating the importance of the criteria used for the selection of agile methods (multiple choice)
- Evaluation of the utility of the employed agile methods (multiple choice)
- Planned utilisation of other or further agile methods (multiple choice)
- Effects of the challenges of the use of agile methods (multiple choice).

The questions were all designed as multiple choice questions but as in the previous rounds the participants had the possibility after each question to explain their answers in a free-text field.

Learnings Round 3

Participants were questioned on several topics in multiple rounds. Altering the question design lead to slightly varying results. Changing the question design helped to reveal thus far undiscovered nuances in the results.

Over the course of the three rounds of questioning, the number of outliers was not reduced significantly. Therefore, the summarising reports of the individual rounds did not cause the participants to align their answers significantly with the answers of the other participants.

The results also confirm that saturation is reached after three rounds. In the hitherto rather unexplored research field in question, answers could be found for all three research questions. Using complementary rounds, research questions could be answered in greater depth, as it was possible to react to unforeseen results.

4. Results

Summarising the results of the three complementary rounds, answers for all of the RQs could be found. They will be described in the following.

4.1. Research Question 1: Agile methods and practices used

To answer the first RQ, the participants were asked which agile methods and practices are used in their teams.

Scrum is the agile method used most by traditional logistics companies as well as by logistics startups (see Fig. 9). This is followed by: Kanban, Lean Startup, XP and FDD. Noticeably, startups seem to use more technical agile methods such as XP and FDD more often than traditional logistics companies (Beck, 2000; Palmer and Felsing, 2002). One possible explanation for this is that start-ups are technologically intensive, as their products are often based on software and new technical innovations. More than 80% of the participants stated that they plan to use additional agile methods, especially methods for scaling Scrum such as Scaled Agile Framework (SAFe) and Large Scale Scrum (LeSS). Logistics companies, especially the logistics startups, seem to plan scaling their agile (IT) teams.

These results can be compared to the results of the 13th State of Agile Report (VersionOne CollabNet, 2019). The State of Agile Report is conducted by CollabNet VersionOne and collects responses from more than 1.000 participants worldwide, from various industries and company sizes, on the use of agile methods. Following the results of the State of Agile report, Scrum is also the most widely used methodology. However, this is followed by Scrumban and a collection of other hybrid approaches. The methods Lean Startup and XP are only mentioned in the State of Agile Report in 2% and 1% of the cases, respectively. For scaling agile teams, the State of Agile report stated that most companies use SAFe, Scrum of Scrum or LeSS, among others (VersionOne CollabNet, 2019).

Additionally, participants stated in free text fields that they use "Scrumban", where *"practices from both methods (Scrum and Kanban) are combined"* or *"other mixed forms of methods to address the specific needs of the company's situation or the skills/strengths of the employees"*.

Looking at the agile practices, "Daily (Scrums)" followed by "Close exchanges within the agile teams", "Reviews" and "Retrospectives" are used most often. For logistics startups, the "Creation of minimum viable products" as well as "Joint team planning" through "Daily (Scrums)" and "Sprint Planning" sessions are especially important. For traditional logistics companies the "Use of Task boards like Kanban boards", the "Close Exchange within the Team" and the "Feedback from the Customer" are the agile practices used most often. Fig. 10 shows the agile practices used by the practitioners.

Comparing this with the results of the 13th State of Agile Report, it is also evident that "Daily (Standups)", "Sprint Planning", "Retrospectives" and the "Iterative collection of customer feedback" are the most important practices (VersionOne CollabNet,
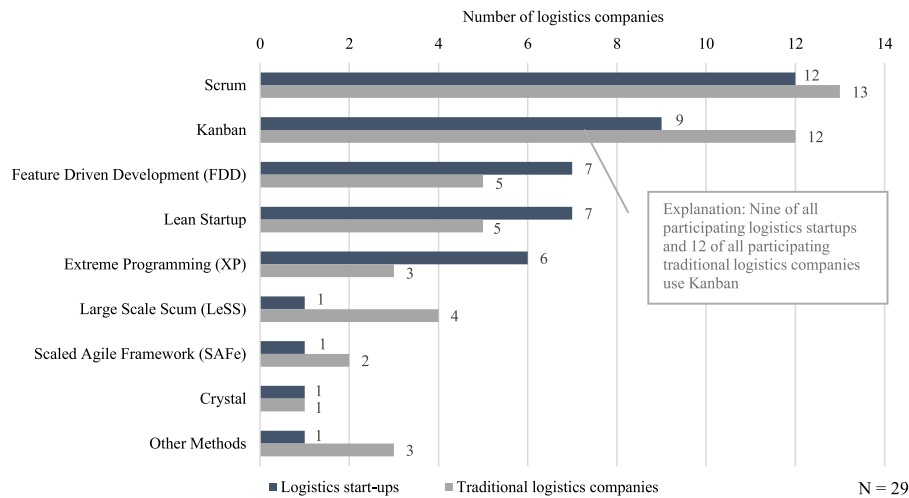
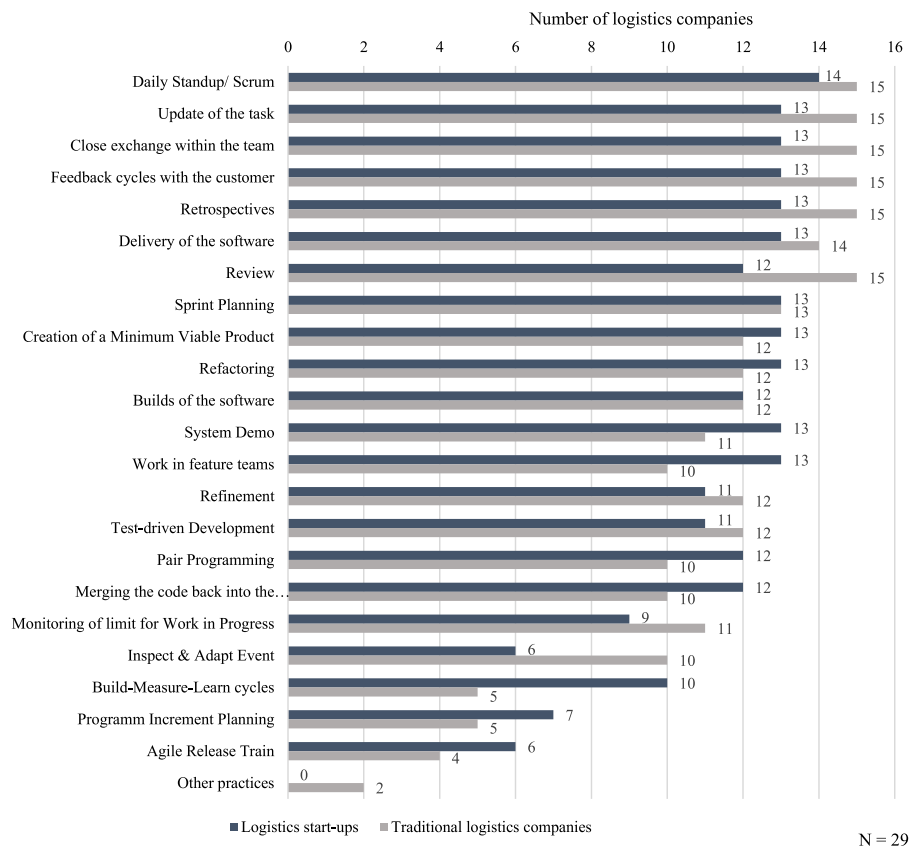**Fig. 9.** Overview of the agile methods used.

Fig. 10. Overview of the agile practices used.

2019). The logistics industry seems to operate similarly to other industries.

In the free text field, participants added they used also other agile practices such as "Definitions of Ready" and "Mob programming". The following comment explains how "Definitions of Ready" are used in the traditional logistics company of one participant: *"We host a daily meeting for the Definition of Ready, which means we discuss upcoming stories/tasks, which can then be prioritised and implemented. We usually take 15 min for this."*

In theory, agile practices are a subset of agile methods. The results of this Delphi Study show that often single practices are used instead of an entire agile method. For example, in all of the cases, "Daily (Standups)" are performed in logistics startups and traditional logistics companies. However, only 86% of logistics startups and 87% of traditional logistics companies use the associated agile method Scrum. The effect is even stronger with more technical agile practices such as "Refactoring" and "Pair Programming": they are used separately more often than the entire agile method of XP. Other studies support this finding (Diebold and Dahlem, 2014a; Jalali and Wohlin, 2010; Pikkarainen et al., 2008).

To understand why certain agile methods and practices were selected for use in traditional logistics companies or logistics startups, participants were asked about their selection criteria in the

second round. Participants could select multiple answers. In the second round, 25 of the 29 experts participated. In the following selection criteria participants could choose in the questionnaire are set into quotations marks.

The criterion used most for the selection of agile methods is "Previous Experience". Other criteria that participants use are "Fit of the Agile Method to Existing Requirements", "Applicability to the Team Size" and "Previous Knowledge of Employees".

Nine participants of the logistics startups stated that they chose agile methods based on their "Previous Experience". In traditional logistics companies, eleven of the 14 participants confirmed this. Of the three remaining participants from traditional logistics companies, two participants had the support of external consultants or an agile coach selecting the method. The fact that "Previous Experience" as a whole is the most frequently chosen criterion is particularly interesting, since the literature so far tends to assume that "Existing Requirements" and "Goals of the Team" are the main selection criteria (Campanelli and Parreiras, 2015).

One participant of a logistics startup expressed that most of the time their approach develops in practice, and once the questionnaires were completed, found out that they actually used FDD. Another participant specified: *"Although trying new things ("Inspect and Adapt") is not a criterion for selection [of agile methods], it determines my everyday life."* Besides Transparency, Inspection and Adaption are two of the three core pillars of the agile method Scrum and support agile teams in continuous improvement.

Less often the decision on the use of agile methods is made based on the "Image of the Agile Methods" and their "Implementation Costs". However, in eight out of ten cases in which company guidelines are used to select agile methods, the use of the Scrum method is proposed.

The chart below (Fig. 11) gives a concluding overview on the distribution of selection criteria used by traditional logistics companies and logistics startups. As described above Fig. 11 shows that traditional logistics companies and logistics startups use different selection criteria.

Even though most decisions in both types of companies are made based on "Previous Experience", traditional logistics companies follow more often the "Advice from External Consultants and Colleagues" and "Company Policies". Logistics startups make decisions on agile methods with a greater focus on their "Fit to Existing Requirements" and more often include "Applicability to the Team Size".

4.2. Research Question 2: Benefits from the use of agile methods

To answer the second RQ, the participants were asked for which reasons they use agile methods and practices. The results show that the reasons why participants use agile methods are largely the same in logistics startups and traditional logistics companies. It is mainly about the responsiveness to changing priorities and demands, the acceleration of (product) delivery, and more intensive coordination between IT and business departments (see Fig. 12).

Regardless of the size of the company, very similar benefits seem to be sought through the use of agile methods. If you compare this with the 13th State of Agile Report, it can be seen that this does not only apply to the logistics industry. Also in other industries, the most important advantages of the use of agile methods are the ability to react to changing requirements, fast product/software delivery, increased quality, and improved coordination between IT and the business (VersionOne Collab-Net, 2019). There is one aspect that seems to be particularly relevant for logistics start-ups, namely the increase in productivity. Increasing productivity is probably particularly important for

start-ups, as they often have fewer resources and have to achieve more with less (Giardino et al., 2014; Caseiro and Coelho, 2019).

Participants were allowed to select up to four answers. One participant stated the following: *"I think almost everything can be checked above, because there are so many dependencies. In our case it is mostly the experience the team made in the past with non-agile methodologies that led to low quality of a product and essentially development of the product nobody actually needs. So, team spirit and employee satisfaction is also there, because with agile methodologies less things go to waste".*

This underlines that the agile approach focuses not only on customer value created and responsiveness — even though these answers are ranked highest in Fig. 12 - but also satisfaction and motivation of the development team. This quotation also represents the approach of the Agile Manifesto, which emphasises the importance of the employees.

In the second round, questions to expand on the findings from the first round were asked. In the following, results from the second round will be described. After analyzing methods used by the participants and benefits of their application (see Fig. 12), participants were asked with which agile practices exactly they realise these benefits. In the following, the agile practices used to realise the most important benefits (Reacting to changing requirements and acceleration of product delivery) will be presented.

To respond to changing priorities, such as changing customer requirements, mainly "Sprint planning", "Daily Scrum" and the "Feedback cycles with the customer" are used.

In addition to the practices mentioned above, many other incremental practices are also used. Clustering the participants' responses shows that 17 of the 25 participants use some form of incremental approach such as "Build-Measure-Learn cycles", "Regular software delivery", "Creation of minimum viable products" and "Reviews".

Several participants explained that more than one practice is suitable to react to changes. The following comment is representative of the comments of a number of participants: *"Several answers would have been possible, since in everyday life each customer/stakeholder also wants to be addressed differently. For some, regular review meetings are suitable, for others, small-step minimal viable products are important. However, I think that all of them are well represented by close feedback cycles with the customers".*

To accelerate product delivery, "Regular software delivery" is most commonly used. "Regular (and automated) software delivery" allows quick feedback from the customer and users. This statement is supported by two additional comments from the participants, who have indicated that they also use continuous integration and continuous deployment.

Participants were also asked whether they made the best use of agile practices to speed up product deliveries. The following points were identified by the participants as obstacles that prevent the best use of agile practices:

- "Resistance from management and lack of understanding among developers"
- "Lack of release automation"
- "Non-resolvable, functional dependencies on stories that are only found during implementation"
- "Lack of focus on product vision"
- "Additional QA cycles are required because QA/testing is not yet an integral part of the sprints".

4.3. Research Question 3: Difficulties adopting agile methods and practices

To answer the third RQ, the participants were asked which challenges and difficulties occur adapting and using agile methods and practices. Overall, there is a rather similar distribution
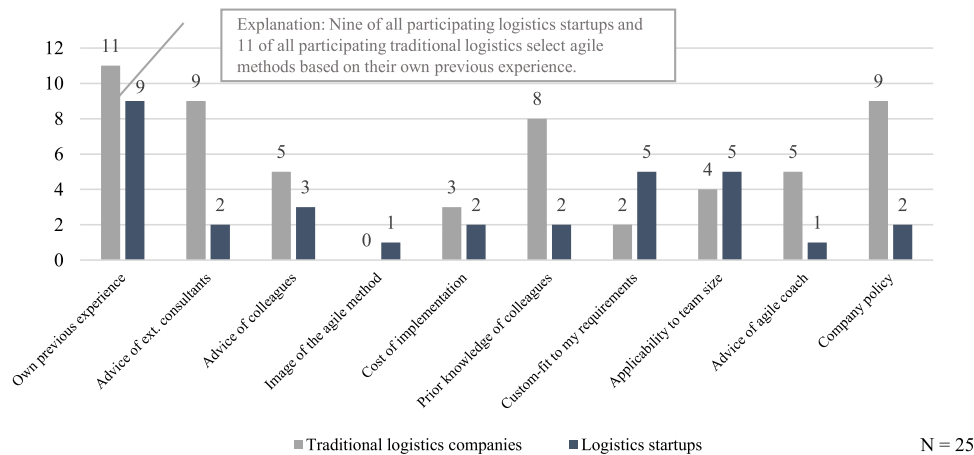
Fig. 11. Division of selection criteria between traditional logistics companies and logistics startups.
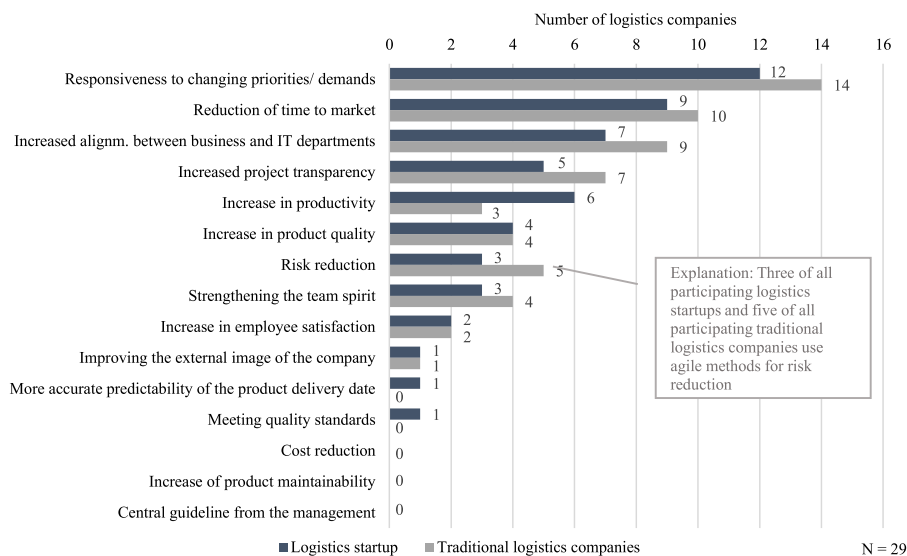

Fig. 12. Top reasons for the use of agile methods and practices.

between the challenges faced by logistics startups and traditional logistics companies when using agile methods. Looking at traditional logistics companies in more detail, they rather have a problem with the organisational culture and lack of willingness to change. Participants from logistics startups stated that their employees/ colleagues do not take issue with change so much as with the unbalanced distribution of knowledge in the agile IT teams. Both types of companies see the partial lack of knowledge about agile methods as a challenge (see Fig. 13).

One participant complemented his selection with the following text: "*I marked "lack of skills or knowledge in relation to agile methods" because being agile is more than following the Scrum ceremonies, it has to be a mindset, the way person works every day — and this is hard to achieve, because a lot of people do not even understand the meaning behind agile. Hiring a Scrum Master does not make team agile, having sprints does not make team agile. Understanding of minimal viable product does*". Another participant stated the users especially have problems defining small-sized requirements. That hinders the participant's team in developing minimal viable products. Another participant stated in addition to the pre-defined answer options that, "*they do not have a dedicated product owner and the executive management has the final say, especially on prioritisation issues*".

These answers underscore the importance of the agile mindset and agile values. Introducing, e.g., the Scrum events, does not

create an agile organisation, but the right mindset can change a lot in the way problems are solved and customer value is delivered.

Looking at different roles of the participants, Agile Coaches and Scrum Masters assess organisational culture in particular, the lack of knowledge about agile methods, and resistance to change as challenges. In comparison, the unbalanced distribution of knowledge within teams, the lack of availability of product owners, and the lack of commitment of the customer regarding feedback are the challenges that top management and department heads see when it comes to the use of agile methods. This shows that in most cases these roles have a different educational and professional background and distinctly different goals regarding the introduction and the use of agile methods.

4.4. Implication of the findings

It can be confirmed that through the iterative approach of Delphi Studies and the realisation of (modified) Delphi Studies (see Section 2.2 Related Work), the research questions could be answered. This Delphi Study contributes to closing the identified research gap. In 2019, an SLR confirmed that no studies could be found that deal with the use of agile project management methods in the IT departments of traditional logistics companies or
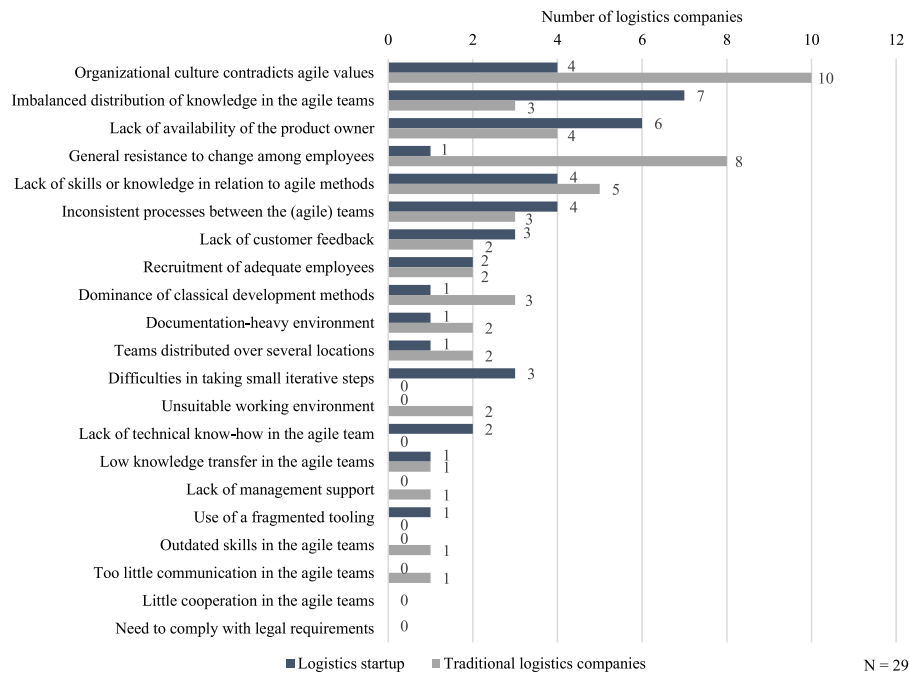
Number of logistics companies

	Logistics startup	Traditional logistics companies
Organizational culture contradicts agile values	4	10
Imbalanced distribution of knowledge in the agile teams	7	3
Lack of availability of the product owner	6	4
General resistance to change among employees	1	8
Lack of skills or knowledge in relation to agile methods	4	5
Inconsistent processes between the (agile) teams	4	3
Lack of customer feedback	3	2
Recruitment of adequate employees	2	2
Dominance of classical development methods	1	3
Documentation-heavy environment	1	2
Teams distributed over several locations	1	2
Difficulties in taking small iterative steps	3	0
Unsuitable working environment	0	2
Lack of technical know-how in the agile team	2	0
Low knowledge transfer in the agile teams	1	1
Lack of management support	0	1
Use of a fragmented tooling	1	0
Outdated skills in the agile teams	0	1
Too little communication in the agile teams	0	1
Little cooperation in the agile teams	0	
Need to comply with legal requirements	0	

■ Logistics startup   ■ Traditional logistics companies   N = 29

Fig. 13. Challenges of startups and traditional logistics companies using agile methods and practices.

in logistics startups (Zielske and Held, 2020a). This Delphi Study was able to identify agile methods and practices used in the IT departments of traditional logistics companies and logistics startups. In addition, the experts were surveyed in successive rounds about the benefits of using agile methods and the difficulties of their introduction and application. The iterative structure of the survey allowed the experts' statements to be questioned more deeply and to react to unexpected results. The implications of the answers to the three RQs are discussed below. Practitioners and researchers can benefit from this research as this study aims to diminish the research gap identified. Practitioners could compare their own use of agile methods and practices with the views of the experts and learn from their experiences especially during the implementation of agile methods. Researchers could use this study as a foundation to carry out other studies, , e.g. large scale surveys, expanding findings of this study. Additionally, researchers could learn from the modified Delphi study used. This Delphi study was carried out in 2020, a year in which the logistics sector in particular is strongly affected by Corona. Especially in these disruptive times, logistics companies can benefit even more from the use of agile methods. There are numerous reports that prove that especially in 2020 companies can increasingly introduce agile methods and benefit from their advantages (Janssen and van der Voort, 2020; Goel et al., 2020).

4.4.1. Findings Research Question 1: Which agile methods and practices do traditional logistics companies and logistics startups use?

In sum, Scrum, and Kanban are the agile methods used most often in both traditional logistics companies and logistics startups. In terms of agile practices, "Daily (Scrums)" followed by a "Close exchange within the agile team", "Reviews" and "Retrospectives" are used most often. Many logistics startups use the "Creation of Minimum Viable products". Decisions to select these agile methods and practices are mainly made based on "Previous Experience", adapted to "Fit to Special Company Requirements" and "Team Size". Traditional logistics companies also frequently take "Company Policies" and the "Advice of External Consultants" into account. This study aligns with findings from several other publications looking at other industries. The State of Agile Report

and publications from Rodríguez et al. and Diebold and Dahlem describe that Scrum as an agile method; SAFe and LeSS as agile scaling methods and "Daily (Standups)", "Sprint Planning", "Retrospectives" and the "Iterative collection of customer feedback" are used most (VersionOne CollabNet, 2019; Rodríguez et al., 2012; Diebold and Dahlem, 2014b). This study shows that the logistics companies interviewed support these findings. In the future, it would be interesting to look at the use of agile methods of other departments of logistics companies and compare their use of agile methods with those of other industries.

4.4.2. Findings Research Question 2: How do traditional logistics companies and logistics startups benefit from the use of agile methods?

The most important benefits that traditional logistics companies and logistics startups aim to achieve with agile methods and practices are the responsiveness to changing internal and external requirements, acceleration of product delivery, and optimisation of the alignment between the customers/ users and the IT departments. "Sprint Plannings", "Regular feedback cycles with the customers" and "Regular (software) delivery" are commonly used to achieve these benefits. The findings of this study correspond to the findings of the State of Agile approach and the publication of Vijayasarathy and Turk and the study of Gustavson. Most companies analyzed aim to improve their to react to external and internal changes (VersionOne CollabNet, 2019; Vijayasarathy and Turk, 2008; Gustavsson, 2016). As the logistics industry is a service industry, it needs to fulfill the requirements of its clients who mainly come from other industries. This might be the reason why the logistics industry seems to use agile methods for the same benefits as other industries.

4.4.3. Findings Research Question 3: What difficulties do traditional logistics companies and logistics startups face concerning the adoption of agile methods and practices?

Organisational culture, and fear and resistance to change make the introduction and use of agile methods in many cases difficult. In traditional logistics companies especially, these mindset-related issues seem to be a major problem. Logistics startups

often struggle with a lack of knowledge distribution in their agile teams and the lack of availability of product owners. Challenges identified in this study differ from the ones identified in the state of agile report and the publication of Vijayasarathy and Turk (VersionOne CollabNet, 2019; Vijayasarathy and Turk, 2008). Especially challenges faced by logistics startups participating in this study vary from those identified in other studies. That might show that traditional companies face the same challenges regardless of their industry but that (logistics) startups have to solve other challenges than traditional companies. Whether these challenges of startups depend on the industry could be the evaluated in future studies. Other than the results of RQ 1 and RQ 2, the results of this RQ show that the logistics industry faces partly other challenges than other industries. Especially the traditional logistics companies have to deal more with challenges that are related to the mindset of the employees. This supports the overall research approach that is based on the assumptions that the logistics industry is of special interest as it is a rather conservative industry.

4.5. Limitations

As the design of a questionnaires is paramount for the data collection process, several pretests were conducted with researchers and company experts. Nevertheless, it cannot be ruled out that nuances in the answers may be lost through this type of online survey. Therefore, the participants had the option to augment their answers into closed questions in free text fields. Following every round of questioning, a report on the results was prepared by the authors of this paper and sent to the participants. Decisions were made on the selected points of interest in these reports. This may lead to distortions in the opinion-forming process of the panel in the following rounds. An attempt was made to minimise this effect by means of a very precise data analysis and the involvement of two additional researchers.

In assessing validity, a distinction should be made between external, internal, construct and conclusion validity. The external validity of the Delphi method describes the similarity between the judgment of the experts and the real value. External validity is influenced by the number of experts and their skills and motivation but also by the quality of the instructions (van Zolingen and Klaassen, 2003). External validity was ensured through the selection of experts based on their expertise with agile methods (Woudenberg, 1991). This expertise was also assessed to reassure the participants' expertise. The fact that many participants filled optional free text fields with additional information underlines the participants' motivation. Quality of the instructions of the questionnaire was guaranteed through multiple pretests. Internal validity of the Delphi method questions whether the method itself allows drawing the right conclusions of the data gathered. The number of participants, their individual expertise and intercorrelation of their views influence internal validity (van Zolingen and Klaassen, 2003; Woudenberg, 1991). In total, 29 experts participated. In the literature a minimum number of at least 10–15 panelists (Dalkey, 1969; Lilja et al., 2011) is advised for reliable results. On average participants assessed their own expertise on a scale of 1 (low) to 7 (high) with 5,1. even if this is a self-assessment, together with the years of experience and the roles of the participants in the logistics companies, this assessment is helpful and emphasises the expertise of the participants. As experts come from different types of companies, different background and different roles, the intercorrelation of the judgment of experts is rated as low.

Construct validity depends on the use of well-established definitions and assessment procedures for variables (García-Pérez, 2012). For this Delphi study, other Delphi studies from the logistics industry and studies focusing on agile methods have been

examined closely and good practices have been adopted (see chapter 2.2., Table 3) (Schön et al., 2017b; Conboy and Fitzgerald, 2007). Also related other studies surveying experts on agile methods have been used to ensure the use of correct terms and definitions (VersionOne CollabNet, 2019). Conclusion validity assesses the degree to which the relationship between the conclusions reached and the data are reasonable (García-Pérez, 2012; Cook and Campbell, 2002; Mokkink et al., 2010). Conclusion validity has been ensured through the data analysis of two researchers. Additionally, hypothesis and relationships found during data analysis have been tested and evaluated through the experts in the next round of the Delphi study.

Finally, it should be mentioned that a hypothesis-testing survey could be used to gain additional insights into the use of agile methods of traditional logistics companies and logistics startups. For a more detailed investigation of the manner in which the agile methods are applied, case studies may also be useful to understand what traditional logistics companies and logistics startups could learn from each other.

5. Conclusion and implications for future research

This paper has focused on the identification of the agile methods and practices used by traditional logistics companies and logistics startups. It has discussed the benefits and challenges of using agile methods. For this purpose, an iterative expert assessment process was carried out. This process consisted of three complementary Delphi rounds. The panel includes the views of 29 experts working in 15 traditional logistics companies and 14 logistics startups who are familiar with the use of agile methods and practices. By identifying the most important methods and practices as well as the benefits and challenges, it contributes to the body of knowledge in the field of logistics. Scrum and Kanban were identified as the most important methods, "Daily (Standups)", "Use of Task boards such as Kanban boards", and "Close Exchange within the Team" and with the customer were identified as the most important practices. The main goals of using agile methods are to be able to react to changes and reduce time to market. The biggest challenges are organisational culture, which contradicts agile values, and an unbalanced distribution of knowledge in agile teams.

Future research could include case studies to find how and what traditional logistics companies and logistics startups could learn from each other, especially in regard to agile methods, but also how they could benefit from each others' approaches in creating customer value. It could also be questioned to what extent the organisational culture of startups is more compatible with the use of agile methods than that of traditional logistics companies, as organisational culture and the fear of change are the biggest challenges for traditional logistics companies in terms of adopting and implementing agile methods and practices.

CRediT authorship contribution statement

Malena Zielske: Conceptualization, Validation, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Tobias Held:** Validation, Writing - review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jss.2021.110950.

References

Abbas, N., Gravell, A.M., Wills, G.B., 2008. Historical roots of agile methods: Where did 'agile thinking' come from? In: Agile Processes in Software Engineering and Extreme Programming. Springer, Berlin, Heidelberg, pp. 94–103.

Abrahamsson, P., Warsta, J., Siponen, M.T., Ronkainen, J., 2003. New directions on agile methods: a comparative analysis. In: 25th International Conference on Software Engineering, 2003. Proceedings. pp. 244–254.

Ahmad, M.O., Dennehy, D., Conboy, K., Oivo, M., 2018. Kanban in software engineering: A systematic mapping study. J. Syst. Softw. 137, 96–113.

Akkermans, H.A., Bogerd, P., Yücesan, E., Van Wassenhove, L.N., 2003. The impact of ERP on supply chain management: Exploratory findings from a European Delphi study. European J. Oper. Res. 146 (2), 284–301.

Anderson, D., 2004. Making the business case for agile management: Simplifying the complex system of software engineering. In: Motorola S3 Symposium. pp. 1–13.

Anderson, D., 2010. Kanban. Blue Hole Press, United States.

Anwer, F., Aftab, S., Waheed, U., Muhammad, S.S., 2017. Agile software development models TDD, FDD, DSDM, and crystal methods: A survey. Int. J. Multidiscip. Sci. Eng. 8 (2), 1–10.

Ashraf, S., Aftab, S., 2017. Latest transformations in scrum: A state of the art review. Int. J. Mod. Educ. Comput. Sci. 9 (7), 12–22.

Baig, J.J.A., Shah, A., Sajjad, F., 2017. Evaluation of agile methods for quality assurance and quality control in ERP implementation. In: 2017 IEEE 8th International Conference on Intelligent Computing and Information Systems, ICICIS 2017, 2018-January. pp. 252–257.

Beck, K., 2000. Extreme Programming EXplained: Embrace Change. Addison-Wesley, Boston, MA, USA.

Beck, K., et al., 2001. Agile manifesto. [Online]. Available: https://agilemanifesto.org/.

Bernal, W., Jimenez-Barros, M., Molinares, D., Peternina-Arboleda, C., 2019. Developing logistic software platforms: E-market place, a case study. In: International Conference Computational Logistics. pp. 380–396.

Boehm, B., Turner, R., 2003. Balancing Agility and Discipline: A Guide for the Perplexed, first ed. IEEE Computer Society, Washington, DC, USA.

Brown, J., Agnew, N., 1982. Corporate agility. Bus. Horiz J. 25 (2), 29–33.

Campanelli, A.S., Parreiras, F.S., 2015. Agile methods tailoring - a systematic literature review. J. Syst. Softw. 110, 85–100.

Carney, O., McIntosh, J., Worth, A., 1996. The use of the nominal group technique in research with community nurses. J. Adv. Nurs. 23 (5), 1024–1029.

Caseiro, N., Coelho, A., 2019. The influence of business intelligence capacity, network learning and innovativeness on startups performance. J. Innov. Knowl. 4 (3), 139–145.

Clayton, M.J., 1997. Delphi: A technique to harness expert opinion for critical decision-making tasks in education. Educ. Psychol. 17 (4), 373–386.

Cockburn, A., 1998. Surviving Object-Oriented Projects: A Manager'S Guide. Addison Wesley Professional, Boston, Massachusetts, USA.

Cockburn, A., 2005. Crystal Clear: A Human-Powered Methodology for Small Teams. Addison-Wesley, Boston, Massachusetts, USA.

Cockburn, A., Highsmith, J., 2001. Agile software development: The business of innovation. Computer (Long. Beach. Calif). 34 (9), 120–127.

Cohn, M., 2009. Succeeding with Agile: Software Development using Scrum, first ed. Addison-Wesley Professional, Boston, Massachusetts.

Conboy, K., 2009. Agility from first principles: Reconstructing the concept of agility in information systems development. Inf. Syst. Res. 20 (3), 329–354.

Conboy, K., Fitzgerald, B., 2004. Toward a conceptual framework of agile methods: A study of agility in different disciplines. In: Proceedings of the 2004 ACM Workshop on Interdisciplinary Software Engineering Research. pp. 37–44.

Conboy, K., Fitzgerald, B., 2007. The views of experts on the current state of agile method tailoring. In: IFIP International Federation for Information Processing, Vol. 235. pp. 217–234.

Cook, T., Campbell, D., 2002. Quasi-Experimentation: Design and Analysis Issues: Design and Analysis Issues for Field Settings: Amazon.de: Cook, Thomas D. Campbell, Donald T.: Fremdsprachige Bücher. Houghton Mifflin, Boston, MA.

Cummins, R., Gullone, E., 2000. Why we should not use 5-point Likert scales: The case for subjective quality of life measurement. In: International Conference on Quality of Life in Cities. pp. 74–93.

Dalkey, N., 1969. An experimental study of group opinion: The Delphi method. Futures 1 (5), 408–426.

Dalkey, N., Helmer, O., 1963. An experimental application of the delphi method to the use of experts. Manage. Sci. 9 (3), 458–467.

Daniels, K.E.S., 2014. The New Venture Manifesto: Redefining the Success Standards of New Ventures with the Agile Methodology. Florida State University.

Davarzani, H., Norrman, A., 2015. Toward a relevant agenda for warehousing research: literature review and practitioners' input. Logist. Res. 8 (1), 1–18.

Delfmann, W., Ten Hompel, M., Kersten, W., Schmidt, T., Stölzle, W., 2018. Logistics as a science - central research questions in the era of the fourth industrial revolution. Logist. Res. 11 (9), 1–13.

Deschene, M., Don Gottwald, W., Clifford, C., 2016. Embracing Security in All Phases of the Software Development Life Cycle: A Delphi Study. Capella University, Capella, Minnesota, USA.

Diamond, I.R., et al., 2014. Defining consensus: A systematic review recommends methodologic criteria for reporting of Delphi studies. J. Clin. Epidemiol. 67 (4), 401–409.

Diebold, P., Dahlem, M., 2014a. Agile practices in practice - A mapping study. In: International Conference on Evaluation and Assessment in Software Engineering (EASE). pp. 1–10.

Diebold, P., Dahlem, M., 2014b. Agile practices in practice - A mapping study. In: Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering - EASE '14. pp. 1–10.

Diebold, P., Schmitt, A., Zehler, T., 2016. Agile potenzialanalyse: Der Weg zum passenden Grad an Agilität. Objekt Spektrum Sonderh. Agil. 1–4.

Diehl, M., Stroebe, W., 1987. Productivity loss in brainstorming groups: Toward the solution of a riddle. J. Pers. Soc. Psychol. 53 (3), 497–509.

Dikert, K., Paasivaara, M., Lassenius, C., 2016. Challenges and success factors for large-scale agile transformations: A systematic literature review. J. Syst. Softw. 119, 87–108.

Ebert, C., Paasivaara, M., 2017. Scaling agile, IEEE software. IEEE Comput. Soc. 34 (6), 98–103.

Finstad, K., 2010. Response interpolation and scale sensitivity: Evidence against 5-point scales. J. Usability Stud. 5 (3), 104–110.

Fleiss, J.L., 1971. Measuring nominal scale agreement among many raters. Psychol. Bull. 76 (5), 378–382.

Fletcher, A.J., Marchildon, G.P., 2014. Using the delphi method for qualitative, participatory action research in health leadership. Int. J. Qual. Methods 13 (1), 1–18.

Fuchs, C., 2019. Adapting (to) agile methods: exploring the interplay of agile methods and organizational features. In: Conference: 52nd Hawaii International Conference on System Sciences. pp. 7027–7036.

García-Pérez, M.A., 2012. Statistical conclusion validity: Some common threats and simple remedies. Front. Psychol. 3 (AUG), 325.

Giardino, C., Unterkalmsteiner, M., Paternoster, N., Gorschek, T., Abrahamsson, P., 2014. What do we know about software development in startups? IEEE Softw. 31 (5), 28–32.

Goel, S., et al., 2020. Resilient and agile engineering solutions to address societal challenges such as coronavirus pandemic. Mater. Today Chem. 17, 100300.

Goldman, S., Nagel, R., Preiss, K., Iacocca, L., 1995. Agile Competitors and Virtual Organizations: Strategies for Enriching the Customer. Van Nostrand Reinhold, New York.

Gunasekaran, A., Subramanianm, N., Papadopoulos, T., 2016. Information technology for competitive advantage within logistics and supply chains: A review. Transp. Res. 99, 14–33.

Gustavsson, T., 2016. Benefits of agile project management in a non-software development context - a literature review. In: Project Management Development – Practice and Perspectives. pp. 114–124.

Helaakoski, H., Iskanius, P., Peltomaa, I., Kipina, J., 2006. Agile business model in the steel product industry sector. In: 2006 IEEE International Conference on Management of Innovation and Technology. Vol. 2, pp. 1010–1014.

Highsmith, J.A., 2010. Agile Project Management: Creating Innovative Products. Addison-Wesley, Boston.

Holcomb, M., Gligor, D., 2012. Understanding the role of logistics capabilities in achieving supply chain agility: A systematic literature review, supply chain manag. Supply Chain Manag. Int. J. 17 (4), 438–453.

Hooper, M.J., Steeple, D., Winters, C.N., 2001. Costing customer value: an approach for the agile enterprise. Int. J. Oper. Prod. Manag. 21 (5/6), 630–644.

Jalali, S., Wohlin, C., 2010. Agile practices in global software engineering - A systematic map. In: Proceedings - 5th International Conference on Global Software Engineering, ICGSE 2010. pp. 45–54.

Jalali, S., Wohlin, C., Angelis, L., 2014. Investigating the applicability of agility assessment surveys: A case study. J. Syst. Softw. 98, 172–190.

Janssen, M., van der Voort, H., 2020. Agile and adaptive governance in crisis response: Lessons from the COVID-19 pandemic. Int. J. Inf. Manag. 55, 102180.

Kähkönen, T., 2004. Agile methods for large organizations - Building communities of practice. In: Proceedings of the Agile Development Conference, ADC 2004. pp. 2–10.

Kaim, R., Härting, R.C., Reichstein, C., 2019. Benefits of agile project management in an environment of increasing complexity—A transaction cost analysis. In: Smart Innovation, Systems and Technologies. Vol. 143, pp. 195–204.

Keenan, F., Bustard, D.W., 2006. Aligning computing systems with their environment: An agile perspective. In: Proceedings of the International Symposium and Workshop on Engineering of Computer Based Systems. pp. 229–237.

Kettunen, P., 2009. Adopting key lessons from agile manufacturing to agile software product development—A comparative study. Technovation 29 (6–7), 408–422.

Kruchten, P., 1998. The Rational Unified Process. Addison-Wesley, Boston, Massachusetts, United States.

Kupp, M., Marval, M., Borchers, P., 2017. Corporate accelerators: fostering innovation while bringing together startups and large firms. J. Bus. Strategy 38 (6), 47–53.

Kurtz, C.F., Snowden, D.J., 2003. The new dynamics of strategy: Sense-making in a complex and complicated world. IBM Syst. J. 42 (3), 462–483.

Laanti, M., Salo, O., Abrahamsson, P., 2011. Agile methods rapidly replacing traditional methods at Nokia: A survey of opinions on agile transformation. Inf. Softw. Technol. 53 (3), 276–290.

Larman, C., Basili, V.R., 2003. Iterative and incremental developments. a brief history. Computer 36 (6), 47–56.

Larman, C., Vodde, B., 2016. Large-Scale Scrum: More with Less. Addison-Wesley Professional, Boston, Massachusetts, USA.

Legendre, P., 2005. Species associations: The Kendall coefficient of concordance revisited. J. Agric. Biol. Environ. Stat. 10 (2), 226–245.

Lilja, K., Laakso, K., Palomäki, J., 2011. Using the Delphi method. In: Technology Management in the Energy Smart World. pp. 1–10.

Lindsjørn, Y., Sjøberg, D.I.K., Dingsøyr, T., Bergersen, G.R., Dybå, T., 2016. Teamwork quality and project success in software development: A survey of agile development teams. J. Syst. Softw. 122, 274–286.

Linstone, H.A., Turoff, M., 2002. The Delphi Method: Techniques and Applications. Addison-Wesley Educational Publishers Inc.

Mokkink, L.B., et al., 2010. The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: An international Delphi study. Qual. Life Res. 19 (4), 539–549.

Mourtzis, D., 2016. Challenges and future perspectives for the life cycle of manufacturing networks in the mass customisation era. Logist. Res. 9 (1), 1–20.

Nagel, R., Dove, R., 1991. 21st Century Manufacturing Enterprise Strategy-an Industry Led View. DIANE Publishing, Darby, PA, USA.

Newkirk, J., 2002. Introduction to agile processes and extreme programming. In: Proceedings of the 24th International Conference on Software Engineering - ICSE '02. pp. 695–696.

Nirwan, M.D., Dhewanto, W., 2015. Barriers in implementing the lean startup methodology in Indonesia – case study of B2B startup. Procedia - Soc. Behav. Sci. 169, 23–30.

Okoli, C., Pawlowski, S.D., 2004. The Delphi method as a research tool: An example, design considerations and applications. Inf. Manage. 42 (1), 15–29.

Palmer, S., Felsing, J., 2002. A Practical Guide to Feature-Driven Development. Prentice Hall PTR.

Pang, J., Blair, L., 2004. Refining feature driven development: A methodology for early aspects. In: Tekinerdogan, B., Clements, P., Moreira, A., Araujo, J. (Eds.), Early Aspects: Aspect-Oriented Requirements Engineering and Architecture Design. pp. 86–91.

Parente, S., 2015. Bridging the gap: Traditional to agile project management 1. PM World J. IV (IX), 1–12.

Paternoster, N., Giardino, C., Unterkalmsteiner, M., Gorschek, T., Abrahamsson, P., 2014. Software development in startup companies: A systematic mapping study. Inf. Softw. Technol. 56 (10), 1200–1218.

Perego, A., Perotti, S., Mangiaracina, R., 2011. ICT for logistics and freight transportation: a literature review and research agenda. Int. J. Phys. Distrib. Logist. Manag. 41 (5), 457–483.

Pikkarainen, M., Haikara, J., Salo, O., Abrahamsson, P., Still, J., 2008. The impact of agile practices on communication in software development. Empir. Softw. Eng. 13 (3), 303–337.

Pikkarainen, M., Wang, X., 2011. An investigation of agility issues in scrum teams using agility indicators. In: Information Systems Development: Asian Experiences. pp. 449–459.

Prater, E., Biehl, M., Smith, M.A., 2001. International supply chain agility Tradeoffs between flexibility and uncertainty. Int. J. Oper. Prod. Manag. 21 (5–6), 823–839.

Qumer, A., Henderson-Sellers, B., 2006. Crystallization of agility: Back to basics. In: ICSOFT 2006-1st International Conference on Software and Data Technologies, Proceedings. pp. 121–126.

Rodríguez, P., Markkula, J., Oivo, M., Turula, K., 2012. Survey on agile and lean usage in finnish software industry. In: International Symposium on Empirical Software Engineering and Measurement. pp. 139–148.

Rowe, G., Wright, G., 2001. Expert Opinions in Forecasting: The Role of the Delphi Technique. Springer, Boston, MA, pp. 125–144.

Sackman, H., 1975. Delphi Critique: Expert Opinion, Forecasting and Group Process, first ed. DC Heath, Lexington, MA, USA.

Sarker, S., Sarker, S., 2009. Exploring agility in distributed information systems development teams: An interpretive study in an offshoring context. Inf. Syst. Res. 20 (3), 440–461.

Schirrmacher, A., Schoop, M., 2018. Agility in information systems - A literature review on terms and definitions: Lehrstuhl für Wirtschaftsinformatik 1. In: UK Academy for Information Systems (UKAIS) International Conference. pp. 344–356.

Schön, E.-M., Thomaschewski, J., Escalona, M.J., 2017a. Agile requirements engineering: A systematic literature review. Comput. Stand. Interfaces 49, 79–91.

Schön, E.M., Winter, D., Escalona, M.J., Thomaschewski, J., 2017b. Key challenges in agile requirements engineering. In: Lecture Notes in Business Information Processing, Vol. 283, pp. 37–51.

Schwaber, K., 1997. SCRUM development process. In: Business Object Design and Implementation. Springer, London, pp. 117–134.

Schwaber, K., 2004. Agile Project Management with Scrum. Microsoft Press, Redmond, WA, USW.

Shah, V., Nies, A., 2008. Agile with fragile large legacy applications. In: Proceedings - Agile 2008 Conference. pp. 490–495.

Stacey, R.D., Mowles, C., 2015. Strategic Management and Organisational Dynamics: The Challenge of Complexity to Ways of Thinking About Organisations, seventh ed. Pearson Education, London, United Kingdom.

Stavru, S., 2014. A critical examination of recent industrial surveys on agile method usage. J. Syst. Softw. 94, 87–97.

Takeuchi, H., Nonaka, I., 1986. The new new product development game: Stop running the relay race and take up rugby. Harv. Bus. Rev. 64, 137–146.

Torrecilla-Salinas, C.J., De Troyer, O., Escalona, M.J., Mejías, M., 2019. A Delphi-based expert judgment method applied to the validation of a mature Agile framework for Web development projects. Inf. Technol. Manag. 20 (1), 9–40.

van Oosterhout, M., Waarts, E., van Hillegersberg, J., 2005. Assessing Business Agility: A Multi-Industry Study in the Netherlands. Springer, Boston, MA, pp. 275–294.

van Zolingen, S.J., Klaassen, C.A., 2003. Selection processes in a Delphi study about key qualifications in Senior Secondary Vocational Education. Technol. Forecast. Soc. Change 70 (4), 317–340.

VersionOne CollabNet, 2019. The 13th Annual State of Agile Report, Alpharetta, GA, USA.

Vijayasarathy, L., Turk, D., 2008. Agile software development: A survey of early adopters. pp. 1–8.

Vijayasarathy, L., Turk, D., 2012. Drivers of agile software development use: Dialectic interplay between benefits and hindrances. Inf. Softw. Technol. 54 (2), 137–148.

Vogel, W., Lasch, R., 2018. Complexity drivers in product development: A comparison between literature and empirical research. Logist. Res. 11 (7), 1–42.

von der Gracht, H., Kauschke, P., Ruske, K.-D., 2009. How Will Supply Chains Evolve in an Energy-Constrained, Low-Carbon World?: Transportation and Logistics 2030. PwC, Wiesbaden.

Wong, S., Whitman, L., 1999. Attaining agility at the enterprise level. In: Proceedings of the 4th Annual International Conference on Industrial Engineering. pp. 1–5.

Woudenberg, F., 1991. An evaluation of Delphi. Technol. Forecast. Soc. Change 40 (2), 131–150.

Yusuf, Y., Sarhadi, M., Gunasekaran, A., 1999. Agile manufacturing: The drivers, concepts and attributes. Int. J. Prod. Econ. 62 (1–2), 33–43.

Zielske, M., Held, T., 2020a. An overview of the use of agile methods in logistics start-ups Results from a systematic literature review. In: International Academic Conferences - Transport, Logistics, Tourism and Sport Science. pp. 40–56.

Zielske, M., Held, T., 2020b. The use of agile methods in logistics start-ups: An explorative multiple case study. Int. J. Innov. Technol. Manag. Oct..

Malena Zielske, as an IT consultant, Malena Zielske is currently responsible for the agile transformation of a scaled team that manages Lufthansa Cargo's historically grown revenue accounting system. Previously, she managed teams using the classical approach and has contributed to further agile transformations within the logistics industry by using various tools. Since 2018, she has been working on her Ph.D. at the University of the West Scotland on the use of agile methods in traditional logistics companies and logistics start-ups.