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Interactive research framework in logistics and supply chain management: Bridging the academic research and practitioner gap

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ABSTRACT

Logistics and supply chain management (SCM) practice has grown in scope and complexity in recent years. A challenge for research in logistics and SCM is to create value for both academics and practitioners. The purpose of this paper is to introduce interactive research (IR) into the domain of logistics and SCM research and to describe the lessons learned from the implementation of this research approach. Compared to traditional empirical research methods, IR takes place in a context where inferences are co-produced in collaboration with practitioners. Taking an academic–practitioner lens, we draw on the IR framework to develop a deeper understanding of academic and practitioner exchanges in the increasingly complex and multidimensional domain of logistics and supply chain research. In addition to introducing the IR approach, based on four collaborative research projects, we outline and provide potential solutions to challenges arising from IR. Introducing IR to logistics and SCM research could enrich the understanding of collaborative research approaches and could act as a catalyst to its wider adoption in future research.

1. Introduction

Logistics and supply chain management (SCM) practitioners currently face several challenges, ranging from eradicating supply chain disruptions to improving the flow of goods, and from increasing the need for supply chain flexibility to mitigating bullwhip effects. To address these growing challenges, firms are developing novel capabilities in digitalization or Industry 4.0, sustainability, servitization, and e-commerce, among others. However, the process of how practitioners are using proposed theoretical models and emerging technologies to address logistics and SCM challenges is an important element in academic discourse. Academic research has been criticized for being detached from practice and relevance (e.g., Alvesson et al., 2017; Maestrini et al., 2016; Van De Ven and Johnson, 2006). It is therefore important to explore new research methodologies that simultaneously provide scientific and practical utility while maintaining a high level of academic originality and practitioner relevance (Corley and Gioia, 2011).

The primary objective of this paper is to demonstrate the value of interactive research (IR) to bridge the gap between theory and practice. The notion of collaborative research is often referred to as an umbrella concept that comprises at least two basic ideas: i) the idea of the threefold task (i.e., creation of scientific knowledge, contribution to practical concerns, and enhancement of competencies of the involved parties through processes of dialogue and learning in the practice of research), and ii) the idea of knowledge creation through some form of co-operation between researchers and practitioners (Ellström, 2008). A variety of collaborative research approaches have increasingly been acknowledged in research to bridge the gap between theory and practice (Adler, Shani, and Styhre, 2004; Aagard Nielsen and Svensson, 2006), including engaged scholarship (Van De Ven and Johnson, 2006), Mode II (Gibbons et al., 1994; Maestrini et al., 2016), participatory research (Park, 2001), action research (Shani and Coghlan, 2019), and collaborative management research (Pasmore et al., 2008). These collaborative research approaches are built upon collaboration between researchers and practitioners from problem statements and analysis to conclusions and dissemination (Näslund et al., 2010; Svensson et al., 2007; Van De

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Ven and Johnson, 2006).

Research on logistics and supply chain challenges typically benefit from these approaches because they often include complex and multi-faceted relationships that result in multi-contextual and cross-level dependencies. In line with advocates of collaborative research approaches, complementarity of knowledge among academics and practitioners helps lay the groundwork and promote understanding of "*complex problems in ways that are more penetrating and insightful than they would be were either scholars or practitioners to study them alone*" (Van De Ven and Johnson, 2006, p. 803).

The action research approach has so far been the most prominent collaborative research approach applied in a supply chain research context (Shani and Coghlan, 2019), where the twin focus has been on taking action and creating knowledge about the action (Coughlan and Coghlan, 2002). The AR approach has been amply recognized for its usefulness to practitioner-oriented logistics and SCM research (Näslund, 2002; Näslund et al., 2010; Touboulic and Walker, 2016), but it has also been criticized for prioritizing its relevance to practitioners over its application to academic research (e.g., Seashore, 1976; Shani and Coghlan, 2019; Svensson et al., 2015). Indeed, it has been called practice masquerading as research (Coughlan and Coghlan, 2002), and its potential to generate academic theory has been called into question (Shani and Coghlan, 2019).

In this article, we contend that an interactive research (IR) approach offers a promising alternative way forward in logistics and supply chain research to bridge the gap between theory and practice. IR is defined as "*a collaborative research approach characterized by recurrent interactions and joint learning activities between researchers and practitioners in commonly agreed upon efforts to study change and innovation in organizations*" (Ellström et al., 2020, p. 1520). Since its origins as one of the key collaborative research approaches in management and organization research, the concept has been applied predominantly in operations, product, production, and innovation management, including the industrialization of new products, globally distributed engineering, and supply chain contexts (Berglund et al., 2020; Ellstrom et al., 2020; Johansson and Säfsten, 2018; Johansson and Wallo, 2020; Lakemond et al., 2007). However, the application of this approach has been overlooked in the logistics and SCM research domains. Although several researchers indicated that there has been an increased focus on the observation methods in the domain, such as case studies and inquiry-based action research (e.g., Kotzab, et al., 2005; Maestrini et al., 2016; Näslund, 2002; Sachan and Datta, 2005; Touboulic and Walker, 2016), there is the need for an advanced research approach, which enables close partnerships and co-production between researchers and practitioners and facilitates long-term knowledge development and capabilities for continuous learning (Kotzab, et al., 2005; Tokar, 2010) with due consideration given to the emerging context of Industry 4.0 (Abdirad and Krishnan, 2020; Hofmann et al., 2019). With an opportunity for researchers and practitioners to perform tasks collaboratively during all research phases (Ellström 2008; Ellström et al., 2020; Svensson et al., 2007), the IR approach can fill this gap in the logistics and SCM domain and provide a sound alternative methodological approach.

The purpose of this paper is, therefore, to introduce IR research into the domain of logistics and SCM research and to describe the lessons learned from implementing such a research approach. We aim to bridge the gap between theory and practice while addressing current and future supply chain challenges. We argue that IR is a collaborative research approach that overlaps with but is distinct from the action research approach. It provides potential clarifications and guidance for logistics and SCM scholars applying a collaborative research approach. In short, compared to the action research approach, we consider that IR places a specific emphasis on the need for: (i) dual attention theory generation *and* practice improvements; (ii) leveraging the roles in theory generation of researchers and practitioners who have different responsibilities, interests, and competencies; and (iii) offering detailed insights into the interaction process and enhancing joint learning in research and practice (e.g., Ellström et al., 2020; Shani and Coghlan, 2019).

Given these arguments, we contend that introducing IR could enrich the logistics and SCM research community's understanding of collaborative research approaches and act as a catalyst to their wider adoption. In addition to introducing the IR approach, we outline several challenges arising from IR that are based on our own experiences from four collaborative research projects, and we discuss suggestions for introducing improvements. Overall, the study contributes to the literature on the collaborative research approach in relation to IR and the literature on research methodologies in logistics and SCM.

The remainder of this paper is structured as follows: Section 2 presents the frame of reference, which includes key concepts and previous research on the topic. Section 3 describes four cases of IR-based projects—each case provides general information, project output, project scope and activities, research project organization, and joint experience exchange seminars. Section 4 describes our experiences in executing four IR-based projects. Finally, Section 5 discusses and summarizes the main conclusions, addresses the study's limitations, and offers suggestions for future research.

2. Frame of reference

2.1. Collaborative research between academia and practice—a background

In their method of engaged scholarship, Van De Ven and Johnson (2006) introduced the concept of arbitrage between academics and practitioners, an idea at the core of collaborative research. Based on different but complementary types of knowledge, researchers and practitioners can jointly contribute to knowledge on a problem of common interest. Thus, at the very center of collaborative research is the creation of relevant and rigorous knowledge by academics and practitioners working together (Hodgkinson, 2001; Sohrabpour, 2021; Van De Ven and Johnson, 2006).

A collaborative research approach between researchers and practitioners starts with a statement and analysis of the problem, moves on to theory- and practice-based findings, and then ends with wide dissemination of its conclusions (Van De Ven and Johnson, 2006; Näslund et al., 2010; Svensson et al., 2007). Compared to a traditional research setting, a variety of methods for data collection and analysis are used (Ellström et al., 2020; Svensson et al., 2007). Here, a researcher views the collaboration partner's organization as a location where knowledge is co-produced by academics and practitioners and not as a place for mere data collection (Van De Ven and Johnson, 2006).

2.2. Collaborative research in the logistics and supply chain management literature

Before discussing interactive research in detail, we explore the broader context of collaborative research. Collaborative research has been gaining interest among researchers into logistics and SCM, mainly in the form of action research (AR). AR is in itself an umbrella term (e.g., Coughlan and Coghlan, 2002; Shani and Coghlan, 2019) defined as "*an emergent inquiry process in which applied behavioural science knowledge is integrated with existing organizational knowledge and applied to address real organizational issues. It is simultaneously concerned with bringing about change in organizations, in developing self-help competencies in organizational members, and in adding to scientific knowledge. Finally, it is an evolving process that is undertaken in a spirit of collaboration and co-inquiry*" (Shani and Coghlan, 2019, p. 3). The origins of AR can be traced to Lewin (1944), and it has since been applied to logistics and SCM-related topics. For instance, Touboulic and Walker (2016) affirmed the value of this approach in addressing current challenges and advancing sustainable SCM research. Maestrini et al. (2016) argued that action research was a valuable approach in understanding typically "messy"

buyer–supplier relationships.

Shani and Coghlan (2019) recommended caution in the execution of AR research. The processual guidelines for implementing AR are often vague, covering a variety of research traditions and diverse conceptualizations. The process has been described as being geared to a *joint* cyclical process in which the roles of research and practice are not clearly defined. For instance, Coughlan and Coghlan (2002) and Maestrini et al. (2016) presented an "action research cycle" ranging from data gathering to evaluation phases involving analysis, planning, and implementation. Although the authors affirmed that these phases should provide theoretical as well as practical knowledge, it is unclear how each of these two types of knowledge can be obtained. Shani and Coghlan (2019), in their review of the AR-based literature, noted that the practical outcomes for involved practitioners were clearly visible in the literature, whereas discussion of new knowledge creation by practitioners was limited. In a similar vein, Touboulic et al. (2020) noted that most AR in a SCM context has been based on the idea that the researchers come to the practical sphere as external experts to solve practitioners' problems. In drawing on Shani and Coghlan (2019) we tackle these shortcomings by using an IR approach that features a collaborative research methodology as a promising alternative way forward in logistics and SCM research.

2.3. Basics of the interactive research (IR) approach

Ellström et al. (2020) defined IR as "*a collaborative research approach characterized by recurrent interactions and joint learning activities between researchers and practitioners in commonly agreed upon efforts to study change and innovation in organizations*" (Ellström et al., 2020, p. 1520). This definition diverges from AR in two main ways.

First, although collaborative research advocates participation and cooperation between researchers and practitioners built on trust and mutual exchange of ideas, IR emphasizes the need for *both* theoretical development *and* practical results, including advancements in a project directed at ongoing change at the participating organization (Ellström et al., 2020; Svensson et al., 2015). Although the overall definitions of AR indicate the need for this duality, extensive criticisms of AR for its failure to contribute theoretical knowledge are often raised. Whereas the relationship between researchers and practitioners in AR is often centered on the researchers' contribution to an organization's practical results, the reverse relationship where practitioners contribute to theoretical knowledge is very much less in evidence (Svensson et al., 2007). In contrast, the IR approach is more strongly geared to theoretical development (Svensson et al., 2015).

Second, to avoid falling into the trap of "only" practical development, IR places less emphasis on researchers' involvement and responsibility for leading actual change processes at the organization and practical problem solving (e.g., Berglund et al., 2020; Svensson et al., 2007). Instead, so as not to fall into a consultancy role and become "one of the gang" (Svensson et al., 2007), the focus of researchers should be on utilizing opportunities for joint learning and knowledge creation (Svensson et al., 2007, 2015). Defining and clarifying the discrete roles of researchers and practitioners throughout the research process is claimed as a decisive success factor in IR (Ellström et al., 2020).

These two differences are further elaborated and promoted in recent literature on IR where there has been an attempt to clarify more precisely the existence of two discrete systems of research and practice and the interaction between them; see Fig. 1.

This figure illustrates the two independent yet interacting activity systems of the research process and practical problem solving. These two systems interact and cyclically feed each other in order to improve conceptualization and interpretation. This interaction results in "cognitive input" (Svensson et al., 2015, p. 352) for both systems, driving them to a new cycle of activities before a new round of interaction between the two systems takes place. The two systems have different aims relating to the targeting of theory development, on the one hand, and practical problem solving, on the other (Ellström et al., 2020). However, the common point of conceptualization and interpretation is central to both. It is the major arena for encounters and dialogues between researchers and practitioners (Ellström et al., 2020) and plays an essential role in IR. This point, often referred to in AR as an "analytic seminar" (Ellström et al., 2020; Svensson et al., 2015) that can broadly be understood as a joint experience exchange seminar, may take different forms and can be based on a variety of different issues including theories, models, examples, and analogies (Svensson et al., 2007). A more detailed example has been provided by Svensson et al. (2015), who described the joint experience exchange seminar as a meeting between researchers and practitioners where prior findings and analysis from researchers are further discussed and commented upon. In the meeting, an improved analysis is made jointly. Then, it is further amplified by the researchers after the meeting, before being sent to the practitioners for feedback (Svensson et al., 2015). As indicated above, the overall objective of conceptualization and interpretation (i.e., the joint experience exchange seminar) is to co-produce knowledge that is valuable for both the theory system and the practice system.

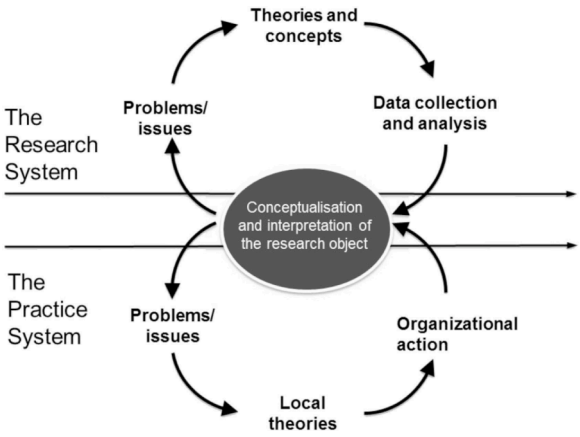

Fig. 1. Practice and research systems in an interactive research model (Source: Svensson et al., 2015, p. 352).

2.4. The role of IR in offering a new, improved approach in logistics and SCM research

The two differences between AR and IR highlighted above, along with the interaction process between theory and practice, form three compelling arguments why we believe IR is more suitable than AR in a logistics and SCM research setting.

First, IR has a stronger focus on both academic and practical utility. As illustrated in Fig. 1 above, the two systems of practice and research have different goals, and their cycles are aimed at theory generation (the research system) *and* practical problem-solving activities (the practice system).

Second, IR stresses clearly that researchers and practitioners have distinct roles and tasks during the research project, with researchers able to engage more actively in theoretical knowledge generated during the project. As indicated in Fig. 1, the IR research process contains a number of activities in the two systems that do *not* directly interact— that is to say, the researchers and practitioners have discrete roles and conduct a series of activities without the involvement of the other party. As stressed by Ellström et al. (2020), there are "on-stage" as well as "back-stage" phases in the cycles presented in the figure.

Third, IR offers detailed insights into how the interaction process between research and practice can take place by clarifying the different interaction points through the joint experience exchange seminars. This provides an appreciation of the two arguments presented above—namely, an understanding of the dual goals of IR research and the role

of the researcher.

We now turn to the description of the four interactive research projects we undertook for this study.

3. Cases of interactive research projects

This section describes four distinct cases of research projects in logistics and SCM that have adopted interactive research as an overall research methodology. The four discrete cases of research projects were selected using purposeful sampling (Patton, 2002) to permit logic generalization and maximum application of the information in a specific area. The cases were selected on the main criteria: (i) the focus of the project should be connected to logistics, supply chain management, or both, (ii) the cases should be based on an interactive research design and carried out utilizing the IR approach, and (iii) the cases must be based on critical sampling, providing complementary perspectives related to logistics and SCM. Case A focuses on a Swedish fashion retailing company with the aim of studying logistics-based capabilities in a retail logistics environment. Case B focuses on a large Swedish industry group, exploring company transformation process in the context of purchasing, logistics, and SCM. Case C spotlights a consortium of large companies, SMEs, and technology companies, including manufacturing and process industries, to investigate ways to transform traditional industrial value chains into digital value chains that encompass manufacturers, suppliers, and customers. Finally, Case D concentrates on two large manufacturing companies—one in the heavy-duty vehicle industry and the other in the railway industry—who are studying experience feedback loops in the industrialization process of new products including sister companies, suppliers, and customers.

Together, these four cases provide a solid foundation to describe the pertinent lessons learned when conducting IR-based research projects in the domain of logistics and SCM research. The direct participation of the authors of this paper in the four projects is obviously a convenience factor. Nevertheless, the choice of these four projects offers a wide range of diverse supply chain contexts, use of theories, and supply chain challenges, and it provides the requisite variety. In addition, all four cases have had a dedicated team of practitioners willing to engage in long-term collaborative research activities.

3.1. Case A

General information: Case A is a research project involving collaboration between a Swedish fashion retailer and a Swedish university. The overall research objective was to explore logistics-based capabilities in a retail logistics environment. The case company provides an information-rich, empirical context with respect to logistics capabilities. The company's logistics development is considered one of the key strategic priorities, not least concerning current omnichannel developments in the retail environment. To foster an innovative development atmosphere with new perspectives, the company has increasingly looked beyond its internal sources of knowledge and experience. One of these external sources is academic influence in the form of collaboration with researchers.

Project output: From the company's point of view, a major output from the project has been new perspectives on the company's logistics practices. In particular, academic research has provided the employees involved with an additional perspective from which additional understanding and new questions have emerged. From the researchers' perspective, the major output from the project has been an in-depth understanding of logistics development practices, which in turn has fed into theoretical developments.

Project scope and activities: For 18 months, two researchers using an IR approach followed three large-scale supply chain development projects at the retailer. In a cross-functional project environment that included functions such as business development, purchasing, logistics, and IT, the researchers participated in working and information meetings (on average, once every second week) and, when possible, contributed theoretical knowledge relevant to the three projects. Follow-up interviews for briefing purposes along with more informal discussions were conducted as necessary to further develop the researchers' understanding.

Research project organization: The research project has been managed and coordinated by one researcher and one company employee. They have met once every third week to discuss ongoing subprojects and to detail the role of researchers in the projects. Whereas the researcher has managed the other participating researcher and continuously worked on the research tasks (including data collection, analysis, and theory development), the company employee has facilitated and coordinated company contacts for the benefit of the researchers. A formal reference group with senior representatives from the retailer and other companies has provided further direction for the research project. In particular, the reference group has been able to undertake joint discussion with the researchers, emphasizing the general applicability of the research findings—that is, their relevance beyond the specific context of the participating retailer.

Joint experience exchange seminar: In total, three different types of joint experience exchange seminar have taken place over the duration of the research project. First, the generation of a joint understanding and knowledge base has been achieved through continuous working and information meetings in the three sub-projects that the researchers followed. During these meetings, researchers have been able to pose questions and reflect on current logistics development practices at the retailer. Overall, these interactions have been characterized by informal, unstructured discussions and exchange of knowledge between the project participants, with the focus often placed on the actual logistics development practices at the retailer.

Second, throughout the project, joint experience exchange seminars have taken the form of more structured workshops to which a variety of retailer employees with widely different expertise and responsibilities have been invited. The principal aim of these workshops has been to compare theoretical perspectives with the retailer's practices, identifying the major gaps through joint discussion. These gaps functioned as a starting point for further development of theory and as suggestions for practical improvements to be undertaken by the retailer. The third type of joint experience exchange seminar has taken place in the form of the joint writing of popular science articles. The collaborative writing process has functioned as a catalyst for joint reflection and knowledge generation on how the retailer's practical logistics development coheres from a theoretical point of view.

3.2. Case B

General information: Case B is a jointly financed research project by a large Swedish industry group and researchers at a Swedish university. As part of a larger transformation process impacting the entire company, senior management initiated contact with the university as a means to obtain external insights for their business, with particular reference to the targets of purchasing, logistics, and product development. The overall project aim was to gain new knowledge in the areas of SCM and project organization. For instance, a longitudinal study was performed to investigate how a recently purchased subsidiary had been incorporated into the company group, focusing on how synergies related to purchasing, business development, and marketing were leveraged. Another sub-project dealt with how hybrid purchasing strategies could be developed in the project, leveraging advantages simultaneously from a centralized and decentralized organization.

Project output: With emphasis on the business functions of purchasing, logistics, and product development, a major project objective for the company was to obtain a theoretical perspective and identify influences as part of its ongoing transformation process. Furthermore, a book was written by a company employee based on the researchers' findings. This book functioned as a translation of the researchers' results

to be used to disseminate actionable knowledge within the company group. For researchers, the project resulted in a variety of theoretical contributions in the areas of purchasing, SCM, and product development. In particular, engagement with and direct access to several senior company representatives over a relatively long period provided valuable input to the research.

Project scope and activities: The project lasted 24 months, engaging 6 researchers and 10 senior managers at the company. During the project, data were collected at various intervals using the interview method. Workshops were held regularly as a means to organize the project and facilitate joint interaction between the researchers and company representatives.

Research project organization: One employee from the company coordinated the company participants, arranging workshops and other joint research activities. Similarly, a researcher coordinated the researchers involved in the project. Over the project's duration, several sub-projects were launched in different research disciplines (purchasing, logistics, and product development) serving different purposes. These projects were undertaken as collaborative endeavors between researchers and company representatives. One researcher and one company representative were appointed as project leaders for each of the sub-projects.

Joint experience exchange seminars: A series of workshops was held in which different practitioners presented their ongoing businesses and current challenges to participating researchers. In the workshops, researchers reflected on company challenges and related them to existing theory. The second type of joint experience exchange seminar was held later on, where findings from specific sub-projects were reported back to company participants. At these seminars, availing themselves of more detailed data collected by the researchers, company representatives were able to comment on the findings, jointly discuss their practical impact, and translate them into an action plan. Another joint experience exchange seminar concerned the writing of the book. Researchers provided the author of each chapter (who was company employed) with materials from their sub-project findings. When written, each chapter was read by one of the researchers and feedback was given to the author.

3.3. Case C

General information: Case C is part of a research project that embraces more than 25 partner companies, including large companies, SMEs, and technology companies. Both manufacturing and process industries were involved as well as research institutes, universities, and co-production platforms. The overarching research objective was to define and test needs and technologies for digital value chains by enabling data transfer between companies in the supply chain networks. In particular, one of the authors was part of a specific work package that focuses on developing possible scenarios for digital twin systems in a SME value chain, including manufacturers, suppliers, and customers. The selected SME operated in the electronics industry and was specialized in both design and production of circuit boards. At the time of the investigation, the SME had initiated several pilot initiatives on digitalization with the ambition to become a smart factory and develop digital information flows across its supply chains. The company is seeking to develop a long-term strategy for its digitalization work, but it has limited resources and lacks competencies. Consequently, it is pursuing many new opportunities in collaboration with researchers from production development and computer science.

Project output: The case SME and its value chain actors are benefitting from the development of a conceptual mock-up of a digital twin ecosystem that is being developed as a project outcome. The mock-up shows the potential in making data/information available in the factory and in the IT systems by giving customers and suppliers access to the digital twin. The available data range from the receipt of customer orders to product end of life. From a scientific perspective, the major output from the project has been the proposal for a method to map a digital twin ecosystem for an SME's value chain actors. The method provides a detailed description of the steps needed by SMEs and their value chain actors to restructure their work through a digital twin ecosystem.

Project scope and activities: For 24 months, four researchers and nine industrial practitioners deployed IR as the pivotal approach to address the project objective. The main activities included:

i) scanning and visualizing a factory using a laser system and exploring possible integration opportunities and potential challenges,
ii) mapping and defining a digital twin ecosystem by using a rich picturing approach. This involved a series of workshops with the manufacturer and two sub-suppliers, both individually and collectively. The activity was launched with the "as-is" situation of an ecosystem acting as the foundation. It then progressed to defining "to-be" situations in the ecosystem using a digital twin and ended with identifying two possible scenarios for digital twin ecosystems, and
iii) realizing the scenarios identified by demonstrating a conceptual mock-up.

All activities were performed in close collaboration with partner companies and researchers in an interactive way by developing relevant theoretical perspectives, showing inspiring examples from practice, introducing new methods such as rich picturing, and facilitating discussion on the phenomenon being investigated by supply chain actors with the involvement of key functionaries. Finally, validation of the conceptual mock-up was carried out in an interactive session involving all key functionaries in the partner companies.

Research project organization: The project has been managed by a practitioner from a co-production platform provider involving a university, a research institute, an industrial technology center, and four industrial companies. The overall project has been coordinated by a national association of engineering industries, involving more than 25 partner companies. In the work package, the total activity plan was initially discussed and agreed by participating actors. The project meetings took place once a month at the work package level and once a quarter at the project level. Each month, all participating actors met and discussed the status of their ongoing activities and presented tentative results on multiple perspectives to inform further discussion. After the meeting, each actor reflected on the collected input and feedback from the project team and continued to work on possible improvements. The entire project consortium met quarterly, and each quarterly meeting was dedicated to a specific theme to facilitate concrete discussion and achieve some tangible outcomes. The work package leader usually summarized and presented the quarterly work and work-in-progress results. These acted as an input to the project meeting and helped to give a bigger picture of the entire project.

Joint experience exchange seminars: The project facilitated several joint experience exchange seminars, both at the work package and the project level. At the work package level, four joint experience exchange seminars were undertaken following a workshop format, with each joint experience exchange seminar representing one complete IR cycle. Each workshop consisted of a specific theme, such as understanding the "as-is" situation of an ecosystem. Researchers provided background details and explained the motivation behind each workshop, offering inspiring examples and proposing interesting scenarios. The workshops were guided by a series of questions that allowed industrial practitioners to reflect on their current/future way of working, current/possible challenges, potential novel opportunities, and current/required organizational capabilities. Some example questions were: *What are the critical aspects of the current work context? How will the context change when a digital twin is introduced? What does the digital twin scenario for an ecosystem look like? How can the scenarios be realized?*

The workshops were initially run by physical face-to-face meetings in the factories of partner companies. However, after the onset of COVID-19, the remainder of the workshops were organized and managed in an online setting. After each cycle of the IR approach, both researchers and practitioners returned to their respective organizations and continued to work on a new cycle of researcher/practitioner activity. In this way, the IR approach encouraged detailed investigations from both researcher and practitioner perspectives, and each other's experiences and lessons learned at the end of each cycle were shared systematically. At the project level, the first few project seminar meetings took place in individual factories, offering guided tours, work package presentations, inspiring guest talks, and workshops. In the workshops, cross-work package team members were typically organized into groups covering different sets of companies and researchers with different competencies and skills. Each group had a dedicated facilitator whose purpose, in documenting the discussion and reporting back to the whole project, was to compile additional feedback and determine whether the results were perceived more positively.

3.4. Case D

General information: Case D is a research project consisting of two large manufacturing companies—one in the heavy-duty vehicle industry and the other in the railway industry—and a Swedish university. The overarching research objective was to develop knowledge to systematically organize feedback loops so that new product introduction capability could be enhanced, with specific regard to the production network and related supply chain actors. Both companies had the ambition to become world-class leaders in new products and production technologies by competing in "time to market" and "time to volume".

Project output: From the perspective of the two companies, the project outcome was a detailed analysis of the current and future state of managing feedback loops, identifying systematic processes and work methods, and defining capabilities for systematically organizing feedback loops to strengthen the management of new product introduction projects. From a scientific perspective, the project shows three types of learning tactics used by companies, a proposal for a five-step method to establish/improve feedback loops, and a five-level maturity scale to improve learning capabilities in new product introduction projects.

Project scope and activities: Over a 24-month period, three researchers, employing an IR approach, performed four work packages: (i) exploration of current experience feedback loop practices, (ii) process management of experience feedbacks and capabilities, (iii) development of methods and managerial processes, and iv) implementation and assessment of new methods and processes. During the project, several cross-functional groups working on the introduction of new products were involved—technology development, R&D, business development, purchasing, logistics, supply chain coordinators, production development managers, and industrialization project managers. Researchers used semi-structured interviews, workshops, participatory observations, and pilot experiments to test various new methods. During the collaboration, industrial needs and pain points were given greater importance and were rigorously discussed in a number of workshops. Several relevant theoretical perspectives were continuously introduced and discussed by researchers in order to direct companies towards new ways of thinking and working.

Research project organization: The research project has been managed and coordinated by one researcher and two high-level managers representing each partner company. The project had a reference group with two senior researchers who were specialists in the investigated phenomenon. The project leader and reference group met formally four times per year. At these meetings, the focus of the field studies, the selection of cases, the research methods, the data analysis, and the tentative results and conclusions were presented and discussed. The reference group also maintained informal contact with project managers on a monthly basis. Two feedback sessions per year were planned with the industrial partners and the reference group to review ongoing studies and tentative results from both academia and partner companies, to decide on improvements, and to determine the next steps.

Joint experience exchange seminars: In total, four feedback seminars were planned over the project period with each representing one cycle of IR, where the research system and the practice system met to conceptualize and interpret the lessons from the project. Each of these feedback seminars were given a specific theme, such as (i) the current state of managing feedback loops, (ii) the future state of managing feedback loops, (iii) systematic ways to organize feedback loops, and (iv) the capabilities needed to run systematic feedback loops. In each feedback seminar, a preparatory task was given to the partner companies as a home exercise in order to work on specific tasks in collaboration with relevant functionaries inside the organization. During the feedback seminar, dedicated time was given to each partner company to present and discuss the outcome of the home exercise. These presentations were foreseen as input to the feedback seminar. Similarly, researchers presented their preliminary findings from the interviews and earlier workshops as further input. After detailed discussions on both inputs from academia and industrial companies, a workshop on specific questions was planned to continue the discussion, ending the feedback seminar with tangible results and conclusions on the dedicated theme of the day. Lastly, both researchers and practitioners decided on the next steps to lead to a new cycle of IR, drawing on the lessons from this meeting. During the project, four such cycles were performed. To conclude, the final project meeting was held to share with partner companies the overall trajectory of the project, including a brief overview of results and reflections on co-production and knowledge development over the course of the project.

Table 1 shows a summary of the four cases described above:

4. Execution of IR-based research projects

An IR approach poses several challenges to be addressed both before and during its execution. In the following section, we provide guidance on the execution of IR-based research projects, based on lessons learned from Cases A to D. In particular, we identify the challenges and offer suggestions to overcome them over three distinct phases of IR-based projects: project planning and initiation, ongoing research activities, and research dissemination.

4.1. Project planning and initiation

In the first phase of project planning and initiation, our experiences in leading research projects using the IR approach have revealed challenges and crystallized suggestions for improvement in two categories—namely, creating commitment at the participating practitioner company, and designing the project.

4.1.1. Creating commitment at the participating practitioner company

As a fundamental starting point for all research projects based on collaborative research approaches, the overall objective of the project and the benefits accruing from it need to be firmly anchored and validated in the minds of researchers and practitioners. Except for theoretical significance and practical relevance, which are typically the main drivers behind the initiation of research undertakings, IR-based research projects need to benefit the specific practitioners involved in the project. A generalized perspective on a project's practical relevance is not enough. Researchers must be able to clearly explain the project and to "sell" it to practitioners who will invariably ask: "What's in it for us?" For practitioners, participation in a research project is one possibility out of many on learning and organizational development. Participation in the research may, therefore, demand that tangible benefits are demonstrated to the company beforehand. This may present a challenge because the outcomes of IR research (as with collaborative research in general) are typically emergent—that is to say, specific outcomes may

Table 1
Key information on four cases A to D

	Case A	Case B	Case C	Case D
Main focus	Explore logistics-based capabilities	Transformation process in SCM	Creating digital value chains between companies in supply chain network	Organizing feedback loops in new product introduction projects
Focus of the industry	Fashion retailer	Large Swedish industry group	Manufacturing and process industries	Heavy-duty vehicle industry and railway industry
Project duration	18 months	24 months	24 months	24 months
Number of researchers	2	6	4 (only in WP)	3
Number of key practitioners	2	10	8 (only in WP)	4
Overview of (formal) data collection methods	4 workshops, 5 formal meetings, 4 interviews; Weekly meetings, interviews	11 workshops, 5 seminars, 6 formal meetings, 15–20 interviews; Interviews, workshops	6 workshops, 10 formal meetings	43 interviews, 5 workshops, 15 formal meetings
Reference group	Yes	No	No	Yes
Number of joint experience exchange seminars	3	3	4	4

be very difficult to delineate in advance (Coughlan and Coghlan, 2002).

To create the necessary commitment and clearly outline potential practitioner benefits, experiences from our previous research point to the need for joint project proposal development from the very beginning. As stated by Van De Ven and Johnson (2006), a "big question" must be identified, which has the capacity to attract and motivate researchers as well as practitioners. Apart from an attractive and unifying question, it is crucial to establish a consensus among researchers and practitioners on the overarching objective of the project and the methods used, as well as the results to be expected. Even though the actual project application may be written by the researchers, it is nevertheless essential to involve practitioners at an early stage. In fact, practitioner involvement in a research application process may provide many valuable viewpoints and ideas, especially in increasing the practical relevance of the project outcomes anticipated.

To reach out to the practitioner company and create the necessary commitment, top management support is vital, but it must equally be recognized that employees at subordinate levels play a fundamental role. In particular, managers of specific departments/functions in a factory have no less significant roles to play. In fact, although top management commitment is crucial for widespread support during both the initiation phase and throughout the project (e.g., in providing resources and facilitating data collection activities), lower-level employees may be just as crucial. In the research projects we conducted, these are the very employees that sustain continuous dialogue with researchers, invite them to meetings and other company activities, and respond to and comment on the researchers' manuscripts. In the initiation phase of the research project, it is therefore essential to target support not only from top management but also from other relevant employees operating on different levels and in diverse departments and functional groups.

In Case A, the researchers had more than a year of dialogue with two employees at the practitioner company before their top management team was approached and made the commitment to an actual research project proposal. Later on, this dialogue proved to be valuable because the in-depth understanding and commitment of these two employees proved to be a decisive factor in the later processes of the project, when organizational changes put in jeopardy other employees' commitment to the research project. In Case D, the researchers collected three types of input from both case companies in the early phase of project initiation. Firstly, a meeting between researchers and an individual company took place, targeting a department/function that would potentially benefit from the research. At this point, researchers presented a brief background, an exposition of the current industrial challenges/academic gaps, the project's aims and tentative research questions, the results anticipated, and the contributions expected from the company. The outcome of this meeting was tentative approval, an indication from the company that it was interested in the project, in addition to some general feedback on research aims and questions, and project organization. Secondly, researchers sent a simple questionnaire to companies to collect information about their needs, pain points, and expected benefits from taking part in the project. This short questionnaire helped companies to reach an internal consensus on their current/future needs and the project results expected across multiple functional groups as well as top and middle management. Finally, the project proposal was distributed to partner companies before submission, giving companies the opportunity to provide detailed feedback on the entire proposal, including the content, resources, time plan, and work distribution. Collectively, these three forms of input from both companies helped researchers to submit a sound research application, resulting in a situation where both parties benefit.

4.1.2. Designing the project

As with all types of research project, careful planning and project design are no less essential in IR-based research projects. Here, it is particularly important to establish a project organization where researchers and practitioners are able to maintain continuous joint interaction throughout the entire project. In contrast to traditional research, the involvement of practitioners stretches over a longer period of time, and it is essential to clarify their specific responsibilities. For a longer research project, it is important to tie these responsibilities to company functions and not individuals in order to ensure that the project will survive any changes in individual participation.

The clarity of the different roles of researchers and practitioners described in IR research, as illustrated in Fig. 1, can offer a useful platform for joint awareness of these roles. As was experienced in these projects, clarification of roles provides support for reasonable expectations over the course of the project. For instance, a detailed design of the project and its dissemination is essential as a means to ensure that practitioners will commit time and effort to the project's ongoing activities (such as inviting researchers to meetings and observations, providing time for interviews, mediating contacts, and participating in workshops) as well as research dissemination activities (such as joint writing of popular science papers, and reading and giving feedback on scientific papers).

As with all collaborative research approaches, IR research is typically characterized as emergent with results being difficult to foresee (Coughlan and Coghlan, 2002). However, an outline of different sub-projects and specific research interests may be very helpful in guiding project participants (both researchers and practitioners). As in Case B, a number of sub-projects were already outlined at the planning stage of the project. In terms of content, these projects were defined very broadly, and their organization (i.e., participating individuals and functions and the research activities to be conducted) was decided in

detail. Here, a series of workshops was planned with the exact content to be decided later, including several interviews whose number could later be supplemented, as necessary. Similarly, in Case C, a number of work packages (WPs) were already planned along with a visual presentation of how they could contribute to the overall project objective. However, at the WP level, the purpose and deliverables were clearly defined, but the means to achieve them were kept open and emergent.

In the design phase, it is vital to maintain a balance between short-term and long-term results because these may be valued very differently by researchers and practitioners. Whereas the needs of practitioners, which drive their participation in the project, often tend to be relatively immediate, researchers are frequently perceived as requiring a long-term focus in which the main "project results" (e.g., a journal article) will be delivered at the end of the project. For instance, in Case A, the company opted for guidelines and a roadmap on how to proceed in their ongoing development projects. Since the researchers were aiming for knowledge on the capabilities in logistics development, such guidelines and roadmaps were considered feasible, but their findings were not theoretically anchored until a later stage. A general insight from our own experience is that researchers need to step outside their comfort zones and consider short-term results—for example, in the form of a workshop or a practically oriented white paper. This is an essential prerequisite for motivation and commitment. In addition, these results provide necessary input to many of the joint experience exchange seminars arranged throughout the project. Therefore, without any results, propositions, or hypotheses from the researchers, it will be challenging for practitioners to reflect on and contribute to the research. As noted above, the structure of IR research illustrated in Fig. 1, which is not provided in an AR approach, supports the need for researchers early on in the project to deliver short-term, preliminary research results as input to the joint experience exchange seminars.

For example, in Case D, a clear time plan was provided for each work package to include information on activities, their brief description, the number of participants, the meeting type, and the time progression in quarters for two years. Several interaction/experience exchange moments were planned in each WP, and roles and responsibilities were clearly communicated in the time plan visually. For instance, for each sub-activity in a WP, the required meeting type and number of participants (i.e., only the lead researcher, the lead researcher plus the reference team, the lead researcher plus company representatives, and finally the lead researcher plus the reference team plus representatives) were already decided and visually displayed on the time plan well in advance. In total, four joint experience exchange seminars were planned to include all stakeholders from both academia and practitioners. For each seminar, a specific theme was predefined, and a preparatory task was given to companies to prepare an input for the seminar. Joint experience exchange seminars were used as a way to disseminate and discuss short-term results in the project consortium. In addition, the dissemination of results was planned in a continuous manner. For example, one conference paper was planned in WP1, one conference article and one journal article were planned in WP2, one conference paper was planned in WP3, and finally one more journal article was planned in WP4.

4.2. Ongoing research activities

In the second phase covering ongoing research activities, researchers were required to manage their own research system in which joint experience exchange seminars play a significant role. In this phase, our experiences from Cases A to D identified challenges and improvement suggestions that fall into two categories—namely. managing the backstage activities in the research system and managing joint experience exchange seminars.

4.2.1. Managing the backstage activities in the research system

Indeed, in the project, the researchers had their own problems, theories, and concepts to contemplate, as well as undertaking data collection and analysis activities (Ellström et al., 2020; Svensson et al., 2015). It was therefore essential that sufficient time for "offstage" work was provided (Ellström et al., 2020). In fact, in our own experience, a majority of the time dedicated by the researchers to an IR-based research project was conducted without including practitioners. Although it is the joint experience exchange seminars that drive forward both the research system and the practice system, the other activities in the research system cycle are required for the successful execution of these. For example, in Case D, analysis of the current and future state of feedback loops was an important topic. Researchers performed a systematic literature review to identify different types of feedback loop as well as relevant theories and concepts. Based on a detailed understanding of theoretical concepts, an interview protocol was developed to collect empirical data from both partner companies. In total, 20 semi-structured interviews were performed to analyze the current and future state of feedback loops. Most of these activities were part of the research system, where researchers took the lead and drove the core activities. Of course, each data collection cycle ended with an analysis of preliminary results. These were then used as an input to the joint experience exchange seminars to discuss and collect feedback from practitioners. At the end of each joint experience exchange seminar, a new set of research-system and practice-system cycles was initiated, drawing on reflections from the seminar and laying out a way forward for subsequent steps.

When conducting the different activities in the research system cycle—from problematization and theory development to data collection—there is a need to maintain focus on the defined unit of analysis (UoA) and the overarching research questions to avoid becoming a consultant and getting too involved in practitioner issues. As often stated in IR research (e.g., Svensson et al., 2007), researchers may need to have experience to be capable of judging the relevance of whatever practitioner-oriented issues they face during the project. Our own experiences indicate that authority and the will to say "no" may be important if the activities lead more in the direction of consultancy-type work. Along with interviews, observations and other data collection activities become critical. For example, researchers experienced such a scenario in project Case C, where the first activity (scanning and visualizing a factory) in the WP was led by practitioners from technology providers, SMEs, and research institutes. Although grasping the potential opportunities and limitations presented by new technologies was a critical step in the WP, the end result was confined to either a purely technical discussion or pilot testing without considering process, organization, or management aspects of the ecosystem. Researchers played a passive role in this activity, although they did offer support and contributed to the discussion by sharing different theoretical perspectives on digital twin ecosystems. Next, researchers coordinated two master's theses on data-driven decision making and its maturity levels in the ecosystem, leading eventually to more interesting work for both parties—namely, mapping and defining a digital twin ecosystem using a rich picture approach.

4.2.2. Managing joint experience exchange seminars

At the very center of IR-based research stands the joint experience exchange seminar (Svensson et al., 2015), where researchers and practitioners jointly reflect on the research object. Perhaps the most well-known format for a joint experience exchange seminar is the meeting in the form of a workshop, as outlined by Ellström et al., 2020; Svensson et al. (2015). In our project Cases A to D, a similar meeting structure or format was applied. The researchers typically presented current findings and initial analysis, on which the workshop could further elaborate. For example, in Case A, a white paper or conference article was presented, on which the meeting collectively reflected. In Case C, a dedicated theme was defined for each joint experience exchange seminar. A number of inspiring examples or scenarios of digital twin ecosystems were presented and discussed, including preliminary observations from the researchers' investigation. Subsequently, a workshop was planned around a set of pertinent questions exploring

current and future ways of working and the associated challenges, potential novel opportunities, and the capabilities required currently and in the future. Similarly, in Case D, a dedicated theme was defined for each joint experience exchange seminar, which included specific presentations from companies on a predefined task, a report from researchers on a preliminary synthesis and their current findings, and a workshop with a pre-defined set of questions. The predefined task for companies assisted in reaching an internal consensus on specific topics because, on most occasions, the principal contact person prepared each presentation with the support of personnel from their own and other relevant departments/functions.

The term "joint experience exchange seminar" is certainly well anchored in IR research, but it may be somewhat misleading, nevertheless. It is important to acknowledge that joint experience exchange seminars may take many different forms that do not always conform to the standard seminar or regular meeting. In our own projects, smaller meetings and discussions combined with interviews may provide an alternative for researchers and practitioners to contemplate jointly and to learn together. We have also experienced a number of rather unplanned but no less rewarding "joint experience exchange seminar moments" where the original plan had been for the researcher solely to observe a meeting. After the meeting, ad hoc opportunities for further discussion with practitioners emerged from time to time—for instance, over lunch after the meeting. These occasions provided opportunities for both researchers and practitioners to further reflect on and share their observations and insights from the meeting. During the COVID-19 pandemic, we felt the lack of this type of spontaneous, ad hoc seminar moment. We believe that physical presence may play a more important role in this kind of reflection than has been previously recognized in the literature. Finally, there are a number of possibilities for joint experience exchange seminars to be combined with joint project dissemination activities, such as joint writing of popular science articles. This will be further discussed in the next chapter.

Independent of the joint experience exchange seminar format and based on our own experiences from such seminars, we can safely say that successful research–practitioner interaction during these seminars requires reflection that encompasses both theoretical and practical outcomes. In other words, for a meaningful interchange to take place, the gap between theory and practice must be bridged. In essence, theoretical knowledge must be translated into practical use and vice versa. Thus, a mutual, double-edged translation process between the two points of departure must be established. Experience from the cases suggests that a crucial element in achieving such translation is to engage practitioners and researchers in each other's objectives. To avoid the "consultancy trap" where practical development becomes the sole objective of the project, the researchers must invite practitioners to problematize and discuss theory development. This requires time and effort on the part of researchers to translate and structure the theory into useful insights that have meaning for practitioners, being mindful that the audience is not composed of students but practitioners. This approach requires another kind of pedagogical skill, which is concerned with imagining and understanding practitioners' reality. Indeed, the lesson from all four cases was that this line of advance required an ability to tackle ad hoc real-life situations in which theoretical aspects are converted directly into practical relevance.

As Ellström et al. (2020) have pointed out, to exploit research findings, practitioners need to learn how to interpret and translate general research findings into actionable steps that are grounded in practice. This ability may improve over time when practitioners and researchers have had the opportunity to interact and learn from each other (Ellström et al., 2020).

4.2.3. The use of theories and concepts

During the research activities, several theories and concepts were used in the discussion between researchers and practitioners in all cases. Some theories were case-specific, core theories related to the investigated phenomenon, and other theories were used as a means to bridge the gap in academic–practitioner exchanges. Table 3 provides an in-depth overview of the academic–practitioner exchange.

The practitioners, who were generally focused on localized problem solving, were exposed to "systems-based" thinking in the shared theoretical approaches. The interactions with the managers consistently showed that the managers were able to adopt different perspectives and form different viewpoints in their problem-solving approaches. The researchers, throughout the series of recurrent joint experience exchange seminars, were able to assimilate practitioner inputs in grasping the theoretical nuances elaborated in the projects. In particular, the practical elements of the organizational challenges discussed during joint experience exchange seminars provided valuable support in developing theory.

4.3. Research dissemination

In the third phase, research dissemination, our experiences from Cases A to D revealed challenges and suggestions for improvement that fall into two categories—namely, the early dissemination of project findings and engaging practitioners in project dissemination activities.

4.3.1. Early dissemination of project findings

As often highlighted in the collaborative research literature, researchers must be able to share knowledge not only *after* but also *during* a project. As discussed above, early results forwarded during the project play a key role in creating a commitment to the project on the part of practitioners and, even more crucially, early results function as an important and necessary input into joint experience exchange seminars. For example, in project Case C, the findings from data-driven decision making and its maturity model helped practitioners to understand the complexity and provided an example case for a discussion on digital twin ecosystems. For instance, researchers used this example case to facilitate discussion of possible scenarios for the first two joint experience exchange seminars. Practitioners were engaged by these questions: *What are the critical aspects of the current work context? How will the context change when a digital twin is introduced? What does the digital twin scenario for ecosystems look like? How can these scenarios be realized?*

The extraction of early-stage project findings, as well as their dissemination, require researchers to be well informed about the practitioner context in addition to possessing communication and pedagogical skills. Perhaps even more importantly, an understanding of and confidence in practical relevance is required by the researchers.

The format of these early preliminary findings may take different forms, as long as the findings can be disseminated to participating practitioners. For instance, presentations or white papers may provide sufficient clarity for the findings to be disseminated. In project Case D, for example, after the completion of the first WP on the current state of analysis of feedback loops, a conference paper was written by two main contacts of the industrial practitioners from two companies. The content on the current way of working, the challenges involved, and the requirements for organizing efficient feedback loops provided a sound basis for mutual understanding of the entire project. This was particularly important in developing new methods, processes, and sub-routines to improve existing feedback loops or establish new ones, whether internally or externally in the value chain in collaboration with practitioners.

4.3.2. Engaging practitioners in project dissemination activities

As was the experience in our cases and as noted by Bäckstrand and Halldorsson (2019), a major objective for researchers when discussing engaged scholarship is to publish research findings in scientific academic journals. Practitioners, who in many cases have no access to scientific journals, instead tend to prioritize practitioner-oriented reports and presentations that are considered much more valuable. In an IR project, both types of dissemination are important—that is to say,

Table 2
Summary of findings from Cases A to D in executing IR-based research projects

Key phases	Findings	Improvement suggestions or lessons learned from Cases A to D	Addressed challenges in Cases A to D from existing practice
1. Project planning and initiation	Creating commitment in the participating practitioner company	-Preparing a joint project proposal development from the very beginning. -Obtaining the commitment not only of top management but also lower levels of multiple functions. -Creating a long-term dialogue and relationship with potential companies that need research support.	-Getting the commitment required from companies and outlining the potential practitioner benefits. -Lack of resources and lack of support for data collection activities. -Lack of support or main contact when there are organizational changes.
	Designing the project	-Including practitioners as a part of the project organization, clarifying responsibilities, and tying them to company functions. -Creating continuous joint interaction points throughout the entire project. -A detailed visual view of the design of the project and its dissemination, including the outline of WPs and sub-projects as well as roles and responsibilities. -Maintaining a balance between short-term and long-term results.	-Practitioners' commitment, time, and effort in activities of the ongoing project. -Difficult to foresee the results and the wider picture in advance. -Motivation and expectations of practitioners on relatively instant results.
2. Ongoing research activities	Managing the backstage activities in the research system	-Researchers should spend a majority of their time on activities in the research system cycle and sometimes without including practitioners. -Maintaining the focus on the defined UoA and overarching research questions throughout the research project. -Each data collection cycle should end with analyzing and identifying preliminary results that can be fed as input into the joint experience exchange seminars to collect feedback from practitioners.	-Lack of understanding of the roles and responsibilities in the research system cycle. -Researchers are in a consultancy role and are involved more in practitioner issues. -Lack of experience of researchers might hinder judging the relevance of practitioner-oriented issues.
	Managing joint experience exchange seminars	-Perform theme-based workshops with a pre-defined set of questions. -Give preparatory work to companies as a home exercise. -Present, reflect, and discuss white papers and conference articles at joint experience exchange seminars. -Consider smaller meetings or unplanned meetings along with interviews and observations as rewarding "joint experience exchange seminar moments" because these could provide an alternative for joint reflection and learning. -Possibility of holding joint experience exchange seminars in conjunction with joint project dissemination—e.g., joint writing of popular science articles. -Enhance mutual, dual-translation process between theoretical knowledge and practical use.	-The term joint experience exchange seminar is somewhat misleading, as seminars may take place in different forms. -Lack of more spontaneous and ad hoc joint experience exchange seminars due to the impact of the COVID-19 pandemic. -Lack of interpretation and translation of general research findings into actionable steps of practice. -Possibility of a consultancy trap where practical development becomes the sole objective in the project.
3. Project dissemination	Early dissemination of project findings	-Prepare for dissemination of early results in different forms (PowerPoint presentations and white papers) that could be used as an input to joint experience exchange seminars. -Define and perform good thesis work in the early stages, the results of which could be used as an example case for discussion and reflection in joint experience exchange seminars. -Writing a conference paper together in the early stages, especially on the topics of challenges, enablers, and capabilities that could help to build a mutual consensus.	-Lack of time to disseminate project results in the early stages of the project as well as difficulties continuously disseminating results. -Early-stage dissemination requires researchers to be well informed about the practitioner context. -Maintaining interest and commitment in the project from practitioners.
	Engage practitioners in project dissemination activities	-Make plans for publishing in both scientific journals and practitioner-oriented reports. -Prepare early on in the project the writing of a series of short, popular science articles with practitioners. -Publish results in a simple and easy-to-understand way in the form of popular science articles or a handbook with useful guidelines and templates. -Publish a cookbook or handbook with a summary of overall project results in collaboration with practitioners.	-Different objectives or preferences for dissemination between researchers and practitioners. -Lack of time and skills of researchers to make easy-to-use handbooks, toolkits, or templates. -Lack of experience by practitioners in writing popular science articles.

research productivity as measured by the number of publications should be weighed against its impact on practice (Ellström et al., 2020). In Case C, the main findings of the project were published as a pathway process for the transformation. They were presented in the form of a popular science article for a popular practitioner-oriented outlet that was simple and easy to understand. In addition, at the project level in Case C, a "cookbook" for digitalization was developed. This was a catalog of methods applied in digital industrial value chains, and it was developed to summarize and present the results from all WPs in the project. Several feedback sessions and workshops were planned to explore expectations and to collect inputs from industrial companies on the cookbook's design. In Case D, all findings from the project were summarized and presented in the style of a popular science handbook, which comprised many easy-to-use templates for companies to continue the work or to conduct follow-up workshops internally and externally.

A possible compromise, which can function as a joint platform for researchers and practitioners and serve as inspiration for scientific articles and practical reports, is to launch a series of short, popular science articles early in the process. Our experience is that writing popular science articles is challenging for practitioners, but with close research dialogue and guidance, this process may well prove rewarding for all parties. Consequently, the writing process can function as a catalyst for mutual understanding among the parties and serve as a basis for discussion and further exploration of project objectives and research questions. Hence, the joint experience exchange seminar is considered a viable vehicle. Another opportunity was demonstrated in Case B, where a company employee was appointed to write a book on the management's research findings. Initially guided by the researchers' findings and supported by a senior researcher who provided continuous feedback, the writing process of this book served as an example of how different interests using written outputs can be managed in an IR approach.

Table 2 below summarizes our findings in the execution of IR-based research projects.

4.4. Perspectives and lessons learned by researchers on the skills required and by practitioners on IR usefulness

Experience with four IR-based projects revealed several important perspectives and lessons on the skills required by researchers in executing IR projects and the perceived usefulness of the approach by practitioners. The skills required by researchers when executing collaborative research have been acknowledged in existing research (e.g. Coughlan & Coghlan, 2002; Näslund et al., 2010), but there is room to build on the issue in greater detail (Ellström et al., 2020). This research explicates the need for three different sets of skills in the domains of: (i) having a relevant industry knowledge, (ii) project management capabilities, and (iii) the ability to over time engage practitioners in the research project.

First, researchers need to highlight the core relevance and potential impact of the project and, for this, researchers are expected to possess practitioner-oriented knowledge not only of state-of-the-art theory but also the topic's industrial relevance and broader impact on society. This is of special importance in the initiation phases of the IR project, where researchers need to communicate the project concept to the organization—not just top management but also middle and operational-level functions and departments. Our experience shows that researchers need to prepare an industry-relevant message that can be easily communicated to diverse levels within the organization.

Second, researchers need to be skilled at project management, including for instance managing feedback cycles over the course of the project. In the planning and initiation stage, it is important to involve participating companies and practitioners early on, not only by collecting their input in different forms, such as meetings, questionnaires, workshops, interviews, and pre-studies, but also by discussing and maintaining a continuous dialogue to reach a consensus on the overall goals. Researchers need to manage such feedback cycles in a way that is intelligent and inspirational. This includes topics such as roles and responsibilities, project activities and associated implementation plans, dissemination of preliminary project results, and identification of further improvements. Clearly, IR-based projects can become time-consuming and often call for exhaustive and frequent communication with the companies involved. Thus, researchers need to be trained in time management and the organization of multiple tasks.

Third, as noted by Svensson et al. (2007), the researchers have to be able to *co-operate* with the practitioners. Our findings indicate that researchers need to be creative when it comes to the planning and execution of joint experience exchange seminars, the design of research studies, the creation of inspiring presentations and discussions based on sound examples, and the management of expectations at both individual company level and project level. These activities make new or additional demands on the pedagogical skills of researchers, whose situation requires them continuously to bridge the academic–practice gap. Similar to other recent research on AR (Maestrini et al., 2016) and IR (Ellström et al., 2020), our research also indicates that trust-building activities are an important aspect for long-term engagement of practitioners. In our four cases, clarity of project structure and industry knowledge are shown to be two important cornerstones for such trust building.

Existing research on collaborative research approaches has been predominantly geared to an understanding of their challenges and benefits for research and theory generation (e.g., Van de Ven & Johnson, 2002; Berglund et al., 2020; Maestrini et al., 2016), and less on their explicit usefulness to and benefits for practitioners. The findings from our research indicate that practitioners derived the following benefits and lessons from the IR approach. First, in all four cases, partner companies felt that IR-based projects helped them to co-produce knowledge in the logistics and SCM areas. Companies found that this type of interactive approach in the co-production of new knowledge has long-term effects on their organizational development—for example, handbooks. In a few projects, companies acknowledged that they had found a clear internal consensus on several problem areas that IR projects had been addressing for quite some time, but they had experienced difficulties allocating dedicated resources and time to reflect on these problems and develop a concrete action plan. From this perspective, the IR-based projects provided a novel opportunity for companies to define an internal project and allocate resources to implement the strategy in a regular business way.

Second, another significant learning experience for many partner companies was the interaction and engagement possibilities that were opened up with other companies and industries. The IR approach enabled companies to continuously reflect on new questions, explore new areas, and examine current practices and ways of working. In particular, the workshops and creative sessions created during the joint experience exchange seminars were found to be effective. All companies felt this was a unique advantage with the IR approach, which helped them to learn much from the experience of other companies and industries on best practice. Moreover, they found it highly beneficial to work with similar and different companies on the new areas and questions of common concern. Many felt that IR-based projects created an arena for reflection and conceptualization, which did not exist in their current practice.

Third, many partner companies benefited from the methods that were developed, the new work procedures and templates, and the various course and thesis projects. The IR approach therefore created immediate and short-term effects, through which companies were provided with the opportunity to formulate topics and issues that needed immediate attention. Companies stated that, in the research projects, the researchers provided steady navigation. They acted as moderators to facilitate engagement in a specific topic and to deal promptly with questions that arose and, in so doing, provided the required amount of support.

Fourth, companies encountered difficulties in providing input to some of the new topic areas, which is often the case with research projects in the particular context of industry 4.0. They appreciated the opportunity to have an arena for reflection and conceptualization. However, they recommended an internal streamlined process for companies, such as a cross-functional reference group, to support them directly with feedback or to receive that feedback from the joint experience exchange seminars to act as the basis for further internal discussion.

5. Discussion and conclusions

An IR-based engagement with practitioners offers a significant opportunity to develop an in-depth understanding of a phenomenon that is equally relevant to practitioners and researchers, and it fosters a capacity to develop new, innovative research questions (Touboulic et al., 2020). In this paper, we have introduced IR as a promising extension of the AR approach in logistics and SCM. This introduction is valuable because, in contrast to other collaborative approaches such as AR, it stresses that researchers and practitioners have distinct roles and tasks during collaborative projects, and it clarifies how the two roles interact with each other. Based on examples and lessons learned in four research projects, this paper has adopted a process perspective on how to organize projects and to handle challenges in implementing IR-based research.

Across the four projects focused on a variety of companies and stakeholders, there are four main inferences that together develop new knowledge on how to execute and benefit from collaborative research projects.

First, the IR approach provides a valuable structure on conducting collaborative research between academics and practitioners. Somewhat paradoxically, by emphasizing their distinct roles and tasks, the structure (see Fig. 1) brings the theory and practice systems together and

Table 3
The results of the IR approach

Case #	What theories were used for academics	How the theories were introduced to practitioners
Case A	For academics, the project was informed mainly by dynamic capabilities theory (Teece, 2007) and organizational learning, including absorptive capacity (Zahra & George, 2002).	For practitioners, Teece's framework of sensing, seizing, and reconfiguring was contextualized into a retail logistics setting, which supported the practitioners in directing their efforts explicitly to a more flexible and innovative logistics system. In a similar vein, organizational learning theory provided structure for the company's experimental logistics development practices. Overall, the use of theories made practitioners aware of the possibility to consciously cultivate their development capabilities—i. e., change does not "just happen" but can be deliberately managed and facilitated.
Case B	For researchers, the academic theory employed was purchasing theory. More specifically, the concept of a hybrid purchasing organization was applied (Trautmann et al., 2009).	For the practitioners, the organization of purchasing was considered from a new angle. Several organizational dimensions that must be managed in hybrid purchasing organizations were outlined, and related areas of responsibility were explicitly discussed and refined. Also, paradoxical thinking in purchasing organizational design, such as the conflict between centralized and decentralized organizations, was outlined and exemplified with data from their own company.
Case C	The following theories and concepts were used by academics during the discussion with practitioners: Ecosystem theory (Jacobides et al., 2018) Value chain theory (Porter, 1985) Technology acceptance model (TAM) (Lee et al., 2003) Strategic information systems (Piccoli and Ives, 2005) Resource-based view of the firm (Wernerfelt, 1984)	The theories were discussed with practitioners in formal meetings and during workshops, specifically value chain theory and the resource-based view of the firm. However, some theories were used in greater detail—for example, discussing "as-is" and "to-be" situations in an ecosystem, a conceptual mock-up of digital twin ecosystems, and the implications of the proposed digital solution for supply chain actors. Theories such as strategic information systems, the technology acceptance model, and ecosystem theory were used in different workshops: i) to set a structure for the workshop, ii) to collect needs and inputs from partner companies, iii) to discuss various implications of digital solutions on the organization level and ecosystem level, and iv) to discuss and validate the conceptual mock-up of the digital twin ecosystem.
Case D	During the project, the academics used the following theories: Knowledge-based view of the firm (Grant, 1997) Knowledge creation theory (Nonaka, 1994) Experiential learning theory (Kolb, 1984) Organizational learning (Argyris and Schön, 1978) Dynamic capabilities (Teece, 2007) Process theories of change (Poole and Van de Ven, 2004)	As with Case C, the theories were discussed with practitioners in formal meetings and during workshops. In addition, some theories were used in a few interview studies to provide a theoretical background and to emphasize the significance of the topic. A few theories, such as the knowledge-based view of the firm, knowledge creation theory, and experiential learning theory were used in the initial phases of the project to explain their significance and to discuss the advantages and benefits of adopting such a perspective in industrial practice. Furthermore, the theory on organizational learning was used throughout the project to discuss the ideal way to organize feedback loops in organizations. More specifically, in different workshops and formal meetings, many examples of single-loop and double-loop learning were introduced both from a theoretical perspective and by the partner companies, with discussion centered on similarities and dissimilarities. These insights and discussions helped industrial practitioners to reflect on their way of working, identify shortcomings in industrial practice, and define new ways of working through new methods, new processes, and new templates. Finally, theories of dynamic capabilities and process theories of change were used in several workshops at the later phases of the project to analyze and define the capabilities required to undertake systematic change and methodically organize feedback loops both within and outside of the organization.

enables them to reinforce objectives of theory generation and practical problem solving. This finding is similar to Berglund et al. (2020) who concluded that, in IR-based research (in contrast to AR), the researcher has an explicit, defined role, which facilitates the researcher's interaction with the practitioner system. In general, the explicit structure of IR means that researchers are conducting research *with* practitioners rather than *on* practitioners (Ellström et al., 2020). Our research offers practical guidance on this structure—by introducing examples of different formats of joint experience exchange seminars—and on the actual research approach taken in four logistics and SCM research projects.

Second, in conjunction with the structure of IR, our research highlights explicit challenges and how to overcome these in three separate phases of IR research related to the role of the researchers. In particular, the findings pinpoint the importance of a continuous dialogue with practitioners throughout the project phases, in which the clear-cut tasks and interests of the research system and the practice system are in focus.

Thirdly, the findings demonstrate that an IR approach is a useful method to generate theory stretching beyond a particular research project. Ultimately, as existing IR literature also highlights (Ellström et al., 2020; Svensson et al., 2007), the IR approach offers a tool to establish long-term partnerships between academics and practitioners. In our experience, the IR approach, with its structures and recurrent interactions, builds trust and understanding between academics and researchers. The changes implemented in a variety of sectors across the four cases further support the robustness and worth of IR-based research.

In conclusion, we hope that the IR-based approach described in this study provides a tool to bridge the gap between research and practice. Adding to the qualitative elements of research, the IR approach provides the iterativity necessary to understand context and nuance, rarely available in one-time interview settings. Similarly, practitioners'

cooperation in research settings is expected to increase as they realize the benefits of the IR approach. However, the application of IR in logistics and SCM is still novel. Thus, the newness of this research opens up several avenues for future research. For instance, although benefits for practitioners have been covered in this article, the practitioner perspective is to a large extent missing in existing research. A crucial next step would therefore be to shed more light on IR experiences from a practitioner's point of view. An example of a theme to be covered in such research could be the requirements needed by practitioners—in terms of organization, capabilities, and resources—in order to participate.

Another critical future research theme is to gain more detailed knowledge of the disadvantages of IR. We believe that not all research projects lend themselves to an IR approach, which by its nature requires close collaboration and dialogue with practitioners. In many instances, this interaction can be viewed as something positive, but there are also drawbacks. For instance, as with all collaborative research approaches, the emergent nature of the research makes it difficult to be categorical on the right research questions to pose at the outset of the project. This implies a degree of risk—for example, the interest of research funders in knowledge generation may differ in important respects from the parties involved in the actual research project. In addition, the search for relevance comes at a cost that may be "too high" (Ellström et al., 2020). That is to say, the effort and time spent on interaction with practitioners may simply not pay off in terms of acceptable levels of knowledge generation. From a research funding perspective, the IR approach may not currently provide the best "value-for-money" alternative.

CRediT authorship contribution statement

Erik Sandberg: Conceptualization, Writing – original draft, Data curation, Writing – review & editing. **Pejvak Oghazi:** Conceptualization, Writing – original draft, Visualization, Project administration, Writing – review & editing. **Koteshwar Chirumalla:** Conceptualization, Data curation, Writing – review & editing. **Pankaj C. Patel:** Writing – review & editing.

Declaration of Competing Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Supplementary materials

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