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Requirements for the Transformation towards Returnable Transport Item-Enabled Circular Economies in the Austrian Parcel Industry

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Abstract: The European Green Deal sets the ambitious targets of establishing the first climate neutral continent by 2050 and reducing emissions by a minimum of 55% by 2030. In order to move the involved stakeholders to action, the European Commission has formulated proposals for regulations. One such proposal defines a legal framework to force industries to reduce the environmental burden caused by packaging waste. A major waste producer is the parcel service industry (CEP; courier, express, and parcel) and the industries it serves. Once put into place by the EU member states, the new laws will force all players in these sectors to increase business innovations in circular economies, which are based on the principles of recycling and reuse. Circular economies can be achieved by the implementation of returnable transport items (RTI) integrated with Industry 4.0 technologies. The ongoing research project ReKEP, which is largely funded by the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, investigates potential impacts of RTI-based circular economies in the Austrian parcel service industry. The project's particular interest is to identify the requirements of the most relevant stakeholder groups in the CEP industry for the successful transformation towards RTI-enabled circular economies. For this purpose, we conducted interviews with leaders and decision-makers of 10 stakeholder organizations, including producers, retailers, CEP contractors and the Austrian Federal Economic Chamber. This paper summarizes the interview results, which indicate that, despite recognizing the high potential of RTIs for reaching ecological sustainability goals, the contemporary awareness of the EU Green Deal and the concomitant responsibility to take action seems too low for successful implementation. The study outcome suggests that research and development in RTI should focus on operational requirements of workers and line managers from CEP industries for successful transformations to circular economies.

Keywords: Circular Economy; Ecological Sustainability; Packaging Waste; Parcel Industry; Returnable Transport Item

1 INTRODUCTION

1.1 Returnable Transport Items for the Elimination of Packaging Waste

The European Green Deal aims at the ambitious target of turning Europe into the first climate neutral continent. As part of this initiative, proposals for policy frameworks were formulated with the intention to ignite business innovations that prioritize the reduction or elimination of the environmental burden of packaging waste. In order to remain compliant with EU regulations in the upcoming years, European courier express parcel (CEP) industries will need to increase recycling, refilling and reusing of packaging material to reverse the trend towards processes that rely on one-time use and disposal of packaging materials [1].

Currently, the most widely used transport items are paper-based boxes, which are a major reason for an ever-increasing environmental burden. Such solutions generally come without refilling or reuse features and thus are usually turned directly into paper waste. While fibers are partly recyclable, the underlying cycles are limited, before ending up in incineration plants that generate carbon emissions (Fig. 1A) [2].

One frequently proposed solution to effectively turn around the trend of mounting paper waste production is putting returnable transport items (RTIs) in circulation, which are defined as "any product for the purposes of transport, handling and/or distribution of one or more products or product packages that are returned for further usage [including] pallets […] as well as all forms of reusable crates, trays, boxes, roll pallets, barrels, and trolleys" [3]. The RTI concept would theoretically allow hundreds to thousands of reuse cycles before recycling becomes necessary. In addition, a single reuse cycle is shorter compared to the recycling process of its paper counterpart. Therefore, RTIs would conceivably create less environmental burden in terms of waste and carbon emissions (Fig. 1B) [2, 4].

Although the advantages of RTIs in contributing to global ecological sustainability goals seem obvious, and were even demonstrated in specific industries [5], implementation on a broader scale is sluggish [4, 6]. One of the challenges for a transformation towards RTI systems is the establishment of a functioning RTI system that meets the needs of several stakeholders. If there is no added value from the stakeholders' perspective, the potentials of RTIs cannot contribute to reaching global sustainable development goals.

With a focus on these notions of stakeholders, this paper investigates the main challenges associated with the implementation of RTIs in the CEP industry and defines the specific needs of the most important stakeholder groups in the Austrian context by addressing the following research questions:

1) Are RTI systems viable alternatives to cardboard-based or other one-way packages?
2) What are the challenges associated with the implementation of RTI solutions?
3) What are the prerequisites for turning RTI solutions into successful enablers of circular economies?

1.2 State of Current Research

The theoretical advantages of RTIs over linear transport solutions and the interest in reaching the global sustainable development goals recently resulted in multiple development projects and research initiatives [7, 8]. Depending on the underlying lifecycle management approach [9], the transportation strategies [10], the design of the logistics system [11], the integrated technical features of the transport

solution [12], or the use case scenario [5], the potential advantages of RTIs seem to be indeed detectable. However, some studies show contradictory results [2], which suggest knowledge gaps concerning the technical and strategic requirements. Shifting research from development of economic and ecological indicators to defining more user-centric success factors (operational requirements for RTI-based circular economies) might increase the rate of adoption.

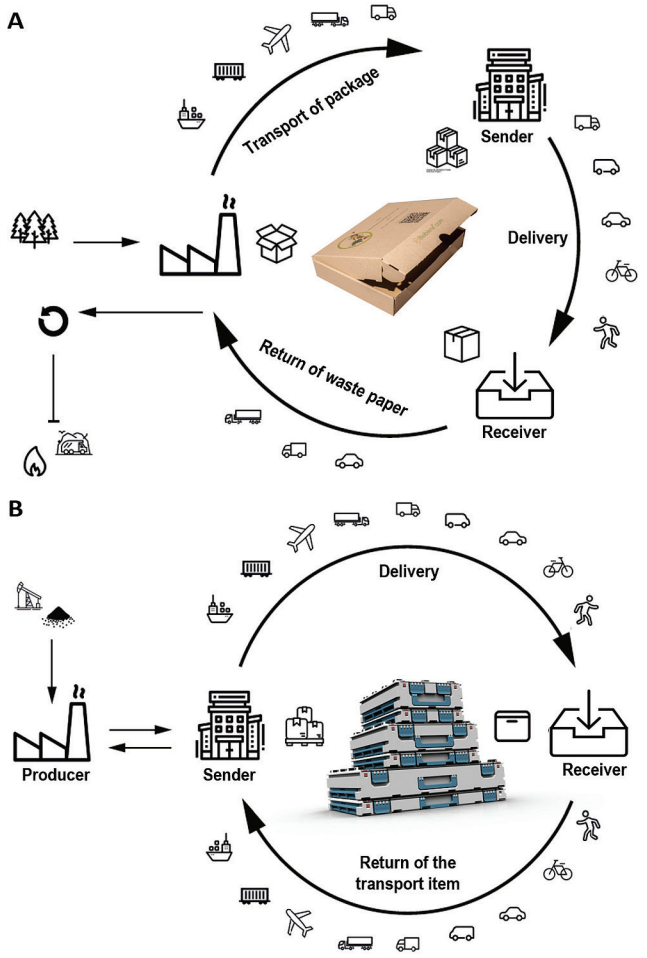

Figure 1 Reuse cycles of returnable transport items are shorter than recycling cycles of fibers. (A) The cycle of fibers from paper-based transport items. The box starts its journey at the box factory, from where it is delivered to another factory of a manufacturing company or a parcel delivery service provider. Once filled with a product, it is used as a transport item for the delivery of a product. After the receiver has unboxed the product, the box is disposed of as paper waste, which is ideally returned to a paper-box factory producing new boxes with recycled fibers. (B) The tightened delivery and reuse cycle of returnable transport items. After manufacturing, RTIs start their cycle at the sender of a product. Once the product is delivered, the RTI is backhauled to the sender for reuse. Figures kindly provided by BOOXit.

Considering these research gaps, currently the most reliable source of information are the stakeholders groups involved in existing supply chain [13]. In comparison to linear supply chains, closed-loop supply chain networks have an increasingly complex stakeholder structure, due to the additional reverse logistics processes [4]. Therefore, a prioritization of the most relevant stakeholder groups might be necessary, before inquiring about their requirements for the implementation of RTI systems in circular economies [7].

The stakeholder view could also apply to either of the recently derived frameworks to develop and implement RTI-enabled circular economies in specific use case scenarios [14–17]. Under this assumption, this paper focuses on the perspectives of the most influential stakeholder groups with the objective of detecting and evaluating the stakeholder requirements, which are to be defined as success factors for RTI systems [18, 19].

1.3 The Research Project ReKEP

This paper is an outcome of the research project ReKEP, a consortium research project funded by the Austrian government to investigate the stakeholder requirements for successful transformation from cardboard-based transport items usage to RTI-based circular economies. The Institute for Digital Transformation and Strategy at the University of Applied Sciences for Management and Communication in Vienna, and the University of Applied Sciences Upper Austria as well as the consortium leader, the Austrian Institute of Technology, conduct the research activities together with start-up and logistics company partners providing consulting services and process resources for on-site investigations [18, 19].

The paradigm technology of ReKEP is the BOOXit RTI solution, which had been advanced by the project DigiPharmaLogNet [20]. BOOXit RTIs have a range of features that are advantageous over cardboard-based boxes in circulation [21]:

- Stackability of boxes with different sizes (Fig. 2A)
- A drawer mechanism for storage in a proprietary rack (Fig. 2B) allowing "one-shot" loading and unloading of multiple boxes (Fig. 2C)
- Detachability of the lid (Fig. 2D)
- Mechanism for combining multiple box frames for upscaling box volumes (Fig. 2E)
- Integrability of Industry 4.0 sensors for the purposes of tracking and tracing of transported products
- Compatibility with a patented robot arm for full automation of warehouse management processes (Fig. 2F)
- A proprietary inventory control system and a mobile application for optimal box management (Fig. 2G).

The establishment of a functioning Industry 4.0-enhanced RTI ecosystem using a solution such as BOOXit requires that the needs of several stakeholders are met. To derive stakeholder needs, a stakeholder identification framework has been established in ReKEP, which allows prioritization of stakeholders according to either a claims-based view (e.g., interested in either financial returns or maximizing sustainability impact) or a resource-based view (e.g., direct vs. indirect providers of supply chain resources).

From a resource-based perspective, courier express parcel (CEP) service providers and their business customers, i.e., retailers, can be seen as the two most important stakeholder groups, since they provide direct input to the transactions [7]; in other words, they perform the delivery and theoretically the reverse logistics.

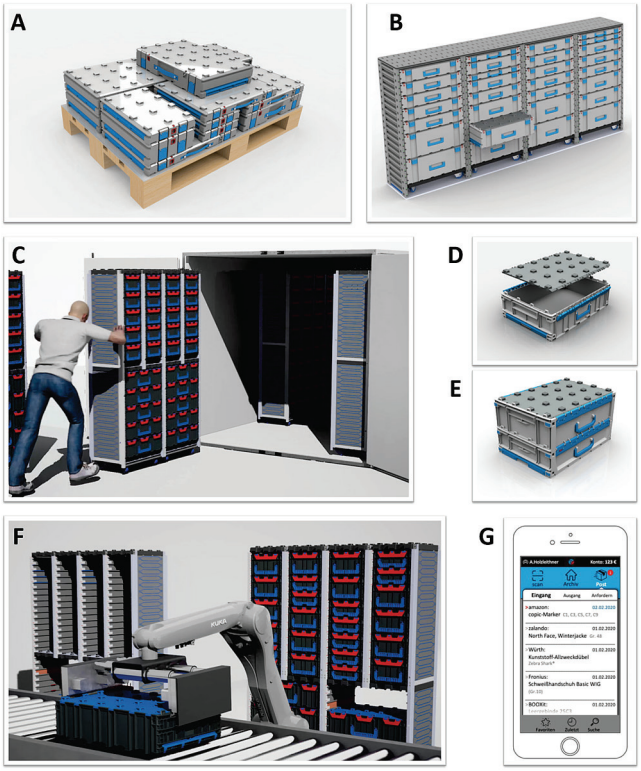

Figure 2 The BOOXit RTI solution. (A) A proprietary mechanism allows stacking and fixation of boxes with different sizes. (B) Proprietary racks enable the drawer mechanism of BOOXit boxes. (C) Racks enable the "one-shot" loading and unloading of multiple BOOXit boxes. (D) Box lids are detachable. (E) Box volumes can be upscaled through the combination of multiple box frames. (F) A patented robot arm for full automation of warehouses. (G) A proprietary mobile app for using an inventory control system. Figures kindly provided by BOOXit.

In order to define the specific needs of these stakeholder groups in the Austrian context, semi-structured interviews of CEP service providers and retailers partaking in the Austrian parcel industry were conducted. The interviews focused on the challenges faced when adopting RTIs in their delivery processes. We deliberately included German companies that have connections to the Austrian market to increase the volume of the database, because the Austrian CEP market is rather small. The Austrian and German markets are also closely connected, since many German companies serve the Austrian market. The analysis of the interviews resulted in the categorization of the responses into themes that highlight the industry's readiness, the barriers of RTI implementation, and the innovative practices applied to achieve a circular economy. The outcome of this study provides a comprehensive understanding of the current state of RTI adoption in Austria and the key influencing factors.

1.4 Organization of the Article

The rest of this article is structured as follows: Section 2 describes the qualitative research approach to data collection and analysis; Section 3 presents the research findings in several subsections; while Section 4 discusses the findings and draws conclusions from the study.

2 METHODS

2.1 Semi-structured Interviews

The research questions were addressed using a qualitative research approach based on semi-structured interviews with executives or senior managers responsible for sustainability issues [22, 23]. The target companies were parcel service providers (PSPs) and retailers either headquartered or operating in Austria or Germany.

The interviews were recorded, and the transcripts or interview protocols were analyzed in-depth for coding of relevant sentences or paragraphs using the ATLAS.ti software program from ATLAS.ti Scientific Software Development or the MAXQDA software program from VERBI. The codes relevant to addressing the research questions were grouped. The coded transcripts were exported as QDPX files for subsequent merging into a single project for the determination of code frequencies or code co-occurrences using ATLAS.ti.

2.2 Interview Partners

A total of 15 invited companies, involving small, middle, and large enterprises operating either as CEP service providers or retailers with their headquarter or subsidiaries established in Austria agreed to an interview. Sustainability representatives of CEP and retailer companies were interviewed (Tab. 1).

Table 1 Interview partners

Interviewee #	Firm	Job role	Country
1	Parcel service provider	Innovation manager	AT, DE
2	Drugstore retailer	Head of Human Resources & Internal Communication	AT
3	Fashion retailer	Head of sustainability	DE
4	Natural cosmetics retailer	Head of Global Relations	DE
5	Office supplies retailer	Head of Sustainability and Quality Management	DE
6	Sporting goods retailer	Head of HR und SCM	AT
7	Coffee and consumer goods retailer	Project Manager Logistics & Sustainability	DE
8	Spare parts retailer	Head of Logistics	AT
9	Installation and fixing material retailer	Executive Board Member and Head of Logistics	AT
10	Apparel retailer	Senior Operations Manager supply chain logistics	AT
11	Installation and fixing service provider	Innovation Manager	DE
12	Parcel service provider	Senior Key Account Manager	AT
13	Parcel service provider	Managing Director	AT
14	Parcel service provider	Sustainability Manager	AT
15	Parcel service provider	Co-founder & CEO	AT

3 RESULTS AND DISCUSSION

3.1 Readiness to Adopt Returnable Transport Items

Given that RTIs have the potential to support companies in contributing to the global sustainability goals, it is expected that logistics providers would design and implement business initiatives for putting RTIs in circulation. Therefore, the interview partners were first asked

about current corporate sustainability measures in general, and then specifically surveyed about ecological sustainability goals in place. As expected from logistics companies, sustainability measures were in place to improve ecological factors; especially, for the purpose of achieving carbon neutrality.

Despite their potential positive impact on ecological factors, RTI solutions seemed to play a rather minor role in the implemented sustainability measures. As shown in Fig. 3, only three statements on sustainability measures involved RTI solutions (retailer #10 and #9). Eleven responses about RTI usage were mentioned in conjunction with the ecological sustainability topics, which were addressed by sustainability measures, e.g., reaching carbon neutrality, improving energy efficiency, reduction of waste production or increasing sustainability in the areas packaging, procurement, or supply chain.

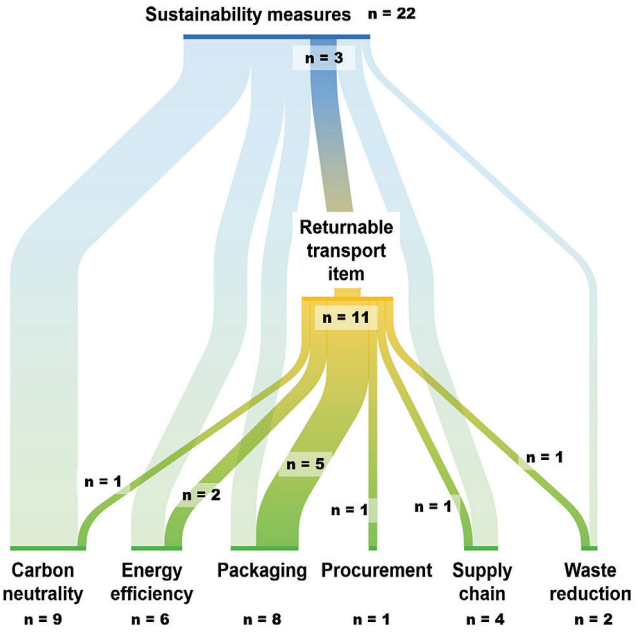

Figure 3 RTIs play a minor role in ecological sustainability measures

This observation indicates that despite CEP companies recognizing the potential of RTIs in reaching sustainability goals, there is a general hesitancy in their exploitation. Instead, interviewees implied that measures with lower associated risk for failure are given priority. For example, in the context of improving energy efficiency and achieving carbon neutrality, PSP #14 mentioned measures that demand less drastic changes in the companies' processes like the use of electric vehicles or installing photovoltaic systems.

3.2 Experiences and Assessments of RTI-Systems

Independent of planned sustainability measures, we continued asking the interviewees about their knowledge of RTI implementation to gain insight on their current perspective of the RTI concept. Some CEP companies already have experience in RTI implementation. For example, retailer #9 reported that they have been working with reusable packaging for 15 years and managed to close the gap internally. Similarly, retailer #5 noted that they had positive experiences with their reusable shipping system and that they were able to reduce the disposable packaging and the resulting waste, and that they even received the Blue Angel award for environmentally friendly practices.

We further questioned them about their opinions on the RTI concept, which indicated apparent advantages and disadvantages of RTI implementation (Fig. 4). The decision on the packaging material (returnable and/or recyclable) appeared to be highly dependent on customer (receiver) needs because the implementation of return processes must allow a win-win situation. This underscores the importance of customer involvement in the design of reuse processes. When retailer #7 spoke of the challenges of transforming to a circular system based on RTIs, they highlighted the following: "The results of the pilot project reinforce our focus on customer needs and our commitment to improve the sustainability of online retail. However, the journey is not without obstacles; the technical integration of incentives, the continuous optimization of packaging and the need for economically viable processes for the return of empty packaging remain key areas of focus."

When asked about the customer (receiver) view of RTIs, the attitude towards RTI solutions seemed positive according to retailer #9, who mentioned that they have a lot of requests from customers who want to be supplied with reusable solutions. Comparable customer feedback was also reported by interview partners without experience in RTI systems.

The only advantage of RTIs seen by both retailers and PSPs is the improved handling (box management) associated with package delivery when the RTI system is enhanced with smart technologies. Retailer #15 commented: "[...] if the [BOOXit] returnable box system works, then collecting the empties is just significantly faster than [...] looking at cardboard boxes […]". This statement referring to semi-automation of delivery and return processes was also underlined by PSP #14: "[...] If we could switch many of our customers to such a reusable system, like a [BOOXit] box or maybe other options, we would be able to [...] know the size of the package by scanning [...] and [...] plan our volume. That would be a big advantage for us [...]".

Unlike the prevailing perceptions of advantages on the customer side, contradictions remain about the (customer) acceptability of RTIs among PSPs and retailers. While interest in sustainable packaging is growing and some customers are willing to share the additional costs, potential risk factors need to be considered.

On one hand, customers of online retailers were mentioned to prioritize product protection over sustainable packaging and seem unwilling to pay for reusable systems, especially if they involve significant additional costs. As retailer #8 pointed out that if customers had to pay a deposit for the boxes and were required to take them back to a special place, this will not be widely accepted.

On the other hand, online retailers, who already offer sustainable products, reported high acceptance, and underlined the need for a deposit on returnable packaging as stated by retailer #3: "We have received positive feedback

from customers using our returnable packaging [...]. Incentives such as a deposit system or bonus points could be part of the strategy to encourage the return and reuse of returnable packaging".

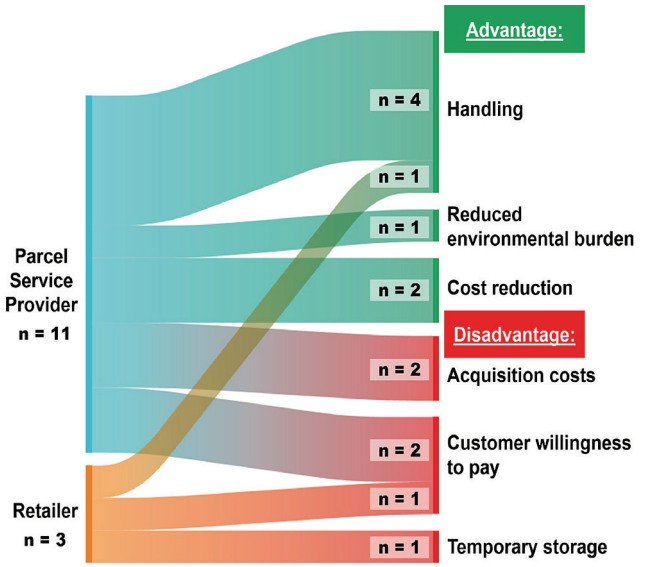

Figure 4 Advantages and disadvantages associated with different experiences in implementing RTIs or comparable systems

The advantages and disadvantages, which were partly pictured based on experiences with RTI usage, insinuated that receivers have a substantial impact on the decision whether to implement RTIs. Therefore, involvement of these stakeholder groups in the design of RTI strategies would probably result in a more directed approach and ultimately elevate the success of putting RTIs in circulation. This view is also supported by previous findings that indicate the need of a multi-stakeholder approach for the sustainable establishment of RTI-based circular economies [7].

3.3 Challenges Associated with the RTI Concept

Considering the advantages and disadvantages of RTI systems, the interviewees were then explicitly asked about challenges they would expect from executing RTI initiatives (Fig. 5). Of these, reverse logistics emerged as the most crucial problem. For example, retailer #10 depicted the issue of reverse logistics, and the development of robust systems for managing the return of empty packaging as critical for its success. It also highlights the importance of collaborations and business relationships with PSPs in both directions of the logistics chain.

The challenge of reaching the necessary customer acceptance was another particularly critical issue with comparable relevance as reverse logistics. Retailer #9 exemplarily illustrated this barrier as follows: "[...] the focus is primarily on acceptance by the customer and even by the PSP. If the PSP must wait for the container to be emptied [...] too much time is lost [...]". This brief statement again underscores the importance of functional return processes that are efficient and accepted by all stakeholders involved.

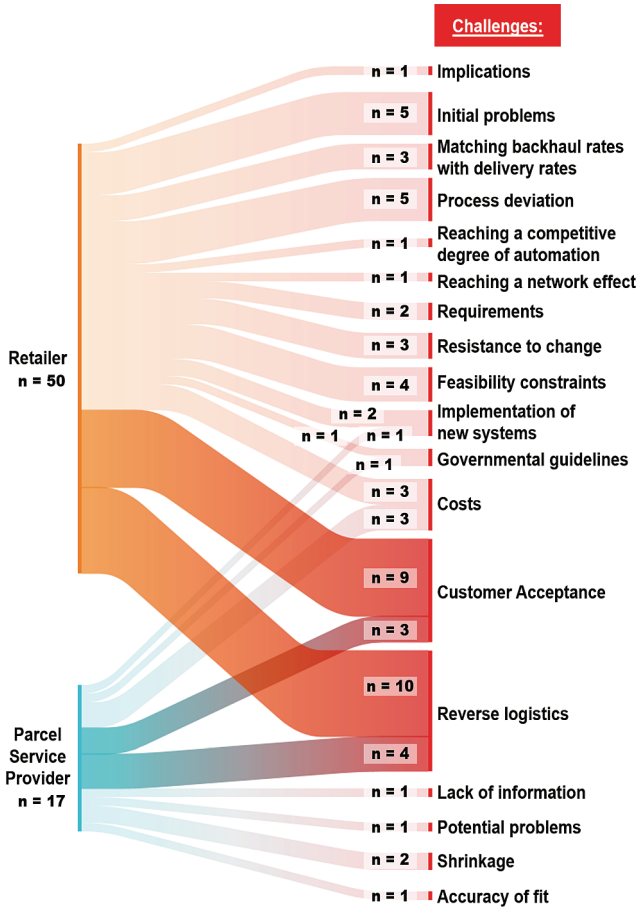

Figure 5 Challenges associated with RTIs or comparable systems

The establishment of reverse logistics processes presents several additional challenges, beyond others, matching backhaul rates with delivery rates, as was mentioned by the apparel retailer #10: "[A] circulatory system obviously needs a sophisticated balance system. With a reusable system, [one] must always have the reusable containers in the right place […], [otherwise] it [remark: the system of forward and reverse deliveries] quickly leads to […] imbalance […], [i.e.,] there is more going in one direction than the other and [one] always [must] balance it out". In case of unmatched reverse logistics rates, compensating backup systems must be in place according to the interviewee #10: "[W]e solved these challenges through mass measures [i.e.] we have a relatively large pool of reusable containers that we use". Such solutions certainly entail additional obstacles in RTI implementation. In fact, the interviewees mentioned challenges, which are relevant to change management: "initial problems", "process deviation", "resistance to change", "feasibility constraints", "implementation of new systems", and "shrinkage".

Interestingly, the role of automation and policy regulation was mentioned less often than expected in these discussions, even though these factors were previously considered as enablers [24] or main drivers [17], respectively, in realizing circular economies. This observation suggests that the focus of current efforts is more on overcoming logistical, financial, and behavioral barriers than on considering technological or legislative aspects,

despite the incumbent European Green Deal and the formulation of EU directives on packaging [1].

Taken together, these are notable barriers, which drive the reluctance of PSPs and retailers to change established business models by switching to RTI systems. This opinion is also reflected by recent findings suggesting a common resistance within the logistic industries to move away from traditional, linear models of consumption and waste [25].

3.4 Requirements for the Adoption of RTI-Systems

Given the multitude of challenges discussed, the interviewees were also asked about their expectations concerning the requirements for successfully putting RTIs in circulation. Surprisingly, the suggestions by the retailers and the PSPs to overcome those challenges turned out to be less multifaceted than expected. Next to "matching backhaul rates with delivery rates", only four additional requirements factors were listed in comparable frequencies (Fig. 6).

Similar to retailer #10, who stated that to "match backhaul rates with delivery rates", retailer #9 drew on in-house experience and suggested putting RTIs in high numbers in circulation. The issue of aligning forward and return rates is also discussed in literature. Since successful matching depends on flexible reverse logistics, the establishment of robust return processes is a must [26].

In connection with the backhaul procedure, some specific requirements for the box material were mentioned; in particular, high robustness for box handling seems to be an issue. The choice of material (and the RTI construction determining nestability) is a disputed topic because it affects the RTI's life cycle, including its recyclability. PSP #12 insinuated that boxes with lids have insufficient durability: "[O]ver time […] boxes become broken because of the [daily] manipulation of these containers […]. We sometimes have boxes with lids. […] And the hinges tend to be a bit vulnerable." Accordingly, hinge parts as shown in Fig. 2D are particularly fragile, which is a problem if stackability is a required feature for backhauling of non-foldable empties since stacking and dismantling may cause attrition.

Recognizing that the transformation towards circular economies, especially if enabled by RTI solutions, is a multi-stakeholder endeavor [7], CEP players do not seem to see responsibility in-house, but at external administrative institutions. For example, PSP #15 indicated that legal frameworks are needed to give the required impetus to RTI implementation: "I think, even if many entrepreneurs don't like to hear it, [...] without legal regulations or guidelines or any pressure from outside, not much will change".

Such governmental guidelines could also stipulate the establishment of standards concerning recyclable materials. The EU directive on packaging and packaging waste already addresses this issue and promotes "standard sizes", which were proposed as a requirement by some interviewees. Standardization of RTI systems is seen as a prerequisite because all stakeholders directly participating in the circular process need to agree on a single solution [7,27]. If a CEP player is a part of different circular logistic systems, the management of different RTI solutions is expected to raise the effort unproportionally, as is sketched by the PSP #14 as follows: "[I]f we now assume, for example, that we have a customer with a lot of small packages […]. And then we have a customer who […] has packages [that] are just a little bigger […], so […] the size is a little different. But if, for example, we were to switch many customers to a [single] reusable system, such as a box or perhaps other alternatives […] we could of course [better] plan our volumes afterwards. That would of course be much more to our advantage."

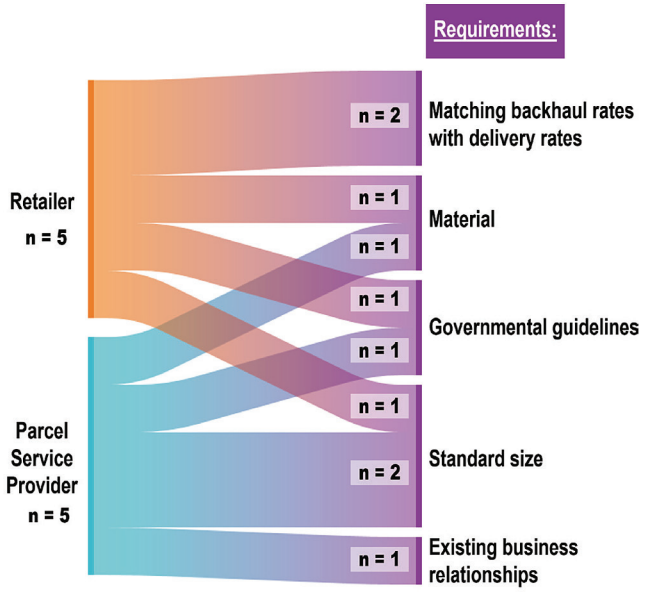

Figure 6 Requirements mentioned to successfully bring RTIs in circulation

The observation that a range of challenges were mentioned, whereas requirements to be met in order to overcome those hurdles were comparably sparse, might indicate a knowledge gap in designing suitable initiatives. A couple of agendas on the integration of Industry 4.0 with circular economies solutions have already been published previously [14-17]. However, those roadmaps primarily focus on strategic issues rather than on operational problems referred to by the CEP players (Fig. 5 and Fig. 6). To guide RTI development and implementation on an operational level, user requirements should be considered as well, including requirements of workers and line managers from CEP industries.

4 CONCLUSION

Our research findings reveal a multi-layered picture of the Austrian parcel industry's journey towards circular economy practices from the perspective of the industry's major stakeholder groups, i.e., the PSPs and the retailers. The specific focus of the study was the adoption of RTI solutions. While the statements of the interviewees indicated a positive attitude towards implementing circular economy practices in the CEP industry, the interviews pointed at a common sense of underlying economic and logistical challenges associated with putting RTIs into circulation. This insight highlights the need for the establishment of a consistent regulatory framework to support an industry-wide transition to circular economy systems. Therefore, collaborative efforts within industries and in cooperation with government institutions

could be the starting point in creating the necessary synergies to overcome the existing challenges.

However, it must be mentioned that the number of available interview partners was limited and geographically confined to Austrian and German companies (Table 1). Accordingly, complementing this study by expanding of investigations to additional countries and industries would provide even more insights on requirements for RTI systems.

Nevertheless, the findings further indicated that the transformation of the parcel industry towards RTI-enabled circular economies requires a profound strategic reorientation within the CEP industry. This includes not only the adoption of new technologies and practices, but also a cultural shift to the focus on sustainability and environmental protection. The success of this transformation will depend on the industry's willingness to invest in innovative RTI solutions and to build long-term partnerships that are a prerequisite in establishing circular economies. Strategic roadmaps, which have been recently published [14-17], thus should also consider requirements on the operational level, since they build the basis of informed decisions for investments in research on RTI solutions and the development of process-oriented circular economies.

In conclusion, this paper provides insights into the dynamics of adopting circular economy practices in the parcel industry and highlights the urgency of a concerted effort to improve environmental sustainability. It calls for an increased commitment from all stakeholders to build a future where economic activity and environmental protection demand equal consideration.

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