Innovating Sustainability: Digital Marketplaces as Catalysts for Circular Economy on the Reuse of Electronic Devices

Anna Lahtinen, Pirjo Saaranen and Sami Nykter
Haaga-Helia University of Applied Sciences, Helsinki, Finland

anna.lahtinen@haaga-helia.fi
pirjo.saaranen@haaga-helia.fi
sami.nykter@haaga-helia.fi

Abstract: This study delves into the synergy between innovation management, the circular economy, and the development of digital marketplaces, with a particular focus on the reuse of electronic devices. It highlights how digitalisation within the circular economy can spur innovation in managing the reuse of electronic gadgets through digital platforms. Drawing on a robust quantitative analysis of data from over 400 Finnish and Baltic companies, this research is pioneering in its holistic integration of these sectors, addressing the critical need for insights into the operational and managerial dynamics of circular economy digital marketplaces. Employing a comprehensive quantitative approach, our investigation uncovered significant insights regarding the perceived opportunities, challenges, and value-added features of these marketplaces for electronic device reuse. Environmental protection, cost savings, and enhanced recycling opportunities were identified as major advantages by participants. However, the study also pointed out significant barriers to effective marketplace operation, including IT system integration, organisational culture challenges, and resource limitations. A noteworthy contribution of this research is its elucidation of the influence of company size on engagement in the circular economy, pinpointing large and micro-enterprises as potential pioneers in this domain. It also sheds light on the business-to-business (B2B) dynamics within digital marketplaces, exploring the interactions among sellers, buyers, and service providers. Our findings underscore digital marketplaces as pivotal enablers for sustainable practices in electronic device reuse, whereas digital platforms may expedite the transition towards a circular economy. This aligns with principles of innovation management by promoting collaboration, minimising waste, and fostering new business models. The conclusion emphasises the digital marketplace not just as a platform for transactions but as a vital ecosystem enabler, providing a wide array of value-added services. It underscores the importance for businesses, especially in the electronics sector, to integrate circular economy principles strategically, leveraging digital marketplaces to achieve sustainability goals while gaining competitive advantages. The research has directly influenced the launch of a pilot digital marketplace for electronic product reuse, showcasing the practical application of its findings. This emphasises the study's role in advancing innovation management practices by demonstrating the transformative potential of digital marketplaces in promoting circular economy practices.

Keywords: Circular economy, Electronic devices, Digital marketplace, Innovation, Sustainability

1. Introduction

The transition towards a sustainable and circular economy represents one of the most pressing challenges and opportunities of our time. In the quest for sustainability, the role of digital innovation, particularly in the context of the circular economy, has gained unprecedented momentum. The focus on electronic device reuse within this context is both a necessity and an opportunity, given the rapid pace of technological advancement and the resulting environmental footprint. Our study ventures into this critical intersection of innovation management, circular economy principles, and digital marketplace development.

The proliferation of electronic devices, coupled with their short lifecycle, poses significant environmental risks, ranging from resource depletion to hazardous waste. The circular economy offers a promising pathway to mitigate these issues by promoting the reuse, refurbishment, and recycling of electronic devices, thus extending their lifecycle and reducing waste. Digital marketplaces, as platforms that facilitate the buying, selling, and exchanging of goods and services, emerge as powerful enablers in this regard. By harnessing digital technologies, these marketplaces can significantly lower the barriers to electronic device reuse, fostering a culture of sustainability and innovation.

Our research looks into how digitalisation can catalyse innovation in the circular economy, specifically through the lens of electronic device reuse. By conducting a comprehensive quantitative analysis of over 400 Finnish and Baltic companies, this study pioneers in uncovering the operational and managerial dynamics that underpin the success of circular economy digital marketplaces. We aim to highlight the perceived opportunities, challenges, and value-added features these platforms offer, and how they can be leveraged to foster environmental protection, cost savings, and enhanced recycling opportunities.

2. Related Work

The European Union has outlined that development of the circular economy is required to combat climate change (European Commission, 2020). The effective implementation of circular economy practices can offer meaningful positive contributions to addressing the current environmental challenges and economic opportunities to shape business sustainability (Geissdoerfer et al, 2018). The current advancements in EU legislation and the Circular Economy Strategy highlight the increasing role of producers in meeting the obligations related to managing the end-of-life of products. Extended producer responsibility (EPR) commonly involves waste reverse logistics, guiding the collection, inspection, and processing of end-of-life products to support circular economy efforts by closing material loops (Bening & Petri, 2024). Research indicates that firm-specific characteristics, such as the sector and type of circular business model adopted, significantly influence the formation of barriers to the adoption of circular economy practices, revealing distinct challenges across sectors and models that can impact the success of these initiatives (Brändström, Jazairy & Lindgreen, 2024).

In circular economy connecting with wider ecosystem is very important (Lacy, Long & Spindler, 2020). In circular economy value creation reuse of products, components and materials is an important part that needs to be encouraged widely across various operations (Cole, Gnanapragasam & Cooper, 2017). The data concerning the quality of a used product, component or material is usually the most important attribute when determining value (Rogers, Lembke & Benardino, 2013). Efficient value creation from used goods therefore requires sharing accurate data between the ecosystem stakeholders. The transition to the ecosystem circular economy requires different stakeholders to share and trade data and goods in circular value networks (Orko & Åkerman, 2019). Digital solutions can be harnessed to enhance material recycling, lengthen the lifespan, and increase the utilisation of equipment (Sinervo et al, 2022). This points towards an increased demand for contemporary solutions and tools that enable a circular economy, such as digital marketplaces.

Growing digitalisation of business processes, along with rapidly advancing technologies, provides ample grounds for digital marketplace solutions and their ability to operate on timely information, current supply-demand matching, and overall transparency (Berg & Wilts, 2019). Digital marketplaces are places of commerce in which sellers and buyers can trade almost anything (Rogers, Rogers & Lembke, 2010). Digital marketplaces have been identified to be promising technologies in value-creating networks between the manufacturing sector, the waste and recycling industry, and digital services (Blackburn, Ritala & Keränen, 2024; Berg & Wilts, 2019). Sharing data and selling goods via digital marketplace in real time enables stakeholders to evaluate the capturable value available before acquiring the assets available. Digital marketplaces also offer the means to reduce the transactional costs related to finding suppliers and buyers and creating the needed documentation regarding transactions (Berg & Wilts, 2019). Digital marketplaces, such as eBay, are very popular within the secondhand consumer market for selling used products such as cars, electronics, clothing, etc. In B2B setting the increased complexity in interactions, the lack of trust and high cost are barriers for establishing standardised online marketplaces (Mourtzis, Angelopoulos & Panopoulos, 2021). Successful implementation of a digital B2B marketplace requires implementing critical success factors that guarantee neutrality in managing the transactions, while maintaining trust between the actors (Bolocco, Perego & Perotti, 2010). In general, a circular economy marketplace operator should focus on finding the right type of buyers, in order to increase the likelihood of customers buying a used instead of new product (Mak & Heijungs, 2022). For their capacity to tackle these and related opportunities, digital marketplaces have been recognised as essential elements in the creation and sustenance of a circular economy (Lacy & Rutqvist, 2015).

Electronic devices represent a special interest in this context, as they constitute the increasing e-waste combined with the lack of established environmentally sustainable reuse and recycling practices (Santato & Alarco, 2022). Electronics and electronic devices refer to computers, mobile phones, remotes, and cameras – devices that use electric current to encode, analyse, or transmit information. The use of electronic devices is characterised by shorter life cycles, as they are replaced and disposed of at a growing pace (Tang et al, 2022). From the environmental perspective, the reuse of electronic equipment should be a priority, though economically the possibilities for value creation are diminishing over time (Hischier & Böni, 2021). As the value of used electronics equipment decreases strongly over time, the speed to complete the transactions becomes one key parameter to measure in the ecosystem.

Following quantitative methodology, the present research investigated the requirements and opportunities associated with the creation of the circular economy digital marketplace for the reuse of electronic devices. The research resulted in meaningful and applicable managerial and business contributions that translated into the launch of the marketplace pilot (2022).

The present research leapt into the future of digitalisation, and brought together three domains: the circular economy, digital marketplace development, and its application for promoting the reuse of electronic devices. The combination of the three has great practical and managerial potential, but to date remains under-researched. For the success of the green transition, there is an urgent need for further understanding of the requirements and opportunities related to circular economy digital marketplace creation and operation.

As opposed to the linear model of production, the circular economy aims to preserve the value of utilised resources and materials as long as possible, use them as frequently as possible, and produce as little waste as possible (Ellen Macarthur Foudation 2020). The concept covers all aspects of economic activity from resource extraction to production, storage, and consumption, ending with disposal or recycling. (Wilts, 2016). To reach this goal, circular economy digital marketplace may serve as an instrument for bringing together the needed scope of businesses, actors, and organisations, and involving them in the reuse of electronic devices. This is aligned with the digital platforms' operational models that represent networked marketplaces and exchange constructs (Berg & Wilts, 2019; MacAffee & Brynjolfsson, 2017).

The research adds value to the existing body of knowledge and management practice by providing insight into requirements and opportunities associated with the creation and successful operation of the circular economy digital marketplace for the reuse of electronic devices.

The research had pursued the hypothesis that the integration of digital marketplaces into the electronic device sector significantly enhances the efficiency and effectiveness of circular economy practices, primarily through improved matchmaking between supply and demand, reduced transaction costs, and the provision of a platform for the exchange of critical product information.

3. Methodology

This study's findings derive from a comprehensive quantitative dataset gathered at the outset of the project. Within the scope of this paper, we narrow our focus to a specific segment of the dataset, examining participants' perceptions of the opportunities and value-added features provided by the digital marketplace, challenges to its adoption, and their preferred role within the marketplace ecosystem. The research received financial support from the Helsinki-Uusimaa Regional Council, Finland. The data collection phase spanned from June to August 2021. We compiled the contact details of the participating firms from Selector's company database, employing specific selection criteria to guide our process:

- Finnish companies with less than 50 employees, incl. CEOs of the following industries: electronics and equipment manufacturers, wholesalers, retailers, and recycling companies;
- Finnish companies with 50+ employees, incl. CEOs and Marketing, IT, Sales, Purchasing, Production, Product Development and Communications Managers from all industries;
- Companies from Baltic countries with more than 5 employees, turnover more than 50 MEUR, industries included manufacture of electronic equipment and components, waste management and recycling, storage, other logistics, film, sound, video, radio and TV program production, communications and satellite communications, computer network services, and repair services.

On June 15, 2021, a survey was distributed to 14,422 organisations in Finland, and subsequently, on July 5, 2021, an additional 1,090 organisations from the Baltic region were included. Follow-up reminders were dispatched on June 22 and August 4, 2021. Out of the total, 404 organisations responded, yielding a response rate of 2.6%.

The survey was conducted using Webropol, an online survey platform. It featured a variety of question types, including single-choice, multiple-choice, and open-ended questions. To gauge the perceived opportunities and barriers within the digital marketplace for second-hand electronic devices, responses were collected on a five-point Likert scale ranging from "fully disagree" to "fully agree" (assigned values from 1 to 5), with an additional "don't know" option that was excluded from the analysis as a missing value.

The data from the questionnaire was analysed to identify trends among the participants and between different groups. Statistical analysis was performed using the SPSS software, employing both descriptive statistics and nonparametric tests (Kruskal-Wallis and Mann-Whitney U tests) to identify significant differences in responses based on the Likert scale across various groups. Spearman's rank correlation was utilised to examine the strength and direction of associations between ordinal variables, an approach necessitated by the non-normal distribution of the attitudinal data, as noted by Metsämuuronen (2017).

3.1 Profile of Respondents

Regarding the demographics of the participants, a vast majority of the surveyed organisations (97%) had operations in Finland, whilst one-third (33%) had operations in other European Union countries and one-fifth (20%) operated outside the EU. Notably, 66% of the organisations operated only in Finland and 18% operated in all listed areas. Of the responding entities, large organisations employing over 249 individuals accounted for one-third (34%), whilst nearly half (47%) were classified as medium-sized, having a workforce of 50 to 249 employees. The survey predominantly captured the perspectives of senior executives, who made up 57% of respondents, followed by middle management, representing 25%.

The composition of the respondents was diverse, with three-quarters (76%) coming from the private sector and 22% representing public sector organisations. The sectors in which these companies operated varied, including manufacturing (29%), services (21%), and trade, both retail and wholesale (15%), in addition to sectors focused on education, consultancy, or R&D (12%).

Technology usage was universal among the organisations, with all reporting the use of IT, computing, and mobile devices. Other prevalent technologies included entertainment electronics like televisions (77%), security systems (73%), and household appliances, such as washing machines and dishwashers (69%), along with measurement and testing equipment (64%) and other specialised professional electronics (62%). A small fraction (2%) were involved in the manufacturing or sales of electronic devices.

The study's validity and reliability were carefully considered. The coherence between the study's outcomes and its initial objectives underscores the accuracy of the measurements. Validity is further enhanced by the integration of literature review and comparisons with prior studies, establishing a connection with established trends.

Despite a modest response rate of 2.6%, the substantial number of respondents (404) deemed the sample convincing and representative, given the broad range of electronics used across the participating organisations. The study's reliability is underpinned by the potential to replicate the findings if the research were to be conducted anew under similar circumstances. Analytical methods were applied to ensure result consistency throughout the survey, and the internal consistency of the Likert scale responses reported was high, with Cronbach's Alphas ranging between .83 and .87.

4. Results and Analysis

The research results show that the circular economy is perceived as important, and businesses are prepared to pay attention to it. Companies tend to have a positive view of their own circular economy practices and believe that the circular economy is incorporated in the company's daily life and routine (81%). In practice, for customer and warranty returns, electronic equipment is mainly recycled back into raw material (56%), serviced and re-sold (49%) and destroyed (36%). As expected, IT and mobile devices circulate faster. More than 70% of respondents felt they would be willing to pay more for electronic devices if their repairs were easier.

The match of the digital marketplace with the internal systems was one of the prerequisites for getting involved in a systematic way with the platform. Security issues were highlighted to be of the outmost importance. Safety and security aspects were noted, including the evaluation of the functionality and integrity of the product for the buyer, enabling secure and environmentally friendly certified process. The platform was seen as the primary responsibility of IT managers and IT departments (51%), but almost all companies noted the current lack of a dedicated resource for this purpose.

4.1 Opportunities Presented by a Digital Marketplace for the Reuse of Electronic Devices

There were several key opportunities that companies perceived as the result of a digital marketplace for the reuse of electronic devices. The list was topped with the protection of the environment and reduction of the carbon footprint. These opportunities were closely followed by the perceived opportunities of utilising the marketplace to find new recycling opportunities and appropriate recyclers and users. (See Figure 1)

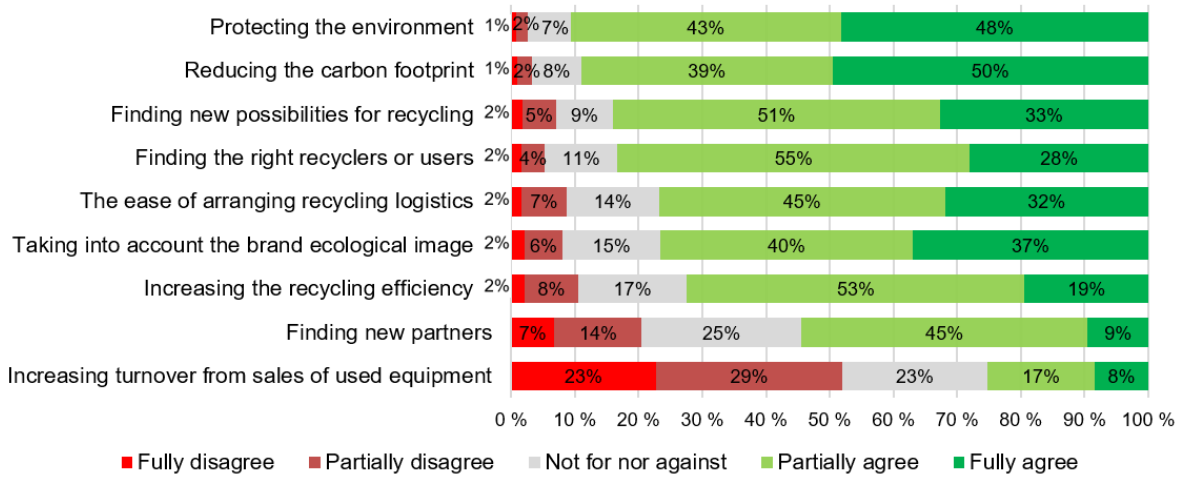

Figure 1: Opportunities for using digital marketplace for the reuse of electronic devices [Fig.: Taking the brand's ecological image into account; Increasing recycling efficiency]

Organisations in public administration saw greater opportunities than companies in two areas, including cost efficiency (p = .049) and finding new recycling opportunities (p = .036). The marketplace was perceived as an opportunity to find new partners mostly in public administration and service companies – and, in contrast, least in training, consulting, research and development companies (p = .039). Increasing turnover is perceived mostly as an opportunity in retail or wholesale companies and least as an opportunity in manufacturing companies (p = .009).

4.2 Value-Adding Features of a Digital Marketplace

The key added value for businesses in the marketplace was the ease of the process of reuse of electronics (72%), finding buyers and sellers (67%) and minimising costs (52%), but not necessarily the best possible price (only 19%). These value attributes translated into key motivations for using the digital platform and parameters sought by companies in a digital marketplace. When asked what services a digital marketplace should offer, it was most hoped that it would bring together buyers and sellers (85%), and well over half (67%) of the respondents wished for a sales service. The next most desired was to get up-to-date information on legislation (45%) and useful links (43%). A third (33%) wanted consulting services. (See Figure 2.)

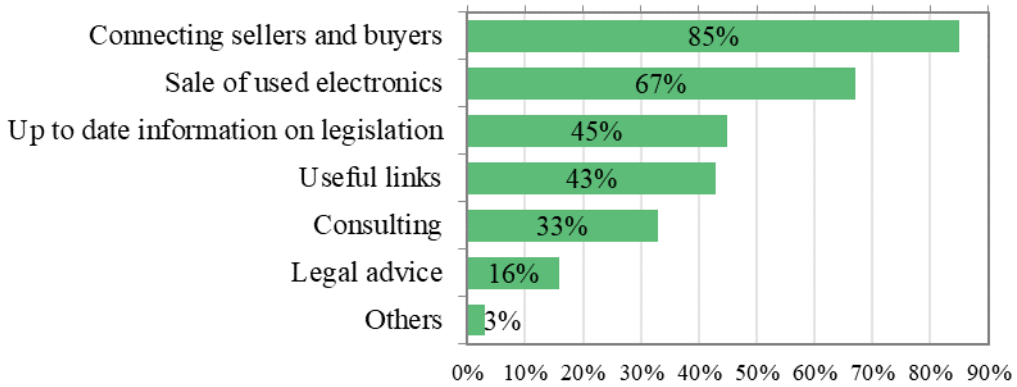

Figure 2: Digital marketplace for the reuse of electronic devices: Services desired by companies (n = 393, 1150 responses)

The respondents further elaborated on the specified digital marketplace features in their open-ended responses. The highlighted services included, for example, a donation service, erasing data on devices, responsibility information, and support in the case of disputes i.e., if the device does not work as required.

Respondents were asked what kind of product data they would like from electronic devices in order to purchase used electronic devices from the marketplace (see Figure 3).

Figure 3: Requested product data in the digital marketplace for the reuse of electronic devices

There were several prerequisites for the product data to enable effective buyer-seller exchange. The most desirable information was service and maintenance history, condition, warranty, security issues, age, price, model, manufacturer, previous owner and technical data.

4.3 Digital Marketplace as an Information Sharing Platform

The research showed that a circular economy digital marketplace may be in demand as a key source of current information for the reuse of electronics. At the moment, there are various sources of information that are not under one roof. Businesses seek information from waste management companies (79%) and to some extent from product manufacturers (51%), though the EU is shifting more responsibility to product manufacturers through legislation. A notable percentage of respondents pointed out the desire to have updated information on current legislation to be made available to them (45%).

It was hoped that the digital marketplace would offer advice-related features on using devices and instructions for safe operation. The companies pinpointed the need for ecosystem-based thinking and service integration. As an example of this, the request for links to similar platforms for various recycled materials, unless they are already offered on the same platform.

4.4 Hindrance Factors to the use of the Digital Marketplace by Companies

The research identified several explicit obstacles to the adoption and use of a digital marketplace for the reuse of electronic devices (see Figure 4). Low-cost impact and limited time resources to fully engage in the marketplace were main hindrance factors as perceived by companies.

IT system integration was another notable challenge. Research showed that the larger the company, the more obstacles are perceived as there is greater need for the coordination of IT systems, well-established recycling practices and the readiness to utilise only highly tested and well-established solutions ($p < .003$). Coordination of IT systems is the least obstacle for companies in the training, consulting, research and development sectors. Public administrations see existing and previously established recycling practices as a greater barrier than companies ($p = .002$).

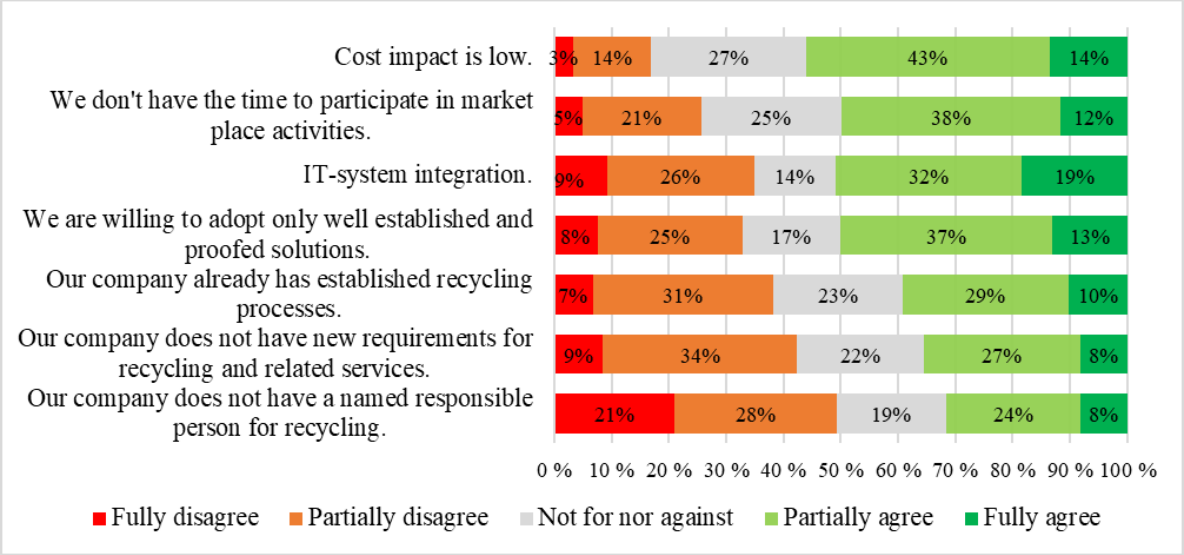

Figure 4: Main barriers in companies for using the digital marketplace for the reuse of electronic devices. [Fig.: well-established; Our company does not have a person designated for recycling responsibilities]

Other obstacles to the employment of the digital marketplace included, e.g. the following: lack of customer acceptance for the recycling of specific equipment, organisational culture (such as large organisation and respective slow decision-making), the lack of a recycling culture, resistance to change within the organisation.

4.5 Company Size Characterises Circular Economy Engagement

Interestingly, large and micro-enterprises (in contrast with SMEs) demonstrated greater motivation towards active engagement in the circular economy and respective marketplace – showing potential for this target group to serve as innovators and early adopters for the digital marketplace. Furthermore, larger companies renew IT and related professional electronics at a quicker pace than smaller companies. This indicates the digital marketplace matching opportunity, where larger companies sell used equipment to the smaller ones.

The interest of the respondents in co-operation with higher education institutions (willingness to actively engage in circular economy research and development activities), positively correlated with the readiness to participate in the digital marketplace. This correlation was noted among large enterprises (public ones included) and micro-enterprises – supporting the above argumentation for this target group as early adopters of the digital marketplace.

The perceived opportunities presented by a digital marketplace were impacted by company size too. Micro-enterprises saw more opportunity in increasing turnover from sales of second-hand goods ($p = .000$) and finding new partners ($p = .021$). Large companies identified more strongly with the opportunities in improving the cost of recycling ($p = .042$), and considering the image of brand ecology ($p = .000$) as associated with the reuse of electronic devices.

4.6 B2B Roles Within the Digital Marketplace Environment

The results of the present research show that in addition to company size, the roles that companies are willing to take on shape their involvement in a digital marketplace for the reuse of electronic devices. Most companies (87%) saw an opportunity in adopting the role of a seller in the digital marketplace. Half of the companies desired to engage in the marketplace in the role of buyers. Only about one-tenth identified with the role of repairer or service provider. Other possible roles that were indicated by the respondents included transportation provider, equipment calibrator, certification provider, information broker and others. (See Figure 5.)

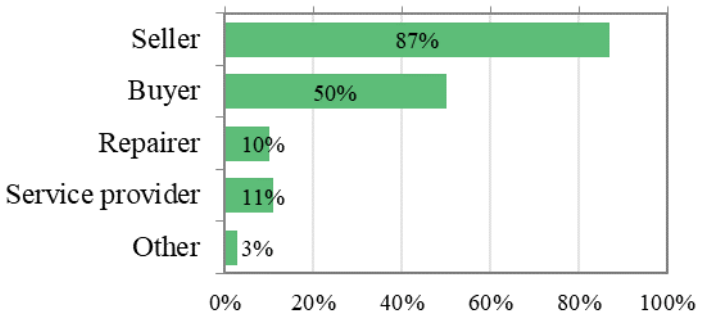

Figure 5: Preferred company role in the digital marketplace for the reuse of electronic devices (n = 374, 607 responses)

The companies willing to adopt the role of sellers mostly represented retail and wholesale businesses (98%). On the other hand, they were least ready to take on the role of a buyer (45%). Service sector companies hoped more for a seller's role (87%) than a buyer's role (46%). All other company types were quite evenly willing to adopt the role of a seller (79% - 86%) or a buyer (51% - 53%). (See Figure 6.)

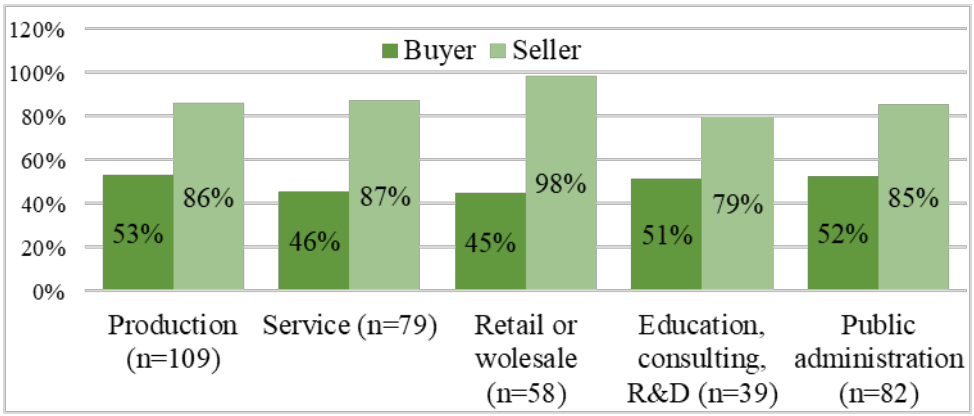

Figure 6: Desired role in the digital marketplace for the reuse of electronic devices by company type (n = 367)

When comparing companies using various types of electronic devices, it was found that all (100%) companies using agricultural electronic devices were interested in the role of a seller. Similarly, 92% of media production device users, 91% of hospital and laboratory device users, and 89% of security equipment users desired the role of the seller. The role of a buyer was most desired by users of agricultural devices (88%), measurement and testing devices (54%), media production devices (53%), and other industrial production or professional equipment (53%).

5. Discussion and Conclusion

Our research substantiates the proposed hypothesis, confirming that digital marketplaces significantly enhance circular economy practices in the electronic device sector. The analysis of over 400 companies indicated that these platforms simplify the buyer/seller matching process and are instrumental in facilitating device reuse. Companies valued the reduction in transaction costs and the exchange of crucial product information through these platforms, aligning with our hypothesis on their efficacy in improving circular economy efficiency.

The study explores the integration of circular economy principles and digital marketplace dynamics in electronic device reuse. Through a comprehensive survey, it identified strong business support for these practices, particularly the use of digital platforms for device recycling and reuse. Notably, businesses are actively incorporating circular economy actions into their daily operations. The marketplace is not only a transactional hub but also supports an ecosystem offering services such as legislative updates and consulting, proving vital for various company sizes.

This work has practical implications, demonstrated by Haaga-Helia University of Applied Sciences in Finland, which has leveraged these findings to pilot a digital marketplace for electronic product reuse, launched in 2022 with partner companies.

5.1 Managerial Implications

For managers and practitioners, this study emphasises the importance of integrating circular economy principles into business strategies, especially in the electronics sector. Adopting digital marketplaces for electronic device reuse aligns with sustainability goals and provides competitive advantages such as cost savings, improved brand image, and access to new markets. Managers should ensure these platforms are secure and user-friendly in order to facilitate broad adoption.

Digital marketplaces may be adopted by companies to support new business models and collaborative opportunities. Companies could adopt various roles within marketplaces such as, for example, service providers, certifiers, and information brokers. Collaborating with higher education and research institutions can advance sustainable reuse practices. The study stresses the need for ecosystem thinking in the electronics sector, promoting information sharing, and collaboration across individual stakeholders.

5.2 Future Research Potential

The research results suggest future investigation into digital marketplace design, including identifying key product categories for transactions, pinpointing business challenges they address, and understanding necessary services. It also explores the motivations behind companies' participation, paving the way for developing user roles and personas in order to engage a broader range of organisations effectively.

The intersection of circular economy principles with digital marketplace development offers fertile ground for further exploration. Future research could explore technological nuances, employing advanced data analytics, blockchain, and AI to boost transparency and efficiency, and examine consumer behavior regarding reused electronic devices. Cross-sectoral studies could assess the scalability of digital marketplaces across industries.

The study, originally focused on Finland and the Baltic countries, suggests expanding research to other European nations, integrating qualitative methods and service design with ongoing quantitative research.

In conclusion, digital marketplaces are transformative for the circular economy, serving as catalysts for systemic change by promoting device reuse. The study underscores the importance of innovation managers in fostering an ecosystem conducive to circular practices. This research not only highlights the operational and strategic requirements of circular economy digital marketplaces but also the collaborative efforts needed from all stakeholders to advance towards a more sustainable and resilient economy.

References

Bening, M. and Petri, H. (2024) "Circular economy through waste reverse logistics under extended producer responsibility in Finland", *Waste Management & Research*, 42(1), pp 59–73.

Berg, H. and Wilts, H. (2019) Digital platforms as market places for the circular economy – requirements and challenges. *Nachhaltigkeits Management Forum, Springer-Verlag GmbH Deutschland*, 27: pp 1-9.

Blackburn, O., Ritala, P. and Keränen, J. (2024) Digital Affordances for a Circular Economy Transition: A multiple case study of digital technology-enabled circular business models, in H. Lehtimäki et al. (eds) *The Routledge Handbook of Catalysts for a Sustainable Circular Economy*. Abingdon: Routledge, pp 403–421.

Brändström, J., Jazairy, A. & Lindgreen, E.J. (2024) "Barriers to adopting circular business models: A cross-sectoral analysis", *Business Strategy and The Environment*, pp 1–20.

Cole, C., Gnanapragasam, A. and Cooper, T. (2017) Towards a circular economy: exploring routes to reuse for discarded electrical and electronic equipment. Procedia CIRP, 61, pp 155-160.

European Commission (2020) Circular Economy Action Plan. European Union.

Ellen Macarthur Foudation (2020) "What Is a Circular Economy?", [online], https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

Geissdoerfer, M., Morioka, S.N., Monteiro de Carvalho, M., Evans, S. (2018) "Business models and supply chains for the circular economy", *Journal of Cleaner Production*, 190, pp 712-721, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2018.04.159.

Lacy, P., Long, J. and Spindler, W. (2020) The Circular Economy Handbook: Realizing the Circular Advantage, [online], Palgrave Macmillan UK, 2020. ProQuest Ebook Central, https://doi.org/10.1057/978-1-349-95968-6

Lacy, P. and Rutqvist, J. (2015) Waste to wealth: the circular economy advantage. *Palgrave Macmillan*, UK.

Hischier, R. and Böni, H. W. (2021) "Combining environmental and economic factors to evaluate the reuse of electrical and electronic equipment – a Swiss case study", *Resources, Conservation & Recycling*, 166, 105307.

Mak, M. and Heijungs, R (2022) "Environmental Externalities of Secondhand Markets—Based on a Dutch Auctioning Company", [online], *Sustainability*, 14, 1682. https://doi.org/10.3390/su14031682

Metsämuuronen, J. (2017) Essentials of Research Methods in Human Sciences. Vol. 3: Advanced Analysis. SAGE Publications, Inc.

Mourtzis, D., Angelopoulos, J., Panopoulos, N. (2021) "A survey of digital B2B platforms and marketplaces for purchasing industrial product service systems: A conceptual framework", *Procedia CIRP*, 97, pp 331-336,
ISSN 2212-8271, https://doi.org/10.1016/j.procir.2020.05.246.
Orko, I. and Åkerman, M. (2019) Ecosystems as a Tool to Circular Economy. Poster session presented at European Days for Sustainable Circular Economy, Helsinki, Finland.
Rogers, D. S., Lembke, R. and Benardino, J. (2013) "Reverse Logistics: A New Core Competence", *Supply Chain Management Review*, May/June. pp 40-47.
Rogers, D. S., Rogers, Z. S. and Lembke, R. (2010) "Creating Value Through Product Stewardship and take-back", *Sustainability Accounting, Management and Policy Journal*, 1(2).
Santato, C. and Alarco, P.-J. (2022). "The Global Challenge of Electronics: Managing the Present and Preparing the Future", [online], *Advanced Materials Technologies, 7(2), 2101265, https://doi.org/10.1002/admt.202101265.*
Sinervo, R., Paajanen, T., Turkki, V. and Herlevi, K. (2022) *10 Kiertotalousehdotusta Suomelle* (10 circular economy proposals for Finland), [online], Sitra, https://www.sitra.fi/julkaisut/10-kiertotalousehdotusta-suomelle/.
Tang, Z., Zhou, Z. and Warkentin, M. (2022) "A Contextualized Comprehensive Action Determination Model for Predicting Consumer Electronics Recommerce Platform Usage: A Sequential Mixed-Methods Approach", *Information & Management*, 59(3), 103617.
Wilts, H. (2016) *Germany on the road to a circular economy?* Friedrich-Ebert-Stiftung, Division for Economic and Social Policy.