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Identifying barriers and enablers for circular ICT practices: An exploratory study

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Abstract: Information and communications technology (ICT) equipment plays an important role in the global transition to a circular economy due to its share in electronic waste generation and its composition of both hazardous and valuable materials. Organizations have the potential to make significant impacts on these transitions due to large amounts of ICT equipment under their care. While research into challenges faced by businesses transitioning toward circularity is growing, information on what factors prevent this transition for the ICT sector is limited. In this research we aim to identify what influences decision-making for incorporating circular practices in procurement, maintenance, repair, and disposal of ICT equipment within organizations. We conducted 10 in-depth interviews across four organizations with individuals involved in all stages of decision-making for ICT equipment in order to identify barriers to making decisions that increase ICT related circularity. Through analysis of the transcribed and coded interviews, we identified 16 barriers to incorporating circular ICT practices in the decision-making processes of interviewees and their organizations. We present actionable, ICT specific areas of focus for organizations to increase their ability to enact circular improvements. Specifically, we identified barriers relating to five themes: limitations to suitable and timely ICT equipment, lack of awareness and knowledge about circular ICT, limitations to individual and organizational decision-making about circularity in ICT, limitations based on ICT contracts, supports, and security, and financial and other cost factors for circular ICT. Based on these barriers, we suggest a set of characteristics for a successful transition to more circular ICT in organizations.

Introduction

A shift from the current status quo to a more circular economy is in heavy focus in the European Union (EU) and of pertinent importance for global legislation[1]. This is particularly true for electronic equipment due to its hazardous nature as waste and its composition of valuable and difficult to obtain raw materials[2] (Baldé et al. 2022). Given that the waste categories that include information and communications technology (ICT) equipment accounted for more than 20% of global e-waste generation in 2019, ICT will play a particularly important role in this sustainability transition (Forti et al. 2020).

Commercial and public entities are responsible for large collections of ICT equipment. Due to this important role, organizations have the potential to make significant impacts to circularity through the prevention of ICT waste. However, today's organizations tend to follow linear processes, resulting in premature disposal of ICT equipment. Lifetime extension of this equipment can provide many environmental benefits for ICT products, e.g., laptops, data servers, etc. (Bakker and Schuit 2017; Den Hollander et al. 2017).

Current studies suggest that the implementation of circular practices, such as reuse and other lifetime extension activities, has presented challenges for organizations (Hina et al. 2021). These extant studies present these barriers as both internal, including financial, structural, attitudinal, and barriers relating to knowledge and technology, as well as external, relating to supply chains, legislation, and governmental support (Ritzén and Sandström 2017; de Mattos and de Albequerque 2018; de Jesus and Mendoça 2018; Vermunt et al.

[1] https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

[2] https://environment.ec.europa.eu/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee_en

2019). Guldmann and Huulgaard (2019) suggested that most barriers to circular business model innovation exist at the organizational level, and Klein et al. (2020) found that research on barriers for the public sector focuses largely on procurement related processes. These studies mostly examine barriers relating to general circular economy and circular business model innovation, while insights on industry specific ICT barriers and enablers are limited. However, in terms of ICT, a notable exception found that value chains and collaboration have been identified as important factors in increasing lifetime extension through reuse of ICT by 'gap exploiters'. These organizations are established to fill existing gaps in lifetime extending opportunities, such as refurbishing (Whalen et al. 2017). Due to the limited presence of ICT specific, actionable information on what might enable organizations to better incorporate circular ICT practices, the study presented in this paper aims to explore what factors cause organizations' difficulty in transitioning from linear to circular decision-making about their ICT equipment. In particular, our study explores which factors influence decisions made about procurement, maintenance, repair, and disposal practices that affect the first use and overall lifetime of their ICT equipment, and thus, how to approach encouraging critical behavioral change and acceptance of more circular ICT practices.

Methods

Interviews

Interviewed organizations were selected from a pool of project participants and through further snowball sampling. Interviewees were nominated within organizations based on job proximity to ICT procurement, maintenance, and disposal processes. A total of 10 in-depth 60 to 90-minute interviews across four organizations were conducted with decision-makers from different functional backgrounds. Interviews were adapted to ICT specific issues based on common barrier themes found in existing literature on circular transitions. Namely, these included the internal and external barrier themes presented in Hina et al. (2021) such as company policies and strategies, finances, lack of resources, supply chain concerns, collaboration, and legislative barriers.

Analysis

All interviews were recorded in order to be transcribed. Interview transcripts were analyzed using Atlas.ti, where quotes could be coded. A thematic analysis of the interview transcripts produced 97 codes, verified through discussion within the research team. Within these codes, we identified 16 barriers, which, through discussion with the research team, were further grouped into five themes presented in the following section.

Results

Grouping the analyzed barriers resulted in the establishment of five key themes relating to the challenges of an organization's incorporation of circularity into their daily practices, which are expanded in the following subsections. While many interviewees highlighted their organization's desire and efforts to improve their circularity, the presence of these barriers often limit their ability to do so.

Limitations in access to suitable and timely circular ICT equipment

Barrier Codes
Access to circular ICT devices and spare parts
Limitations to incorporating refurbished ICT equipment

Table 1. Barriers relating to accessing suitable and timely circular ICT equipment.

The first theme relates to limitations in obtaining circular ICT devices within time frames that do not impact functional performance (Table 1). For already purchased ICT equipment, obtaining and storing spare parts for older models can also be difficult, which limits repair options.
Although interviewees expressed interest in procuring refurbished ICT equipment, they found that the immediate availability of refurbished equipment with the needed specifications is limited, due to dependence on incoming equipment, existing stocks, and processing time. There is also limited or no support contracts for refurbished ICT equipment, which further limits the ability of organizations to choose refurbished equipment.

Lack of awareness and knowledge about circular ICT

Barrier Codes

Lack of awareness about the benefits and importance of circularity in ICT
Lack of knowledge about and/or ideas for incorporating circularity in ICT
Limitations in the flow of ICT device related sustainability information

Table 2. Barriers relating to the awareness and knowledge needed to incorporate circular ICT practices in organizations.

Awareness and knowledge were highlighted as important factors in making an organizational transition to circular practices (Table 2). However, interviewees felt that organizational decision-makers often lack the awareness of circularity's importance and benefits that is necessary to effectively initiate more circular ICT activities within the organization. Interviewees also reported that a lack of understanding of the benefits of ICT circularity and how circularity and other necessary processes fit together results in fewer, less effective circular initiatives at various employee levels.
Furthermore, both producers and purchasing organizations have information about devices (e.g., material content, energy consumption of production, etc.) that would benefit circular decision-making. However, interviewees stated that the parties often have difficulty passing this information to each other through the suppliers serving as a bridge between producer and purchaser.

Limitations to individual and organizational decision-making about circularity in ICT

Barrier Codes
Difficulties in assessing the true impact of differing circular ICT strategies and choices
Difficulty translating ideas for ICT circularity into concrete actions
Lack of accountability and initiative for circular ICT decisions
Prioritization of basic organizational and ICT equipment needs over circularity
Pressure from the product user based on their wants for and perspective on long lasting and circular ICT equipment

Table 3. Barriers relating to limits to individual or organization level decision-making about circularity in ICT.

Even when awareness of the benefits of circularity is present, organizations still face a number of barriers that can impact whether a circular decision will or will not be made (Table 3). For instance, many organizations lack a person to take accountability for the decision to make a transition. Others find limited support or requirements from upper management to increase circularity in ICT. These were reported to result in less action.
Furthermore, interviewees find it difficult to implement (often vague) ideas into concrete actions for ICT equipment that have a real impact on circularity. In the words of one interviewee, "the tough part is translating the sort of high-level statements on circularity to very concrete things which impact individual departments (P2)."
A lack of previous baseline measurements, difficulties in knowing which ICT decision would make the most impact, frequently changing eco-standards, and potential misrepresentation of the actual circular impact of services (i.e., greenwashing) further contribute to confusion over what decision will have the biggest positive impact on circularity.
Beyond that, organizational needs often have greater priority than circularity or new circular initiatives, including changes in circumstances necessitating purchase of new or updated ICT equipment, energy costs, as well as a need for low-cost, reliable ICT equipment that meets performance goals, standardized orders and equipment, and support for existing/mature sustainability initiatives.
Lastly, the user of the device has preferences about what ICT device they want outside of the necessary specifications. These include wanting new and aesthetically pleasing devices, devices with performance capabilities higher than their needs, and devices of a familiar brand or model. One interviewee, referring to the perception of the average ICT user, stated that "we don't like change; we like new stuff; we don't like old stuff (P3)." Interviewees stated that users also often perceive personal ownership of the device, resulting in the push for their own preferences. These preferences often create premature ICT equipment turnover, shorten the lifetime of existing ICT equipment, which limits the circularity of the new equipment that is purchased.

Limitations based on ICT contracts, supports, and security

Barrier Codes
Limited supplier interest in lifetime extension
Existing or available contracts limiting circular choices
Concerns for data security in outdated or unsupported ICT equipment

Table 4. Barriers relating to ICT contracts, supports, and security.

Interviewees noted that lifetime extension is often not in the ICT supplier's financial interest, which lowers supplier's participation in lifetime extending initiatives, especially when the organization does not express circularity as a priority. Resulting contracts have limited built-in circularity and shorter service-period lengths, after which ICT equipment that the organization may decide to keep longer would be unsupported and more difficult to maintain. Older and/or unsupported ICT equipment may also have outdated software and hardware security compliance, which risks data security and compliance, complicating lifetime extension.
At the end of life, maintaining the reusability and recyclability of ICT equipment is an important step in the transition to a circular economy. However, interviewees reported in some cases organizational hesitancy about the completeness of data wiping processes, leading to non-circular waste treatment activities (e.g., shredding hard drives).

Financial and other cost factors for circular ICT

Barrier Codes
Financial barriers to circular ICT
Costs and limits specifically to repair
Short lifecycle management (LCM) periods

Table 5. Barriers relating to financial and other cost factors of incorporating circular ICT practices.

Financially, a number of factors affect the decision to transition ICT processes to longer lifetimes (Table 4), such as existing budgets that do not include circularity, the potential or perceived higher initial cost of circular equipment, and the cost of extending contracts for supported longer life equipment.
Repair was conducted at some level by most organizations. However, there are also different types of costs that affect the decision of whether or not to repair a device, including the necessary time and specialized tools to conduct the repair and the total cost of repair weighed against the current value of the ICT device. When these costs are considered too high, repair is not done, limiting the lifetime of the device.
From purchase to disposal, LCM helps organizations monitor assets in an efficient and cheaper way. However, LCM periods, which set a number of years a device should be used, can result in premature disposal of usable ICT equipment when the LCM period is over.

An 'ideal' scenario

These reported barriers illustrate several paths forward for organizations to succeed in transitioning to a more ICT circular workplace. On one hand, interviewees suggested that organizations must make a number of structural adjustments in order to encourage accountability and initiative to create and enact circular ICT practices. Interviewee suggestions included dedicating a role within the organization specifically to sustainability as well as incorporating sustainability into each and every role. One interviewee emphasized the importance of this with the statement that "you just have to more and more convince people that it's part of their role as part of their DNA as well (P2)". From another angle, the importance of showing organizational initiatives was highlighted by another interviewee in terms of talent retention, stating, "we sometimes see that we even lose [people] because they want to dedicate [a percent of] their roles to sustainability (P2)". A common method suggested by interviewees as an enabler for increasing accountability and initiative and incorporating circularity into employee roles was the introduction and use of targets and incentives. As an illustration of the potential success of such initiatives, one interviewee indicated that in the first year of an incentive program tied to decreased emissions the employees have nearly maxed out the possible payout. Organizational targets and the pressure to report improvements set by the legislature or influenced by political or public pressure were also suggested to enable circularity incorporation. This is highlighted in interviewee

statements such as “it would help us a lot to be challenged... we need to somehow share what we have accomplished (P6)” and “the pressure to report on these kinds of sustainability aspects is now very high again (P8).” These external pressures place responsibility on high ranking, influential decision-makers by “[making] the director responsible for sustainability and [he or she] would be measured on that at the end of the period (P1).”

On the other hand, improved access to information about circularity for ICT and the communication of that information is indicated as a key factor in the future success of organizations’ circular transitions. Interviewees expressed an interest in obtaining factual, representative, and comparable information on the true impact of a circular ICT choice over a traditional linear choice, or of one circular ICT choice over another. Interviewees were further asked to specify what types of information would be beneficial to their decision-making when provided in a tool such as, for instance, a digital product passport. Digital product passports (DPPs) have become increasingly topical as a tool to contain material, use, and reuse, supply chain, and other data about an individual device in one accessible place and have been incorporated into several recent proposals by the European Commission. To contribute to this development through our research, Table 6 shows a list of information types for such a digital ICT product passport that interviewees expressed interest in obtaining to better understand and implement solutions to circular ICT needs.

Types of Circular ICT Device Information
• Realistic expected product lifetimes
• Energy consumption in production
• Energy consumption in the use phase
• Recycled material content
• Information on financial costs and toward of equipment with a high circularity standard
• Repair and performance history (device tracking)
• Accurate recyclability of the device and components (including actual returns with current technology)
• A comparative assessment of circular impact of different choices and devices

Table 6. Examples of specific information types that would benefit organizations in a digital product passport.

The combination of these structural changes in employee roles and responsibilities and improved spread and absorption of information would also enable better communication and negotiation with suppliers for the inclusion of impactful circular choices. Interviewees stressed the importance of communicating clearly to suppliers that circularity was a top priority for their organizations.

Conclusions

This study presented important and timely empirical evidence about what factors prevent organizational decision-makers from incorporating ICT circularity into their daily business. These insights provide a useful set of actionable recommendations for what organizations may do, or not do, to facilitate their transition from linear to circular ICT practices. These results will be further helpful in the development of ICT specific tools for improved circularity, such as product passports.

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