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Evaluation Criteria for Sociotechnical Systems for the Digitally Disadvantaged

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Short Paper

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Abstract

This paper addresses the challenge of finding criteria to evaluate social inclusiveness of sociotechnical systems (STS). While IT offers opportunities to reduce inequalities, the "digital divide" is a growing challenge. This divide between individuals with access and sufficient digital literacy, has economic and social consequences. Although several factors have been identified as barriers to the use of IT or design principles for socially inclusive research, there is a gap in the literature in assessing the final STS in their social inclusivity. This paper aims to identify criteria for evaluating STS in terms of social inclusion of the digitally disadvantaged. Based on the STS perspective, design requirements and principles are derived to help design a checklist of whether needs of digitally disadvantaged have been met. The paper contributes to the existing body of knowledge by adding the STS design evaluation step to the current literature.

Keywords: Digitally Disadvantaged, Digital Divide, Sociotechnical Systems, Design Science Research

Introduction

The profound influence of information technology (IT) on today's society is undeniable. The interaction between IT and people offers opportunities to address societal challenges to reduce inequalities. But even if IT solutions have been developed to be socially inclusive, they can still miss their target (Curto-Millet & Cañibano, 2022). To our knowledge, there is currently no opportunity to evaluate developed IT solutions in terms of their socially inclusive design. This short paper will address this challenge by using the sociotechnical perspective to identify current challenges in socially inclusive design. Preliminary design requirements and principles are derived from the identified challenges from the literature. This paper thus contributes to existing knowledge by adding to socially inclusive design the ability to evaluate IT artifacts in terms of their social inclusivity.

The overarching perspective that has been considered for a particularly long time in the information systems (IS) discipline and is thus deeply rooted is the sociotechnical systems (STS) perspective (Mumford, 2006; Sarker et al., 2019; Trist & Bamforth, 1951). STS involve the integration of social and technical

components to achieve a common goal (Mumford, 2006). The basic concept of an STS is the joint optimization of the social and the technical system, and a related ideal output (Trist & Bamforth, 1951).

As the importance of well-functioning STS is undeniable, recent examples show how the digitally disadvantaged can face problems with STS that do not adequately address special needs for the targeted users. One example can be found in the contact tracing apps on smartphones during COVID-19. People without access to the technical system or not enough digital literacy to use it, such as people with insufficient technical education, faced a disadvantage (Bente et al., 2021). Another example is the ongoing debate about a cheap monthly trainflat-ticket in Germany, which should be only available in a digital form in a year from now (Augusteijn, 2023). This gives digital disadvantages to people who do not use smartphones, lack digital literacy or capabilities to use the digital tickets. As these examples show, it is very important to know the users within a social system, so that the STS can reach its goal.

In the context of technological progress, the "digital divide" is a growing challenge for the society (Lee & Rao, 2012). This term refers to the gap between individuals and communities or groups who have access to technology and those who do not (Cullen, 2001), and the differences in the effectiveness of using IT (Dewan & Riggins, 2005). The digital divide has different origins, such as income (Hsieh et al., 2008), geographical factors (Venkatesh & Sykes, 2013), age (Lawson-Body et al., 2014), education (Wei et al., 2011), disabilities (Newman et al., 2017), or cultural factors (Díaz Andrade & Doolin, 2016). People who find themselves in the digital divide, by having difficult or less access to technology or who cannot effectively use it, can experience economic (Dewan & Riggins, 2005) as well as social consequences (Sipior et al., 2017).

The fact that the digitally disadvantaged require special attention is not completely new. So far, various factors have been identified for barriers or factors that impede or prevent the use of IT (Olphert & Damodaran, 2007; Ortiz et al., 2019). In the design process of IT artifacts for the digitally disadvantaged, there are also design principles for socially inclusive research (Wass et al., 2023). Nevertheless, there is a gap in the literature about the evaluation of the final STS. By examining the characteristics of digitally disadvantaged people and related factors within STS, this paper aims to identify criteria for evaluating STS that are more accessible, inclusive, and supportive for the needs of the digitally disadvantaged. Therefore, our research question is as follows:

RQ: What are criteria to evaluate STS in terms of social inclusion for the digitally disadvantaged?

This paper offers an extension of the current literature to the step of evaluating STS. Although STS are already designed with methods to ensure inclusion, there are ongoing challenges that the needs of the digitally disadvantaged are not being met with the final STS. To this end, this paper aims to provide a tool for evaluating whether the needs of the digitally disadvantaged have been met by means of a checklist. Furthermore, the short paper offers an STS perspective on the links between factors resulting from the digital divide and the digitally disadvantaged.

Theoretical Background

Sociotechnical Roots and IS

The STS perspective is considered as a guiding framework for the IS discipline (Sarker et al., 2019). It describes a fundamental concept in the IS discipline, emphasizing the interconnectedness of human and technological components within complex organizational environments. Trist and Bamforth (1951) developed the concept of the "sociotechnical system". They argued that both, the social and technical aspects of organizations need to be considered to optimize their outcome. This perspective acknowledges that effective information systems go beyond technology and must account for the social, organizational, and human factors that shape their design, implementation, and use (Sarker et al., 2019).

IS research contributes to sociotechnical solutions and is of high importance for addressing societal challenges (Thomas et al., 2020). Since the investigation of technological artifacts within any social context can be framed as an STS (Briggs et al., 2010), it is important to understand the characteristics of the various stakeholders and interactions between the two subsystems because they can influence the design, implementation, and adoption of the whole STS. The social system, which consists of people, organizations, or institutions, interacts with the technical system, which consists of hardware and software to achieve results. The STS approach recognizes that technology is not neutral and that its design and use are

influenced not only by technical factors but also by social and cultural factors (Mumford, 2006). It also recognizes that people's experiences and behaviors are shaped by the technical systems they use.

The holistic view is critical to understanding STS because it recognizes that technology is not isolated from either the people who use it or the contexts in which it is used. A purely technological focus on technology neglects the human component and can result in systems that are not aligned with user needs or preferences. From a sociotechnical perspective, understanding the social and organizational context is as important as understanding the technical specifications. This includes consideration of factors such as organizational culture, power dynamics, communication patterns, workflows, and user behavior.

Digitally Disadvantaged in Sociotechnical Systems

Socio-cultural diversity is of high importance in societies and the combination of digital innovations and technologies can enable growth, productivity, and poverty reduction by inclusion (Ahuja et al., 2023). Since social participation in an increasingly digitized society depends on digital skills (i.e., understanding and using technology), there is a risk of digital exclusion and thus being digitally disadvantaged for people who have difficulties acquiring these skills (Díaz Andrade & Doolin, 2016).

One concept that describes and classifies this disadvantage is the digital divide. The digital divide refers to the unequal distribution of access to and use of IT (Dewan & Riggins, 2005; Venkatesh & Sykes, 2013; Wei et al., 2011). The digital divide can be further divided into a first-order and second-order divide, highlighting different aspects of inequality. The first order digital divide refers to the gap in access to IT between those who have access and those who do not (Dewan & Riggins, 2005). The first order digital divide is usually measured in terms of access to basic infrastructure such as the Internet, computers, and cell phones. In developing countries, access to IT may be limited due to lack of infrastructure, high costs, or limited availability (Venkatesh & Sykes, 2013). The second order digital divide refers to digital skills and the ability to use IT effectively. The second-order digital divide is characterized by differences in digital literacy and skills that can affect an individual's ability to access information, communicate, and participate in digital society (Dewan & Riggins, 2005). Even in countries with high levels of IT access, there can be significant differences in digital skills and the ability to use IT effectively, for example among groups with low-income, older adults, or people with disabilities. It should be noted that the first order digital divide overlaps with the second order digital divide, as, for example, people without access to IT infrastructure are less likely to develop digital skills and knowledge (Dewan & Riggins, 2005). These people or groups are often also referred to as marginalized (Ortiz et al., 2019) or underrepresented in the context of a disadvantage. A second important point is that the digital divide remains an existing challenge, as a lack of IT experience is not a "dying" problem, as new technologies emerge over time (Mead & Fisk, 1998) or migration processes are very present nowadays.

Individuals who have access to technology but lack digital skills may underutilize available resources, contributing to the digital divide. This STS-based research examines the interplay between people and technology, with a particular focus on the digital divide. This focus is warranted because marginalized groups often face challenges that arise from broader societal issues. Consequently, the digital divide serves as a link to the STS perspective, which is concerned with its immediate effects rather than the complex societal problems that marginalized groups face.

The digital disadvantaged, considering the perspective from the digital divide, can be found in the following exemplary groups: Older adults (Srivastava & Panigrahi, 2019), people aged 60 and over, who face age-related physical and cognitive limitations, lack of digital skills, and financial constraints in accessing digital technologies, are affected by both the first-order and second-order digital divide. Further, people with disabilities (Istenic Starcic & Bagon, 2014) may have difficulties in using technology through physical or cognitive impairments. They may need assistive technologies or specialized software and hardware to participate in the digital world. Furthermore, low-income populations or individuals living in poverty who may not have the financial means to afford access to IT (Hsieh et al., 2008) and are thus affected by the digital divide of the first order. People living in rural areas (Venkatesh & Sykes, 2013) with poor or no access to (high-speed) internet or IT. People with different cultural backgrounds (i.e., refugees (AbuJarour et al., 2019)) who face barriers to digital access due to cultural and language challenges. It is important to note that these groups are not necessarily mutually exclusive and that individuals may belong to several disadvantaged groups.

When dealing with the digitally disadvantaged, researchers need to be considerate about potential vulnerability and inclusion of the people within the research process. In order to achieve a socially inclusive design process, attention has been given to the design of the research process with vulnerable groups, leading to design principles for this purpose (Wass et al., 2023). Other research show up guidelines to aim for in the design process of artifacts for digitally disadvantaged, like older adults (Holgersson et al., 2019). Another investigation by Curto-Millet and Cañibano (2022) shows that IS design has the potential to include and exclude, and therefore shape a paradoxical relationship between those concepts. It is also noted that efforts to include digitally disadvantaged can have an opposite and unintended effect of excluding individuals from the targeted groups (Huo et al., 2018; Petter & Giddens, 2023; Young & Wigdor, 2021).

For achieving the goal of this paper, however, the focus is not on the research or development process. Instead, our emphasis lies on the outcomes of research projects and final artifacts and products specifically designed for the digitally disadvantaged and their needs.

Suggested Method

The proposed method for the current short paper is a design science research approach (DSR) according to Peffers et al. (2007). DSR is a research methodology focused on developing and evaluating innovative solutions to complex and real-world problems (Hevner et al., 2004). DSR involves the systematic design, development, and evaluation of artifacts, which may include software systems, processes, frameworks, models, and more (Gregor & Hevner, 2013). The main goal of DSR is to create new knowledge by developing and validating solutions to real-world challenges. In the case of the present paper, a DSR is chosen as a methodological way to guide the creation of the artifact "Evaluation Checklist".

The DSR process is separated into six steps: Definition of the problem, goal, design and development, demonstration, evaluation, and communication. Within this short paper the problem definition and the search for a possible solution took place. The design and development of the artifact is being described, as well in the form of an ongoing search for design requirements (Walls et al., 1992) and principles (Schacht et al., 2015). The further planned steps include the demonstration of the artifact as soon as sufficient literature is reviewed and considered within the design process. The DP will serve as the basis for developing a checklist (artifact) for evaluating STS. It is important to note that the development of this checklist will occur after the next steps of the research are completed. To validate the effectiveness of the artifact, the checklist will be evaluated as part of a research project focused on older adults with specific IT needs. In addition, we will evaluate the applicability of the checklist in relation to IT for people with disabilities and people with lower incomes. Following the demonstration step, potential iterations will take place. The research process described is shown in Figure 1.

As part of the second step of defining a solution, the “Senior Scholars' List of Premier Journals” (2023) was systematically searched using the search string [“digitally disadvantaged” OR “digital divide”] AND [“sociotechnical” OR “socio-technical”]). Using this search string, the journals were scanned for articles that focused on digitally disadvantaged from a sociotechnical perspective. The first search revealed 67 articles. After a first screening of the abstracts of the found literature, 20 articles were excluded due to insignificance (editorials or list of contents). The second screening was conducted by reading the full articles and by excluding articles that did not focus on the digitally disadvantaged. Therefore, research articles that only focused on a user group without acknowledging interests of individuals from the investigated group were excluded. From the sample of 47 articles, 13 were considered for the final sample for the investigation within the short paper. The following design requirements (DR) and design principles (DP) are based on the final sample of included papers from the short review, and the explorative review of the theoretical background and the related work to include a broader view on the topic.

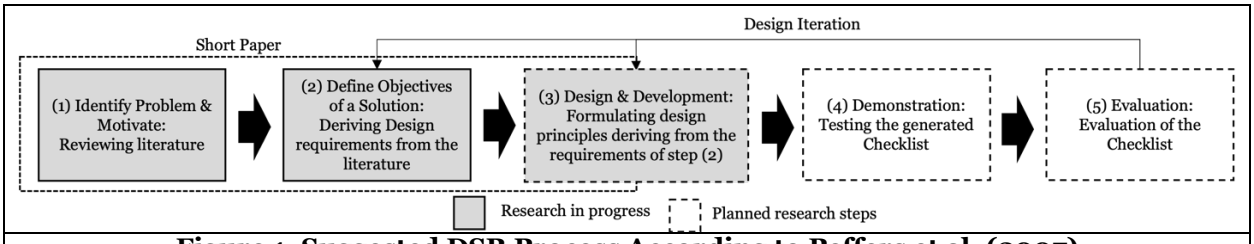

Figure 1. Suggested DSR Process According to Peffers et al. (2007)

Conceptualization

The factors that arise for the digitally disadvantaged from the digital divide are a lack of access and less digital literacy (Dewan & Riggins, 2005). It is necessary to dive into the reason for the lack of access, which can vary in the group of the digitally disadvantaged. For example, some face barriers related to the broadband infrastructure, and others due to financial limitations (Panopoulou et al., 2014). The first DR emphasizes the need for assessing the barriers faced by digitally disadvantaged, considering the range of challenges they encounter. By understanding the different forms of non-access, STS can not only effective but also sensitive to the needs of different user groups. *DR1: Unavailable access does not affect the IT artifact.*

Due to the overlaps within the group of the digitally disadvantaged, e.g., older adults (Srivastava & Panigrahi, 2019) and people with disabilities (Istenic Starcic & Bagon, 2014), we derive the following DR. This DR emphasizes the need for a holistic and inclusive STS that acknowledges the diverse and often overlapping challenges for digitally disadvantaged. *DR2: The intersections within the groups of digitally disadvantaged are considered by the IT artifact.*

The lower digital skills can also have different causes. In this case it is also important to know why digitally disadvantaged people have poorer digital literacy (Dewan & Riggins, 2005). For instance, the primary cause for older adults may be the unfamiliarity with new IT. Individuals with diverse cultural backgrounds may face language barriers, making it challenging to utilize digital resources effectively. The third DR highlights the importance to identify the barriers faced by different subgroups within the digitally disadvantaged. By gaining a comprehensive understanding of the causes, IT can address unique challenges posed by contributing factor. This approach ensures that interventions are not one-size-fits-all but rather tailored to the distinct needs and circumstances of different user groups. *DR3: Poorer digital literacy does not affect the IT artifact.*

Beyond knowing the reasons for digital literacy skills of the digitally disadvantaged, it is also important to check for practicing opportunities for the users. In addition to access issues, the inability to effectively use IT is also a driver for the digital divide. Adequate training for users, can provide support for the use of IT (Panopoulou et al., 2014). This concerns not only the help but also the knowledge that can be built up and passed on from digitally disadvantaged as peer support, since specific perspectives or needs are considered (Choudrie et al., 2003). This DR emphasizes the importance of not only providing initial support but also creating an environment where digitally disadvantaged can acquire, enhance, and share their digital skills and knowledge. *DR4: Training, education and knowledge deployment needs to be offered (continuously).*

The motivation of digitally disadvantaged can also help to strengthen their engagement with technology (Spagnoletti et al., 2015). This can be influenced through their own social environment or through third parties that have a reputation as a brand (Hoffmann et al., 2015). These external endorsements can contribute to ensuring that digitally disadvantaged are more involved and supported in their use of IT. *DR5: Influences of social environments and third parties are considered and utilized.*

A reason to know the characteristics of groups is that they may have individual needs and requirements for technology. For example, older adults benefit from technology that is simple to use while people with disabilities benefit from accessible features such as text-to-speech or alternative input methods (Zaphiris & Constantinou, 2007). This DR stresses the importance of analyzing the diverse needs and perspectives. By doing so, shared DP and DR are unveiled that can serve as a unifying framework for inclusive STS, ultimately benefiting a wide range of users within heterogeneous groups. *DR6: A framework of differences and similarities of digitally disadvantaged for the use of the IT artifact is used.*

As researchers need to be considerate about vulnerability, DR7 aims for the inclusion of digitally disadvantaged within the research process. Researchers may unintentionally overlook critical perspectives and therefore miss them in the final IT artifact (Olphert & Damodaran, 2007). To moderate this oversight, the target group needs to be asked for feedback, not only for enhancing their own life by sharing needs, but also by having the chance to be critical about access or infrastructure (Olphert & Damodaran, 2007). In addition, the active participation of the digitally disadvantaged gives them the opportunity to protect their dignity and to recognize it in the STS (Deng et al., 2016). The seventh DR emphasizes the importance of involving the target group as active stakeholders, ensuring their voices are heard and their perspectives are integrated into STS. *DR7: Feedback of digitally disadvantaged is considered and obtained.*

Since related literature showed that STS specifically designed to include digitally disadvantaged can have an effect of excluding individuals (Olphert & Damodaran, 2007), the following DR can be derived. It needs to be examined whether there is a paternalistic effect, either from the IT itself or from societal attitudes over the IT, towards the digitally disadvantaged. Such effects can contribute to the perpetuation of stereotypes and further exclusion of this group (Lee & Rao, 2012; Lin et al., 2015). The eighth DR highlights the importance of considering the potential unintended consequences of IT and the impact it can have on digitally disadvantaged. By ensuring that STS are inclusive, respectful, and free from paternalistic biases, digital inclusion can be promoted and the risk of reinforcing stereotypes or widening the digital divide, can be minimized. *DR8: IT artifacts are not (accidentally) excluding digitally disadvantaged.*

Another aspect that emerges from the literature is the significance of emotional connectedness (Abubakre & Mkansi, 2021). This DR highlights the need to have technology that not only facilitates functional interactions but also nurtures a sense of emotional connection and engagement. By taking this into account the overall usability and effectiveness of IT solutions can be enhanced. DR9: *The emotional connectedness between users and the IT artifact is considered in the STS.*

Trust also represents an important component in the STS of the digitally disadvantaged. The trust that is placed in IT relates not only to functionality but also to reliability (Hoffmann et al., 2015; Nwankpa & Datta, 2021). For example, in mobile payment solutions, trust is crucial for everyone, and even more important if a socioeconomical disadvantage is faced. The tenth DR underlines the need for technology that not only functions effectively but also generate confidence and reliability for its users. *DR10: A matured IT artifact is essential to facilitate trust from the digitally disadvantaged.*

The interconnectedness is also a factor that needs to be considered while designing an STS. Researchers and practitioners alike need to ask whether the proposed IT solution serves as an enhancement with sufficient infrastructure and whether it can be integrated within existing IT systems, services, or broader structures such as legal frameworks and industry standards, as emphasized by Racherla and Mandviwalla (2013). A technology does not have to be individualized for the digitally disadvantaged, but the execution should reach and include more groups (Srivastava & Shainesh, 2015). In other words, the STS should aspire to benefit not just a specific group but also consider its potential to positively impact and include a wider spectrum of users. *DR11: The STS enhances connectivity and integration with existing STS.*

The derived design requirements can be divided into four categories (Table 1). For each category, a DP was developed from the DR, so that four principles for evaluating STS are currently available.

Design Requirements	
User Needs and Context	DR1: Unavailable access does not affect the IT artifact.
	DR2: The intersections within the groups of digitally disadvantaged are considered by the IT artifact.
	DR3: Poorer digital literacy does not affect the IT artifact.
	DR6: A framework of differences and similarities of digitally disadvantaged for the use of the IT artifact is used.
DP1: The IT artifact respects the background and needs of digitally disadvantaged.	
Inclusivity and Support	DR4: Training, education and knowledge deployment needs to be offered (continuously).
	DR5: Influences of social environments and third parties are considered and utilized.
	DR7: Feedback of digitally disadvantaged is considered and obtained.
DP2: The digitally disadvantaged are included and supported in using the IT artifact continuously.	
Trust and Reliability	DR8: IT artifacts are not (accidentally) excluding digitally disadvantaged.
	DR10: A matured IT artifact is essential to facilitate trust from the digitally disadvantaged.
	DR11: The STS enhances connectivity and integration with existing STS.
DP3: Earn trust of digitally disadvantaged for an STS.	
Motivation and Emotion	DR9: The emotional connectedness between users and the IT artifact is considered in the STS.
DP4: Consider relationships between digitally disadvantaged and STS.	

Table 1. Preliminary Design Requirements and Design Principles

In Figure 2, the STS is shown with the DRs and DPs identified so far. The categorization of the DR towards the DP (grey background) is shown. The further aim is to fill the evaluation criteria by continuing the DSR.

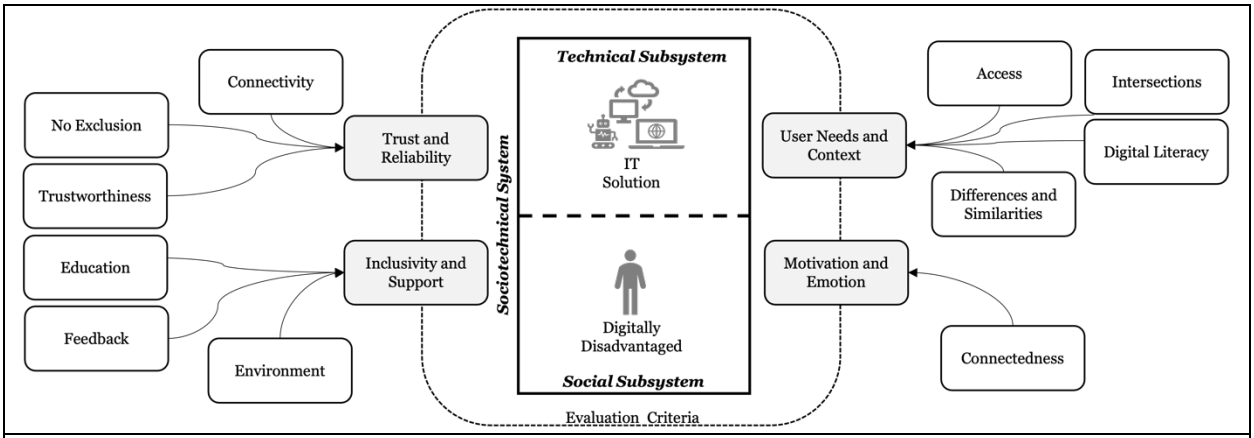

Figure 2. STS of Digitally Disadvantaged with DRs and DPs

Conclusion and Expected Contributions

In conclusion, the current research aims to establish criteria for assessing the interaction of STS, offering researchers a framework for evaluating socially inclusive artifacts. In this paper, we present ongoing research on the evaluation criteria for the socially inclusive design of STS. We explore the link between STS and the digitally disadvantaged and emphasize the importance of further investigating the interaction processes within STS. This short paper addresses the critical issue of digital inequality arising from the digital divide. Through an STS lens, we identified factors that impact STS, which led to the derivation of eleven design requirements that form the basis for four design principles.

In our next phase of research, we will expand our literature review by examining journals related to the "Special Interest Group Social Inclusion" and other IS journals and conferences. This review represents a key part of our development process, aligned with the DSR approach that has been introduced. Once the review is complete, we will establish additional DR and DP. It is important to note that the development of this checklist will occur after these steps of the research are completed. To validate the effectiveness of the artifact, the checklist will be tested with different digitally disadvantaged group members

The expected contribution of the paper is to provide a reference point from which it should be possible for both, researchers, and practitioners to identify whether the product or artifact developed is socially inclusive towards digitally disadvantaged groups. Previous research has shown that projects that pursue an inclusive goal can turn in the opposite direction and the unintended opposite occurs (Curto-Millet & Cañibano, 2022; Lin et al., 2015). The preliminary meta-requirements and design principles already offer a point of reference against which to reflect and quickly identify potential pitfalls. Therefore, researchers will profit from the current research by having a starting point for contextualizing STS research with digitally disadvantaged and enhancing evaluation criteria tailored to specific artifacts or user groups. Beyond the theoretical and practical contribution, the research also aligns with the United Nations sustainable development goals (2015) specifically targeting the reduction of technology access inequalities. The evaluation of STS for digitally disadvantaged addresses four of the set of 17.

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