Rural Living Labs: Inclusive Digital Transformation in the Countryside

Abdolrasoul Habibipour, Johanna Lindberg, Mari Runardotter, Yomn Elmistikawy, Anna Ståhlbröst, and Diana Chronéer

“ Don't walk in front of me, I may not follow. Don't walk behind me, I may not lead. Walk beside me and be my friend. ”

Albert Camus

Digital transformation (DT) has received increasing attention in recent years. Up until now, most of the current studies focus on digital transformation in advanced and dense societies, especially urban areas and technologies. Hence, the phenomenon of DT is under-researched in the context of rural and sparsely populated contexts. This study aims at exploring how a rural living lab (RLL) can be shaped and how this approach can be designed to support digital transformation processes in rural contexts. In so doing, following a design science research methodology (DSRM) approach, we have made an artefact (that is, RLL framework) that is an "instantiation" that supports user centric digitalization of rural areas. The designed framework is developed based on the key components of "traditional" and "urban" living labs, as well as empirical data which was collected within the context of the DigiBy project. The DigiBy project aims at conducting DT pilots in rural areas to elevate peoples' understanding of digitalization and the application of digitalization opportunities for service development in rural areas in the north of Sweden. As a result of these studies, five key components that guide the design of digital transformation pilots in rural areas emerged, namely: 1) rural context, 2) digitalization, 3) governance, control, and business mode, 4) methods facilitating DT processes, and 5) quintuple helix actors. We also offer an empirically derived definition of the rural living lab concept, followed by avenues for future research.

Introduction

Digital transformation (DT) nowadays is changing the dynamics of how societies are shaped (Agarwal, 2020). DT can be understood as the "changes that [the] digital technology causes or influences in all aspects of human life" (Stolterman & Fors, 2004). These changes are visible in different levels and scales, from individual to societal levels, and from more modernized urban areas, like smart cities, to less digitalized rural areas, in which DT occurs in an uncontrolled real-life context, and where people are involved in their everyday use context (Bockshecker et al., 2018; Spagnoli et al., 2019). Since most studies of the societal effects of digitalization and DT have been carried out in urban areas, there is a dearth of research on the effects of digitalization in rural areas (Salemink et al., 2017; Rotz et al., 2019; Runardotter et al., 2020). Following a participatory design approach, we believe that people have the moral and ethical right to be a part of DT processes (Bansler, 1989; Bjerknes & Bratteteig, 1995), also in rural areas, since digitalization of society can bring enormous (positive and negative) impact in peoples' lives.

In this paper, we focus on DT and innovation pilots carried out in rural areas, aiming to manage the

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challenges that emerge in these contexts. The study is supported by a living lab (LL) approach (Bagalkot, 2009; Schaffers et al., 2009; Schuurman, 2015) that has been introduced and proposed as an inclusive and sustainable approach involving various stakeholders, focusing on how individuals in their role as citizens, inhabitants, end-users, etc., are engaged throughout the DT process in their real-life settings (Ståhlbröst, 2008; Bergvall-Kåreborn et al., 2009). Accordingly, LLs can be seen as an approach for facilitating innovation processes, as they allow one to simultaneously focus on individuals, technologies, tasks, and structures, and on the interactions between various stakeholders (Schaffers et al., 2009). To date, most research attention has been paid to urban areas as the context for LL activities, the so-called Urban LL (or ULL) (Steen and Bueren, 2017; Chronéer et al., 2019), for example, the initial list of key components of traditional LLs were further revised and modified for the context of Urban LLs by Chronéer and colleagues (2019).

Nevertheless, few studies have examined the possibilities and potentials of LL activities in relation to rural areas. Most have investigated, for example, one specific dimension such as business models for Rural LLs (RLLs) (Schaffers et al., 2009), co-creation activities and actions in rural context (Bagalkot, 2009), as well as nature-based solutions and sustainability in rural contexts (Zavratnik et al., 2019; Lupp et al., 2021). None that we are aware of have investigated the overall construction of RLLs and their key components. In addition, most studies of LL activities in rural areas have focussed on the context of innovation (Bagalkot, 2009; Salemink et al., 2017; Rotz et al., 2019) in relation to traditional rural activities such as farming and agriculture. Following that, little attention has been paid about how to design RLL activities, as well as to what constitutes a RLL. This is important for boosting peoples' understanding of LL innovation activities in rural areas, and for building a solid research foundation upon which innovation processes can be built.

One important aspect in relation to the character and philosophy of RLLs compared with ULLs is related to the way they can be interpreted. ULLs are often considered as a context that supports and boosts the development of smart city innovations (Chronéer et al., 2019). In the same vein, RLLs can be seen as an approach that facilitates digital innovation in rural areas. In addition, ICT and digital innovations in ULLs are relatively mature technology (Salemink et al., 2017). Meanwhile, in RLLs, digital innovations and ICT infrastructure are less mature, at the so-called fuzzy front-end of innovation (Koen et al., 2001; Takey & Carvalho, 2016).

The aim of this paper is to explore how the LL approach should be designed to support DT pilots distributed in rural areas, while including a diversity of stakeholders. Our point of departure is the five "traditional" key components of LLs, namely, ICT and infrastructure, management, partners and users, research and approach (Bergvall-Kåreborn et al., 2009; Ståhlbröst, 2012). By adopting a "design science" research methodology (Peffers et al., 2007; Gregor & Hevner, 2013), we identify and assess what distinguishes ULL and RLL approaches, and present a framework for RLL DT pilots that contributes to the overall body of research. We also propose a definition for RLL, as well as highlight the key differences and similarities between RLLs and traditional ULLs.

Theoretical Foundation: LLs, Urban LLs and Rural LLs

The need for new approaches to engage various stakeholders and users (rural residents) in the DT process is growing (Evans & Karvonen, 2011). Considering the various consequences of digitalization on peoples' everyday lives (Yoo, 2010; Bockshecker et al., 2018; Baskerville et al., 2019), several reasons exist, such as empowerment and democracy (Boston College et al., 2014) for the acceptance and adoption of digital technologies (Moore, 2019; Padyab et al., 2020). LLs offer an approach to managing innovation activities (Ståhlbröst, 2008; Leminen et al., 2012). Accordingly, LLs facilitate DT, as they emphasize simultaneous focus on technologies, people, tasks, and structures, as well as the interactions between them (Schaffers et al., 2009). LL milieus enable and host digital innovations, usually including five key components: ICT and infrastructure, management, partners and users, research and approach (Ståhlbröst, 2008, 2012; Bergvall-Kåreborn et al., 2009).

As innovations are contextual and situational, various types of LLs have emerged to support innovation processes, for example, with energy efficiency, e-health, human-centred AI, and ULLs (Chronéer et al., 2019). What distinguishes urban from traditional LLs is the

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focus on the context of innovation with stakeholder and user engagement. However, the distinction between the two is not always clear-cut (Steen & Bueren, 2017).

To identify the key components of ULLs, Chronéer and colleagues (2019) investigated the main differences between traditional LLs and ULLs. They extended the five key components of traditional LLs, and identified seven key components of ULLs, namely:

1. Governance models including management structure, politics, and policies.

2. Financing and business models.

3. Physical representation that takes place in a real-life setting in city contexts.

4. An innovation to experiment with.

5. Partners and end-users (that is, quadruple helix).

6. Approaches for engaging various stakeholders and collecting data.

7. ICT and infrastructure access, such as Internet of things (IoT) devices (Chronéer et al., 2019).

Yet innovation does not solely happen in urban areas. Some examples of studies that have investigated LLs in a rural context, are Guzman and colleagues (2008), who discussed RLLs as an approach for enabling user-driven ICT-based innovation geared towards economic and social development in rural areas. Another example is Zavratnik et al. (2019), who evaluated the possible contributions of LLs to sustainable rural development and argued that the element of community and social change should be considered as a key element in enabling sustainable living. There have also been attempts to consider RLLs as an experimental milieu where various partners and rural residents develop, implement, and evaluate solutions to address problems that affect their environments (Fleet, 2020). Hence, to date there are no studies that have investigated RLLs from a constructional perspective that aims to define the key components supporting local pilots for DT.

This understanding is of central importance for three main reasons. First, the aim of a LL approach is to facilitate innovation in various contexts. Thus, the impact thereof needs to be traced and measured. Second, a framework is needed that supports and empowers stakeholders to innovate in rural areas (rural residents, companies, officials). Third, identifying key components will help support a comparable design of distributed innovation activities in rural areas where different stakeholders are engaged in local DT pilots. Designing and evaluating local DT pilots by using the same key components will facilitate knowledge growth and understanding of DT in rural areas. Thus, we argue that a richer understanding of the RLL concept and its various constructions and meanings is needed, which relies on experiences and empirical data from several real-life cases (local pilots) of DT in rural contexts. The real-life cases for our research here were carried out within the realms of a project called "DigiBy", which will be explained in the next section.

Methodology

This study follows a design science research methodology (DSRM) (Hevner et al., 2004; Peffers et al., 2007). DSRM aims to create an artefact to solve generally ill-defined problems and enables working with socio-technical systems to understand and develop existing structures and processes in an iterative manner (Carlsson et al., 2011). Accordingly, DSRM is known as an appropriate approach that proposes solutions for specific problems in real life settings (Gregor & Hevner, 2013), that is also one of the key principles of all LL activities (Ståhlbröst, 2008; Bergvall-Kåreborn et al., 2009). In this research, DSRM supports the design of the RLL framework, which could be viewed as an "instantiation" (see Hevner et al., 2004), since the framework acts as a "prototype" of a RLL approach and its components, as well as supporting the user-centric digitalization of rural areas. Also, Peffers' (2007) DSRM followed, which consists of six steps, namely, 1) problem definition, 2) development objectives, 3) artefact development, 4) demonstration, 5) evaluation, and 6) communication.

We collected the empirical data within the context of the "DigiBy" project. The purpose of the project, in collaboration with Luleå University of Technology, the Norrbotten Region and all Norrbotten municipalities in Sweden, was to conduct local DT pilots to increase awareness of digitalization and the application of

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digitalization opportunities for service development in rural areas. Thus far, the artefact produced has undergone two iterations of the DSRM process. The problem identification phase consisted of (1) exploring and using the theoretical background of the rural situation (Section 3.1) and LLs (Section 3.3), (2) a pre-study period where focus groups were used to determine digitalization needs with village residents and local rural retail coordinators (RRC) in attendance (the results of the pre-study can be seen in Runardotter et al., 2017), and (3) the use of two focus groups and questionnaires about rural digital policies (Section 3.2). These two focus groups consisted of officials at regional and municipal levels, who discussed the rural-urban digital divide and explored what opportunities the participants felt they had to influence rural digital policies, as well as the responsibility they felt to bring rural perspectives into the policy process. These focus groups were conducted with semi-structured questions (Flick, 2014), and the results made it evident there are two specific groups of officials working with digitalization of rural areas at the regional level in Sweden. Therefore, an online questionnaire was sent out to both these groups to ensure inclusion. The two focus groups were recorded and transcribed, and Critical Systems Heuristics (CSH), a philosophical framework to support reflective practice (Ulrich, 2000), was used to analyse both the two groups and the questionnaire results. The identified problem (end of Section 3.3) was used in setting the development objectives (Section 4). The development objectives were also based on previous studies of the key components of LLs and ULLs (Ståhlbröst, 2008; Bergvall-Kåreborn et al., 2009; Chronéer et al., 2019).

Based on development objectives and the rural situation in northern Sweden, a draft RLL framework was developed. The draft RLL framework was demonstrated

Table 1. DSRM process for designing the Rural LL framework

Iteration	Phase	Method	Objective	Target group	Number of participants
1st iteration	Problem identification	Pre-study focus groups	Identify needs for digitalization	Rural Residents Local RRC	9
		2 focus groups	Rural digital divide Rural perspectives in digital policies	Officials at regional and municipal level	9
		Questionnaire		Two groups of officials working with digitalization of rural areas	29
	Development objectives	No data collection: the design objectives based on identified problems and the key components of LLs and ULLs			
	Artefact development	ULL Framework used as a basis for the development of the artefact and the pilots			
	Demonstration	RLL pilots	Demonstrate the draft RLL framework	Pilots	14
	Evaluation	Online workshops and unstructured discussions	Evaluate the draft RLL framework	Pilot leaders	4
				Regional development experts	2
2nd iteration	Artefact development	4 online workshops	Refine and redesign the RLL framework	Pilot leaders	7
	Demonstration		Demonstrate and evaluated the revised RLL framework		
	Evaluation				
	Future demonstration and evaluation	RLL pilots			

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in the projects "Digiby" and "Predictive Movement" with a focus on digitalization of rural areas. In these projects, 14 local pilots were conducted following the first draft of the RLL framework. The researchers met with pilot leaders to ensure their understanding of the framework and to ensure that the framework was implemented consistently throughout all pilots. The pilots then used the draft RLL framework in their planning and evaluation of digital innovations in rural areas. We conducted an online workshop using open-ended questions and unstructured discussions with pilot leaders and regional development experts to evaluate the draft RLL framework. The researchers took notes during both the online workshop and unstructured discussions.

Based on feedback that the draft RLL framework was too comprehensive, complex, and used difficult language, the RLL framework underwent a 2nd design iteration. The entry point of the 2nd iteration was artefact development where 4 online workshops were conducted with the Digby pilot leaders. In each of these workshops, the key components of the RLL framework (rural context and the physical conditions, governance and control, quintuple helix approach, and digitalization) were refined by using simplified language, thus making it easier to follow. Within these workshops the revised framework was demonstrated to and evaluated by the pilot leaders. They saw that the revised framework (explained in Section 4) was still comprehensive, but easier to understand and follow. The next planned step was to further demonstrate and evaluate the revised RLL framework in the pilots. A summary of the methodology can be found in Table 1.

The Rural Situation

Tobler's (1970) phrase "everything is related to everything else, but near things are more related than distant things" (also called the first law of geography), explains well the difference between urban and rural areas. Despite the vision of "a sustainable digitalized Sweden, where everybody in the whole country is part of and has confidence in the digital society" (Regeringskansliet, 2017), Swedish digitalization policies mainly have an urban focus, where commercial actors are expected to drive the development (for example, neoliberal economic philosophy, see Grimes, 2003; Malecki, 2003). However, commercial initiatives are inevitably profit-

driven, and one way to make profit is to encourage people living close to each other to share costs. Consequently, non-profitable sparsely populated areas become largely dependent on state support (Lindberg, et al., 2021). Moreover, to depend on societal intervention for support becomes problematic in rural areas (Regeringskansliet, 2016). Among others reasons, it often requires collaborations that are not easily achieved between the state, commercial actors, and individuals (Salemink et al., 2017; Cras et al., 2019). As a result, actors in rural areas develop their own solutions, such ase village associations, formed by village residents themselves, to cope with things like broadband expansion and digital (extension) services.

To help facilitate the possibility of having a vital and sustainable countryside, great importance is placed on becoming "smarter", that is, deploying digital technologies and solutions that digitally transform society. DT offers great potentials for the countryside and rural areas in the northern parts of Sweden. By means of digital solutions, we can overcome rural challenges such as geographical distances to potentially ensure that equal opportunities can be reached regardless of where we live (Gillespie et al. 2014). Through the digital economy and remote working conditions, new possibilities for self-employment can increase, which contributes to solving many of the challenges facing rural areas, such as an ageing population, young people leaving, and lack of labour market diversity (Intereg Europe, 2019; Vironen & Kah, 2019). Adding to rural challenges, a discourse analysis of Swedish national policy focusing on rural areas carried out by Rönnblom's (2014) showed that national policy places the responsibility for rural development primarily in the hands of rural residents themselves. Looking at the urban context there are no similar demands on urban inhabitants (Rönnblom 2014), which leads us to believe that there is need for approaches that strengthen and support rural development by addressing the rural uniqueness and involving the rural inhabitants.

Rural Resilience
Digital policy must take three factors into account to be resilient: It must be multi-scalar (governing collaboration), normative (social and technological factors), and have an integrated approach to resilience (Roberts et al., 2017). Rural digital policies incorporate these factors at a local level, but the expectation of a commercial actor to drive the development is a barrier,

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since corporate profitability is prioritized before individuals' needs and desires. A triple helix model for implementing digital services and connection in Swedish rural areas exists. Yet the public (rural residents), which is the fourth component in the quadruple helix model, is so far missing in the policy development process (Lindberg, J. et al., 2021).

For instance, in Sweden, 80% of citizens have a fiber connection to their home, yet this coverage is unevenly distributed between urban and rural areas (only 48% in Swedish rural areas). In addition, surface area coverage in Sweden for mobile broadband and mobile telephony is 82% for 10 Mbit/s (2G/3G), whereas the Cellular Coverage index (CCI) shows high inequalities between rural and urban areas (Beek & Reje, 2020).

The Rural Situation

This section outlines the situation of rural areas, based on officials involved in the DigiBy project, in connection to two themes, namely distance and collaboration.

Distance

Regional rural retail plans have an overall vision that rural retail should be available everywhere in Sweden. Everyone should have a grocery store within 10 km and a fuel station within 20 km. These distances are practically impossible to achieve, however, in sparsely populated areas with between 0.2-5 inhabitants per square km, which is common in the four most northern counties in Sweden. The officials there indirectly relate to distance when discussing difficulties of getting support for alternative techniques. For example, many believed that radio technology or 4G LTE would be a solution for connecting rural areas. In 2018, the Swedish Board of Agriculture, responsible for broadband expansion, approved radio links as a Next Generation Access technology (approved for EU-funding). They have not yet, however, approved 4G LTE.

Collaboration

The officials emphasize that collaboration is important from a rural retail perspective. Collaboration between relevant levels would provide a more transparent view of the situation and facilitate decision-making. In addition, collaboration is regarded as a prerequisite for increasing the service level in a rapidly changing society with the argument that work should be evaluated based on how they collaborate, and how partners experience the situation. One official said: "This is done through a multi-level collaboration locally, municipally and regionally. I believe coordination and collaboration has important intrinsic values, but to increase the commitment, the subject matter must be meaningful in a broader context. Otherwise, cooperation will not become collaboration and co-creation."

Rural Living Lab (RLL) Framework

To facilitate the processes of piloting with digital innovations and DT in rural areas, we developed a framework to support our efforts in the DigiBy project. To ensure that those involved in the project performed their activities in a similar vein, we introduced an Urban LL approach, based on the five key components of traditional LLs (Ståhlbröst, 2008; Bergvall-Kåreborn et al., 2009) and considering the key components from Urban LL (Chronéer et al., 2019) and the interactions with officials.

Taking into consideration the evaluation of the proposed RLL framework, the draft framework was perceived as extensive and unmanageable for a practitioner (that is, pilot leaders). However, in a second design iteration, the pilot leaders were involved in online workshops to redesign the RLL framework, they evaluated the revised framework as still extensive, but used a simpler language, and was easier to understand and follow. They also reasoned that the framework could be divided into parts and used separately for different target groups.

In this article, the endeavour is to adapt the key components (developed to support the design of LL pilot milieus in an urban context) to a rural context where the LL will be more flexible and at the same time stream-lined, time-limited and focused on supporting rural DT initiatives. Thus, the RLL framework is for local and distributed pilots with digital innovations in rural contexts and thus facilitate DT. It is not focusing on the innovation processes per se since there are other key principles i.e., openness, realism, value creation, influence, and sustainability (Ståhlbröst, 2012) that should guide these processes in a LL context. As suggested in Peffers et al.'s (2007) DSRM, we design the RLL framework based on the above-mentioned studies of the key components of LLs and Urban LLs approach (Ståhlbröst, 2008; Bergvall-Kåreborn et al., 2009; Chronéer et al., 2019), as well as the empirical data

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gathered within the context of the DigiBy-project. Considering the presented issues and complexities of DT in rural context, we ended up with the five overarching key components to support the design of RLLs, namely (see Fig. 1):

Each of the key components in the RLL framework are explained in more detail below.

Rural context
The rural context is a key component due to the importance of understanding the specific context of the local DT pilots. For instance, villages depend on governmental support while simultaneously being left to take care of matters themselves. Swedish digital policy follows the prevailing trend that societal digitalization should be carried out and supported by commercial actors. However, in rural areas, with low profitability, low density of inhabitants, village residents initiate digital solutions themselves, for example, associations arrange to dig down fibre cables themselves. Situated conditions must be understood, like status and engagement in local associations, where the local pilot is located, its digital infrastructure (broadband, mobile connection etc), demography of the local context, companies and relevant public services (for example, schools, post office), who owns the place in which the innovation is to be implemented, plans for the areas (for example, exploitation plans, new natural reserves, changes in laws), and also responsibilities related to the context. In RLL activities, places and spaces that support innovation activities are important to understand and design for (Bergvall-Kåreborn et al., 2015), since all activities should take place in inhabitants' real life with supportive engagement. In the DigiBy project, one of the local DT pilots (digital lock) facilitated an innovative type of collectively-owned grocery store that does not have any employed personnel and is open 24/7 by offering digital and personal logins to the store. Here, the engagement of rural residents in their village association, based on their drive and enthusiasm, were critical to make DT happen. People in the village (both inhabitants and visitors) do not now need to drive 88 kilometres to buy their food, which is good for their economy as well as for the environment.

Governance and business model
Another key component is the governance and business models of sustainable DT on a long-term basis.
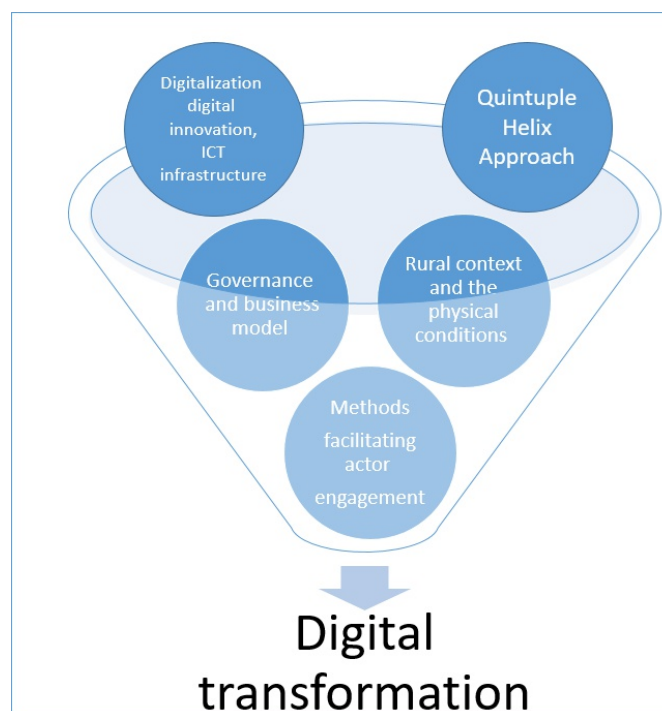

Figure 1. An overview of RLL key components

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Governance and business models include considering aspects such as risk management, planning for setting up as well as closing a pilot, the spread results of the pilot, keeping track of income/costs, managing material and immaterial resources, working with potential financiers, while also setting up contracts between   actors in the RLL. For instance, the ownership of innovation and data, leadership structures and decision making power related to putting content into digital innovations, and thus boosting DT in the countryside. Regarding the business model, it should create, deliver, and capture values for all stakeholders affected by DT. Here is it important to identify value propositions, communication channels, revenue streams, and so forth (Osterwalder & Pigneur, 2010).

As in ULLs, local governments and decision makers have a prominent role in the facilitation of RLLs, for example, sharing experiences between various local initiatives so that learning and opportunities can emerge in other locations. For instance, in the DigiBy-project, officials with the role of rural developers shared our project findings with other villages in their municipalities. Further, DT initiators in the municipalities had contact with each other and the researchers. These rural developers have good local and people knowledge, that is, they know the people running various rural initiatives, and they have ongoing communication with them. In the rural context, being able to live and make business locally is of utmost importance. For instance, introducing ICT can lead to the creation and development of new BM areas (new potential revenue streams), and also be an enabler of various types of innovations, and thus businesses. As an example, in the DigiBy project, information screens were implemented in a local grocery store, which made it possible for local companies to post adds that all visitors in the store could see. This created a new revenue stream for the local grocery store, as well as new business opportunities for the local company.

Methods facilitating actor engagement

The methods used support planning and carrying out data-collection in the local pilots, as well as knowledge sharing between the many actors involved in local initiatives. The methods aim to encourage active engagement within and between local pilot sites, rural residents, researchers, and government throughout the entire DT processes. The FormIT methodology (Ståhlbröst, 2008) has been developed to support LL innovation processes, emphasizing the inclusion of external sources of knowledge and ideas in exploration, creation, implementation, and evaluation of concepts, together with prototypes and innovations in real-life settings, which is of utmost importance to support DT with a RLL approach.

To support inclusive DT in rural areas, multi-disciplinary approaches and various methods are needed (for example, brainstorming sessions, future workshops, gamification, heuristic evaluation, personas), along with tools that can support these processes (Scholl & Kemp, 2016). Actor engagement in a LL context is an iterative process characterized by complex interplay between different phases and activities, including planning for engagement, realizing planned activities in real-life settings, and reflecting upon the plans and actions as a way to sustain user engagement and commitment to use the innovation in their everyday use (Habibipour, 2020). In the DigiBy project, the engagement of multiple actors was supported with a structured approach to each individual local pilot. This made it possible to keep track of timelines, innovations, actors, and research questions to be emphasised, as well as supporting a streamlined approach to the local pilots, which in turn facilitated knowledge sharing and producing research results.

Digitalization, digital innovation and digital infrastructure

In RLLs, digitalization has a broader scope than merely digitizing a business. Digitalization as a key component integrates both digital innovations that will be co-created by various stakeholders and rural residents, as well as the digital infrastructure (Verhoef et al., 2021). In RLLs, digital infrastructures are intertwined with the innovations that are usually in the fuzzy front-end stage. "Digital infrastructure" here refers to hardware, software, data (open or closed data), networks (for example, 4G, 5G, fiber, Wi-Fi), as well as other IoT-solutions such as smart cameras, sensors in smart agriculture, and wearables. In relation to this key component, a shared understanding of the purpose of the digital innovation and the expected value the innovation can offer is vital.

Identifying specifically what a digital solution offers, including its broader ecosystem and value chain, with hardware, software, services, data, and communication

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network is important to facilitate ownership, agreements, licences, and so forth. The aim of the local pilots in rural contexts was to facilitate long-term DT by experimenting with digital innovation. To illustrate, in the DigiBy project we aimed at buying all equipment, having low cost licences that could be transferred to local pilot owners after the DigiBy project ended. In the RLLs, our study also identified that digital innovations not only transform organisational processes, but also societal and individual processes. One example was the digital lock at a local grocery store, which impacted peoples' buying and travelling habits. Hence, we can see that digital innovations transform behaviours as well as processes. Thus, it is important to have an open mind when designing and evaluating DT pilots.

Quintuple Helix

All LL activities involve quadruple helix networks, that is, both public and private sectors, academic institutions, and citizens. However, due to rapid climate changes occurring in natural environments and ecosystems, an urgency is in place to follow general recommendations from the latest IPCC report to consider climate change in innovation projects depending on the context (Masson-Delmotte et al., 2021), which emphasizes the importance of including all environmental aspects.

The quadruple helix of innovation should therefore include "natural" environments, as the fifth key actor in the DT process for rural areas. This is called the "quintuple helix" of innovation (Carayannis et al., 2012), which adds the helix (perspective) of natural environments in various societies. Hence, it is important to consider those affected that do not have a voice, which could be the environment, but also people, for example, unborn children. This quintuple helix approach can also facilitate collaboration in RLLs and their DT processes, that is, risks and workload can be divided among various partners. However, the helix has no formal partnership or dedicated leadership, as is also the case in ULLs. Therefore, identifying relevant stakeholders is one of the most challenging tasks (Zavratnik et al., 2019), which should be carried out while planning DT processes. Aspects such as stakeholder motivation to contribute, their objectives and intentions, as well as their expected level of engagement, should be stated up front. Furthermore, the quintuple helix component should help RLL

organizers to define the different roles of engaged partners including individual users (rural residents), and their degrees of engagement. The partners might have passive roles such as "affectees" (Ståhlbröst & Holst, 2017), who are affected by, but do not influence the DT process, along with more active roles, such as tester, experimenter, innovator, or lead participant.

In the DigiBy project, the quintuple helix approach took the form of collaborations between researchers, municipalities, local grocery stores, rural residents engaged in village associations, end-users of the suggested solutions, and also specific aspects of the environment, as seen for example with the digital lock solution. In this project, the involved actors took different roles, for example, where researchers had a facilitating role in investing, implementing, and evaluating the digital innovations. The municipalities also had a facilitating role focussed on knowledge sharing and knowledge transfer between different local actors. They also had vital network connections, important for the DT process. The local actors (for example, local store owners, citizens, end-users) had a diversity of roles, spanning from "need owners" to affectees. In RLL pilots, the environment become a ubiquitous actor that is an integral part of the rural residents' activities. To conclude, when engaging in quintuple helix processes it is important to consider and clarify the roles and expectations of the different actors.

Discussion and Conclusion

In contrast to ULLs (Chronéer et al., 2019), RLLs do not merely consider LLs as a milieu or a place-specific context. Instead, the RLLs are an approach that facilitates processes of local DT pilots in rural areas, where identified key components are an integral part of the overall processes of experimenting and evaluating digital innovations in real-world contexts. In our study, some specificities that have been identified regarding RLLs should be taken into consideration when designing DT pilots. Firstly, RLL pilots are contextually situated, since they are driven by local needs as they are experienced and expressed by local actors, for example, a local grocery store needing to broaden their business to become viable. Secondly, the rural DT pilots in northern Sweden are experimenting with innovations at a high technology readiness level (TRL, for example, using digital locks, digital touch screens, digital package boxes) to create initial instant value for its actors, which

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is of utmost importance in rural areas due to the vulnerability of local businesses that might have a somewhat limited customer basis. Related to that is the fact that the pilots are being carried out in real-world contexts with real customers and other actors. This requires fast, established, and dynamic processes, but also an investment of time from local actors in the pilot.

In our study the RLL pilots were geographically distributed with several small pilots in a diversity of villages, in contrast with ULLs that usually have one (somewhat) controlled place for the LL activities. For instance, in urban contexts, cities are considered as ULLs, which is associated with long-term and sustainable planning (Evans & Karvonen, 2011; Steen & Bueren, 2017), while RLLs have shown to be more distributed in character. In addition, RLL activities can be considered as small-scale activities that are carried out within defined boundaries of a local pilot, while involving a possibly limited number of actors and rural residents. As a result, having a deep understanding of qualitative aspects should be sought. Rural pilots that are carried out in distributed real-world contexts with real customers in live situations, require that the pilots are facilitated and supported with frameworks that enable knowledge transfer and building both among local actors, as well as the other actors in the quintuple helix collaboration.

Based on the findings of this study, we propose the following definition of RLLs:

> *A rural living lab is a local innovation pilot that aims to solve rural challenges and contribute to inclusive digital transformation of society by engaging quintuple helix actors including rural residents and natural environments in real-life digitalization experiments.*

Important to note here is that the proposed definition addresses those RLLs that pursue pilots aimed at DT. Therefore, this definition cannot be generalized to all other types of RLLs, for example those focused on non-digitally enforced social goals, such as strengthening inclusiveness in the society, advancing eco-cultural restoration, increasing land-based learning, or fostering entrepreneurship in tribal contexts.

Overall, our results revealed that the proposed RLL

framework highlights some key differences between ULLs and RLLs. The first and most important aspects relate to the character and philosophy of the way RLLs and ULLs can be formed and interpreted. Even though ULLs are mainly considered as a context in which to develop innovations, RLLs can instead be seen as an approach that aims at solving issues that emerge locally while, facilitating DT in rural areas. In addition to that, the scope of activities in RLLs is more focused on short-term activities compared with Urban LLs, the latter which have more long-term planning for defined activities. Furthermore, in contrast to ULLs that usually involve a quadruple helix of innovation, RLLs also necessarily include the natural environment as a fifth actor that influences DT processes in rural areas.

RLLs facilitate piloting digital innovation in rural areas with an aim to include and empower a multitude of rural stakeholders in various DT activities. In this study, we identified five key components that supports the design of DT pilots in rural areas. RLLs can be expected to represent a local ecosystem where multiple involved actors are motivated by various objectives, yet at the same time benefit from their engagement, for example, a collectively owned local grocery store. A RLL should also facilitate engagement by providing tools for planning and evaluating local pilots in real-world contexts. The RLL approach can thus be seen as an innovation management tool for inclusive DT of rural areas.

The RLL framework is suited not only for designing local DT pilots, but can also support the structure of work in a policy process, according to officials working with policy processes for local development. Here the framework can be used in various stages of the policy process to collect input from target groups, spanning from politicians' visions to individual needs.

Based on the results of this study, potential avenues for future research are revealed. One limitation of this study was to restrict RLLs to those aiming to enable DT processes. However, a clear classification and categorization of RLLs seems of vital importance toward fostering an enhanced understanding of what differentiates between RLLs and ULLs, and why. Another interesting topic for future research is to study how a RLL can be seen as a "model" that describes a set of propositions or statements expressing relationships among constructs (here key components). For example, how different ways of governing and control might be

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affected by a rural context, or how actors (quintuple helix) and their engagement approach might differ, depending on the digital innovation type as well as the digital infrastructure in rural areas. Our hope is that the presented RLL framework and definition can be used as a starting point for facilitating and supporting DT processes in rural areas, by further iteration of design cycles and evaluations in real-life settings.

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