

Rural Living Lab: What is that and how is it shaped?

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Abstract

Digital transformation (DT) has received increasing attention in recent years. Despite this, most of the current studies focus on digital transformation in more advanced societies, particularly urban areas, and the concept has not been investigated enough within rural contexts. This study aims at exploring how a rural living lab (Rural LL) is shaped and how this approach can be designed to support digital transformation processes in rural context. In so doing, following a design science research methodology (DSRM), we have designed an artefact (i.e., Rural LL framework) which 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 main constructs (key components) of this framework are: 1) rural context, 2) digitalization, 3) governance, control, and business mode, and 4) quintuple helix actors. We also offer an empirically derived definition of the rural living lab concept, followed by avenues for future research.

Key words

Digital transformation, Living Lab, Rural living lab, Components, Rural residents, User engagement.



Introduction

Nowadays, digital transformation (DT) is changing dynamics and how the society is 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, p. 689). These changes are visible in different levels and scales, from organizational to societal levels, and from more modernized urban areas to less digitalized rural areas, in which DT happens in an uncontrolled real-life context and where humans are involved in their everyday use context (Bockshecker et al., 2018; Spagnoli et al., 2019). To date, most studies of the societal effects of digitalization and DT has been carried out in urban areas, and there is a lack of research on the effects of digitalization in rural areas (Rotz et al., 2019; Runardotter et al., 2020). Since digitalization of society has a huge (positive and negative) impact on human’s life, people have the moral and ethical right to be a part of DT processes also in rural areas, which is in line with “participatory design” approach (Bansler, 1989; Bjerknes and Bratteteig, 1995). Hence, this paper focuses on DT and innovation in rural areas, and their challenges. 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 individuals in their role as citizens, inhabitants, end-users etc., are engaged throughout the DT process in their real-life setting (Bergvall-Kåreborn et al., 2009; Ståhlbröst, 2008). 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 the interactions between different stakeholders (Schaffers et al., 2009). To date, much attention has been paid to urban areas as the context of LL activities, the so-called Urban LL (Chronéer et al., 2019; Steen and Bueren, 2017), e.g., the initial list of key components of the traditional LLs were further revised and modified for the context of Urban LL by Chronéer et al. (2019).

Though, few studies have examined the possibilities and potentials of LL activities in relation to rural areas and then mostly investigated e.g., one specific dimension such as business models for Rural LL (Schaffers et al., 2009), co-creation activities and actions in rural context (Bagalkot, 2009), and nature-based solutions and sustainability in rural contexts (Lupp et al., 2021; Zavratinik et al., 2019). None has investigated the overall construction of Rural LLs and their key components. In addition, most of the studies on Rural LLs are mainly focused on the context of innovation (Bagalkot, 2009; Rotz et al., 2019) in relation to the traditional rural activities such as farming and agriculture, hence, rarely investigated the overall structure and key constructs of a Rural LL.



The aim of the study is to explore how the LL approach could be designed to support innovation processes aimed to include a multitude of rural stakeholders in DT activities of rural areas by following the five key components of “traditional” 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 (Gregor and Hevner, 2013; Peffers et al., 2007), the study outlines the differences that distinguishes a Rural LL and presents a framework for Rural LLs that contributes to the body of literature by identifying the key components (constructs) of a Rural LL, proposing a definition for Rural LL, as well as understanding the key differences between Rural LLs with traditional and Urban LLs.

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 and Hevner, 2013), that is one of the key principles of all LL activities (Bergvall-Kåreborn et al., 2009; Ståhlbröst, 2008). Also, DSRM supports the Rural LL framework design, which could be categorized as an “instantiation”, see (Hevner et al., 2004) as it is a “prototype” of a Rural LL approach and its components and supports user centric digitalization of rural areas. Also, Peffers’s (2007) DSRM was followed which consists of six steps namely, 1) problem definition; 2) development objectives; 3) artefact development; 4) demonstration; 5) evaluation and 6) communication.

The empirical data was collected within the context of “DigiBy” project. The purpose of the project was to, in collaboration with Luleå University of Technology, the Norrbotten Region and all Norrbotten municipalities, conduct pilot tests to increase awareness and the application of digitalization opportunities for service development in rural areas.

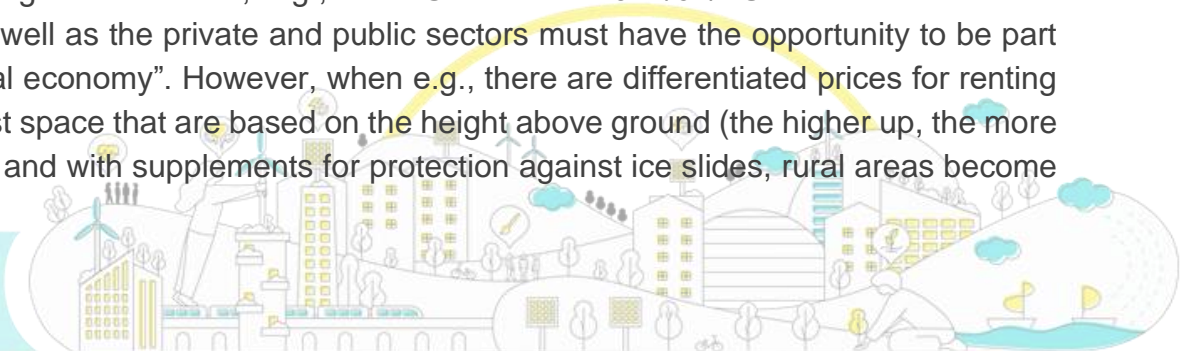
Thus far, the artefact has undergone three iterations of the DSRM process. The problem identification consisted of (1) exploring and using the theoretical background of the rural situation (Section 3.1) and LLs (Section 3.3), and (2) the use of focus groups and questionnaires about rural digital policies (Section 3.2). Two focus groups consisting of officials at regional and municipal level, discussed the rural-urban digital divide and explored what opportunities the participants felt they had to influence rural digital policies and the responsibility they felt to bring in the rural perspective into the policy process. These focus groups were conducted with semi-structured questions (Flick, 2014) and the results made it evident that there are two specific groups of

officials working with digitalization of rural areas at regional level in Sweden. Therefore, an online questionnaire was sent out to both these groups to ensure inclusion. In this questionnaire, the Critical Systems Heuristics (CSH), a philosophical framework to support reflective practice was used (Ulrich, 2000). The identified problem (end of Section 3.3) was used in identifying the development objectives (Section 4). The development objectives were based on previous studies of the key components of LLs and Urban LLs (Bergvall-Kåreborn et al., 2009; Chronéer et al., 2019; Ståhlbröst, 2008). The Rural LL framework was demonstrated in the projects 'Digiby' and 'Predictive Movement' with a focus on digitalization of rural areas. In these projects, evaluation interviews were conducted with each pilot leader (ten and three pilots respectively). The framework underwent a second design iteration to incorporate some suggested improvements. A second demonstration and evaluation were performed in an online workshop with open-ended questions, and through free and unstructured discussions. The participants had used the Rural LL in their planning and following up tests of digital services in the rural areas. These results (Section 5) were used in a third iteration. The demonstration and evaluation of the third iteration is the topic of a future research paper.

The Rural Situation

The first law of geography phrased by Tobler (1970), "everything is related to everything else, but near things are more related than distant things" provides an understanding of the difference between a city and a rural area. For example, policies and development for digitalization in cities build on a commercial view where commercial actors drive the development (e.g., the Neoliberal economic philosophy) (Grimes, 2003; Malecki, 2003). Commercial initiatives strive for profit, and one way to maintain profit is to let people living close to each other share the costs, hence, sparsely populated areas become non profitable and largely dependent on state support (Lindberg, J. et al., 2021). This is problematic for rural areas, since areas with low profitability are dependent on society intervening with support opportunities ("Sverige helt uppkopplat 2025 - en bredbandsstrategi - Regeringen.se," n.d.). This requires collaboration that is not easily achieved between the state, commercial actors, and individuals (Cras et al., 2019; Salemink et al., 2017). As a result, actors in rural areas develop their own solutions like village associations, formed by the villages' residents themselves, to cope with e.g., the broadband expansion and digital services.

There exist good intentions, e.g., the EU directive 2014/61/EU that states that "all citizens as well as the private and public sectors must have the opportunity to be part of the digital economy". However, when e.g., there are differentiated prices for renting mobile mast space that are based on the height above ground (the higher up, the more expensive) and with supplements for protection against ice slides, rural areas become



the losers. This creates an injustice, in line with Miranda Fricker's (2010) concept of 'epistemic injustice', which adapts to the rural-urban context as well. In short, Fricker (2010) argues that those who are always considered to be wrong, whose beliefs are not taken seriously, will eventually not trust their knowledge themselves.

Rural challenges

A Community Resilience framework suggest that digital policy must take three factors into account to be resilient; 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 - corporate profitability are prioritized before individuals' needs and desires. A triple helix model for implementing digital services and connection in Swedish rural areas exists, but the public (rural residents), a fourth component in quadruple helix is missing in the policy development process (Lindberg, J. et al., 2021).

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

Views on the Rural Situation – as perceived by officials

This section describes the stories, as told by officials working with digitalization in rural areas, structured in the themes Distance and Collaboration.

Distance. Regional rural retail plans have an over-all vision that rural retail shall be available everywhere in Sweden. Everyone should have a grocery store within 10 km and a fuel station with in 20 km. These distances are impossible to achieve 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 indirectly relate to distance, when discussing difficulties of getting support to alternative techniques. For example, many believe that radio technology or 4G LTE would be a solution for connection in rural areas. In 2018 the Swedish Board of Agriculture, responsible for the broadband expansion, approved radio link as a Next Generation Access technology (approved for EU-funding). They have not yet 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.”

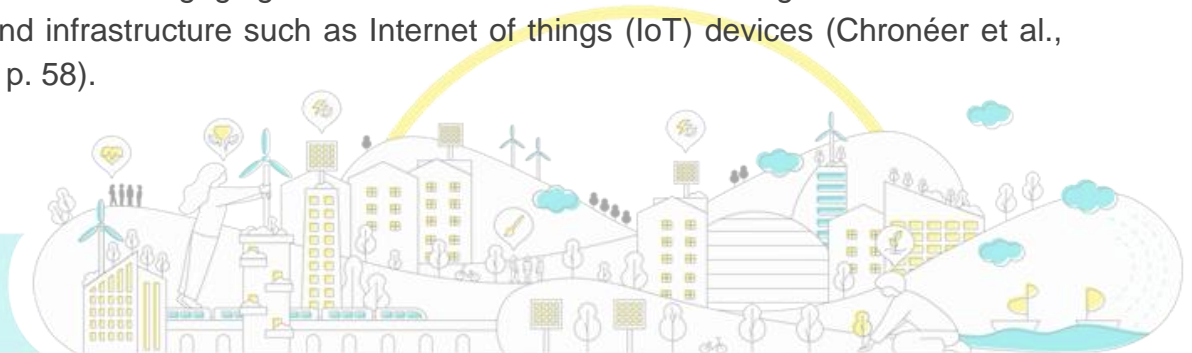
Living Labs and Rural Studies

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

As DT is contextual and situational, different types of LLs have emerged to support innovation for e.g., energy efficiency, e-health, human centred AI, and Urban LLs (Chronéer et al., 2019). What distinguishes urban from traditional LLs is related to the context of innovation and stakeholder and user engagement, however the distinction between the two is not clear (Steen and Bueren, 2017).

To identify the key components of Urban LLs, (Chronéer et al., 2019) investigated the main differences between traditional and Urban LLs. They extended the five key components of traditional LLs and identified seven key components of Urban LLs, 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 the city context.
- 4) An innovation to experiment with.
- 5) Partners and end-users (i.e., quadruple helix).
- 6) Approaches for engaging different stakeholders and collecting data.
- 7) ICT and infrastructure such as Internet of things (IoT) devices (Chronéer et al., 2019, p. 58).



Examples of studies that have investigated LLs in a rural context, are e.g., Guzman and colleagues (Guzman et al., 2008), who discuss Rural LLs 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 LLs possible contributions to sustainable rural development and argue that the element of community and social change should be considered as a key element in enabling sustainable living. There has also been attempts to consider Rural LLs as an experimental milieu where various partners and rural residents develop, implement and evaluate solutions to address the problems that affect their environment (Fleet, 2020). Hence, to date there are no studies that have investigated the Rural LLs from the constructional perspective aiming to define its key components. This understanding is of central importance for three main reasons. First, the aim of a LL approach is to facilitate innovation in different 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. Final, identification of key components will support the design of innovation activities in rural areas aiming to facilitate DT. Thus, we argue that a richer understanding of the Rural LL concept and its constructions is needed, which relies on experiences and empirical data from a real-life case of DT in a rural context, that is the project called ‘DigiBy.’

Rural LL framework

To facilitate the processes of innovation 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 way, we introduced a LL approach, based on the five key components of traditional LLs (Bergvall-Kåreborn et al., 2009; Ståhlbröst, 2008) and considering the key components from Urban LL (Chronéer et al., 2019). This resulted in a Rural LL framework since it is important to adjust the LL framework to the context. In this article, the endeavour is to adapt these key components (developed to support setting up a LL as an organisation or milieu in an urban context) to a rural context where the LL will be more flexible, time-limited and focused on supporting rural DT initiatives. Thus, the Rural LL framework is for piloting digital innovations in rural contexts, and it is not focusing on the innovation processes per se since there are 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 Rural LL framework based on the above-mentioned studies of the key components of LLs and Urban LLs approach (Bergvall-Kåreborn et al., 2009; Chronéer et al., 2019; Ståhlbröst, 2008), as well as the empirical data gathered within the context of DigiBy-project. Considering the presented issues and complexities of DT in rural context, we ended up with the four overarching key components to support the design of Rural LLs, namely (see Fig. 1):



- 1) Rural context and the physical conditions
- 2) Governance and control (including methods for engagement and business model)
- 3) Quintuple Helix Approach
- 4) Digitalization (including innovation, ICT infrastructure)

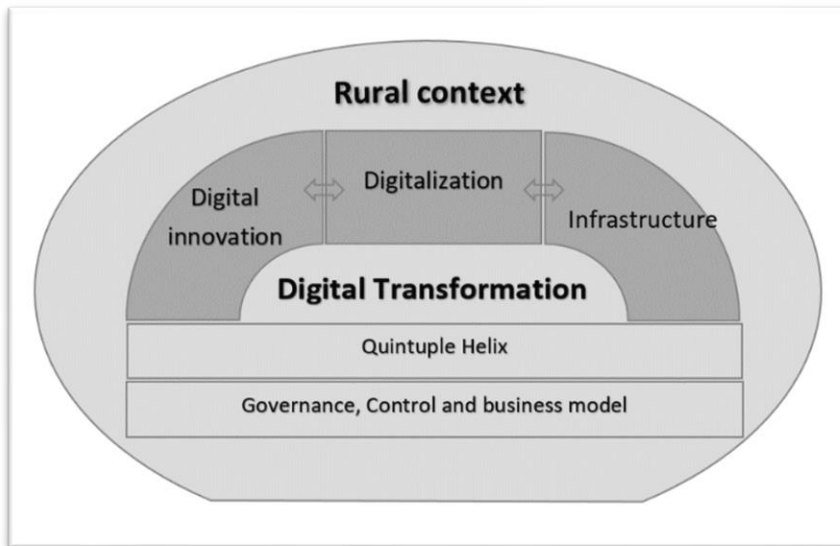


Figure 1. An overview of the developed Rural LL framework

Below, each of the key components in the Rural LL framework are explained in more detail.

Rural context

The rural context is a key component due to the importance to understand the specific nature of the context of DT. For instance, villages are dependent on governmental support while simultaneously being left to take care of matters themselves. Swedish digital policy follows the prevailing trend that digitalization of society should be carried out by commercial actors. However, in rural areas, with low profitability, low density of inhabitants; villages' residents initiate digital solutions themselves, e.g., associations arrange for digging down fiber cables. Situated conditions must be understood, such as who owns the place in which the innovation is to be implemented, plans for the areas (company establishment, new (updated) infrastructures, governmental decisions (e.g., exploitation plans, new natural reserves, changes in laws) and responsibility. In Rural LL activities, places and spaces that support organization of innovation activities is of utmost importance to understand and design for (Bergvall-Kåreborn et al., 2015) since all activities should take place in inhabitants' real life and support engagement, but there is lack of control over the situation and the DT process.



Digitalization

In Rural LLs, digitalization embraces more than merely digitalizing a business. It is about digitalization for inclusion and access to societal services. Digital innovation 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 Rural LLs, infrastructures are intertwined with the innovations that usually are in the fuzzy front-end stage. Here, digital infrastructure refers to the hardware, software, data (open or closed data), networks (e.g., 4G, 5G, fiber, Wi-Fi), as well as other IoT-solutions such as smart cameras, sensors in smart agriculture, and wearables.

Governance, control, and business model

One key component is the organization and management of a sustainable Rural LLs. This includes aspects as; the overall aim and objectives of Rural LLs, risk management and assessment, knowledge sharing with stakeholders and rural residents, and dissemination of the DT activities throughout the Rural LL lifetime. Regarding the business model, it should create, deliver, and capture values for all Rural LL stakeholders. As in Urban LLs, local governments and decision makers have a prominent role in the design of Rural LLs, e.g., to share experiences between different local initiatives so that learning and opportunities can emerge in other locations. For instance, in the DigiBy-project, officials with the role as rural developers shared our findings to different villages in their municipalities. Further, initiators of DT in the municipalities had contact with each other and the researchers. These rural developers have good local and people knowledge, i.e., they know the people running different rural initiatives, and they have ongoing communication with them.

The governance and control component focuses on governing and controlling LL activities, but it also supports knowledge sharing among the stakeholders involved in local initiatives and encourage active engagement between them and rural residents throughout the entire digital innovation processes. The FormIT methodology (Ståhlbröst, 2008) emphasizes the inclusion of external sources of knowledge and ideas in exploration, creation, implementation and evaluation of concepts, prototypes and innovations in real-life settings.

There is a need for multi-disciplinary approaches and various methods (e.g., brainstorming sessions, future workshops, gamification, heuristic evaluation, personas) and tools (Scholl and Kemp, 2016). User engagement in a LL context is an iterative process characterized by complex interplay between different phases and activities, including planning for engagement, realization of the planned activities in real-life setting, and reflecting upon the plans and actions aiming to sustain user engagement and commitment to use the innovation in their everyday use (Habibipour, 2020). In the rural context, being able to live and make business is of utmost importance. For

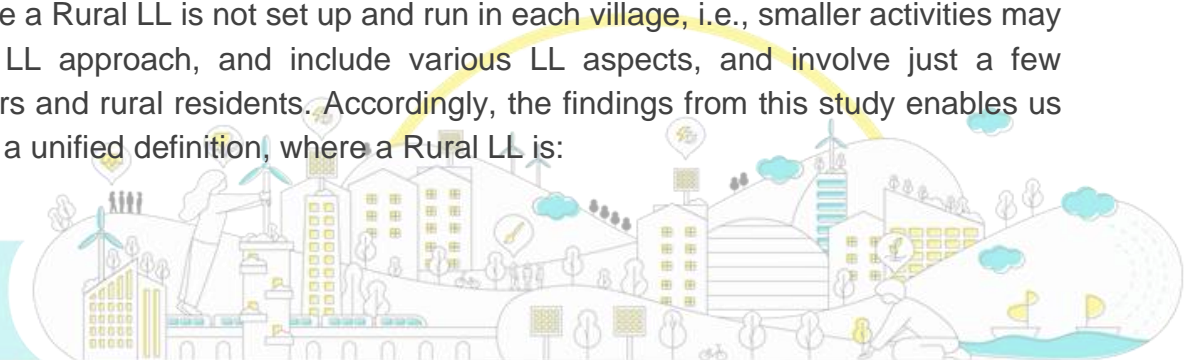
instance, an introduction of ICT can lead to the creation and development of new BMs areas (new potential revenue streams) and be an enabler of different types of innovations and thus businesses. In addition, ICT allow the creation of new networks and partnerships between local economic actors.

Quintuple Helix

All LL activities involve quadruple helix networks, i.e., public and private sectors, academic institutions, and citizens. However, it is natural in rural areas to be close to, dependent on and respectful of the environment and the natural resources, innovations need to embrace this context. Therefore, the quadruple helix of innovation should include this ‘nature’ (environment), as the fifth key actor in the DT process for rural areas, i.e., “Quintuple helix” of innovation (Carayannis et al., 2012), which means adding the helix (perspective) of “natural environments of society.” This quintuple helix approach can also facilitate collaboration in Rural LLs and their DT processes, i.e., risks and workload can be divided among different partners. However, there is no formal partnership or dedicated leadership as is the case in Urban LLs. Therefore, identification of relevant stakeholders is one of the most challenging tasks (Zavratnik et al., 2019), and it should be carried out in the planning of the DT processes. Aspects such as stakeholders’ motivation to contribute, their objectives as well as their engagement should be stated. Furthermore, the quintuple helix component should help Rural LL organizers to define the different roles of engaged partners including individual users (rural residents), and the degree of engagement. The partners might have passive roles such as affectee (Ståhlbröst and Holst, 2017), who are affected by, but will not influence the DT process, but also more active roles such as tester, experimenter, innovator, or lead participant.

Discussion and conclusion

In contrast to Urban LLs (Chronéer et al., 2019), Rural LLs do not consider LLs as an environment or a context. Instead, Rural LL is an approach that facilitates the processes of DT in rural areas where the identified key components will be a part of the overall innovation process, such as piloting and experimentation. Hence, in Rural LLs, smaller activities (e.g., pilots) will follow the LL approach and become an “instantiation” of LLs. In addition, in Rural LLs, the dimension of “time” plays an important role. For instance, in the urban context, the city is considered as an Urban LL and it is associated with a long-term and sustainable planning (Evans and Karvonen, 2011; Steen and Bueren, 2017), while a Rural LL is not set up and run in each village, i.e., smaller activities may follow the LL approach, and include various LL aspects, and involve just a few stakeholders and rural residents. Accordingly, the findings from this study enables us to propose a unified definition, where a Rural LL is:



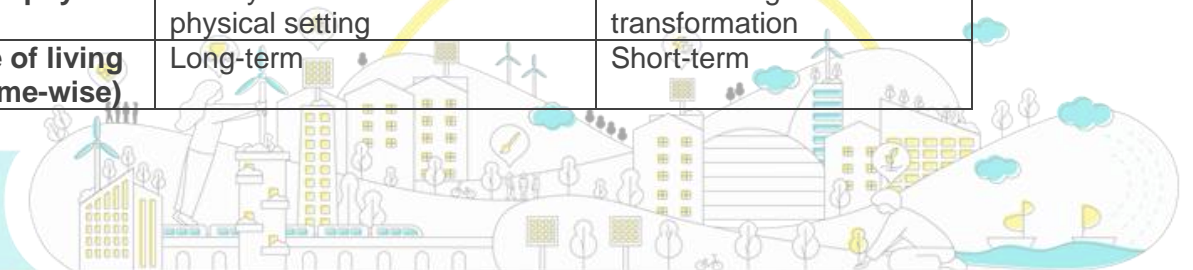
“An approach that facilitates digital transformation processes in rural areas by engaging quintuple helix actors including rural residents and natural environments throughout the digitalization of society in real-life settings.”

When it comes to the methodological contribution, the use of Peffers’s (2007) DSRM provided several advantages when designing and evaluating the Rural LL framework. It provided a systematic and structured approach for 1) identifying the problem and objectives based on theory and empirical data, 2) developing guidelines and designing the Rural LL framework, and 3) identifying criteria in the demonstration and evaluation of the framework. The iterative nature of the DSRM also enabled multiple cycles of design and evaluation that improved the framework until it reached its full potential. This methodology also provided the ability to use other methodologies, including focus groups and questionnaires for problem identification, and interviews and online workshops for demonstration and evaluation. Overall, as our results revealed, the proposed Rural LL framework highlights some key differences between urban LLs and Rural LLs, as it can be seen in table 1.

In respect to the evaluation of the proposed Rural LL framework, rural residents saw the benefit of it on an overall level. The design of the framework was perceived as extensive and unmanageable for a practitioner, however they reasoned that the framework could be divided into parts and used separately for different target groups. According to the received feedback from officials in the workshop who work with policy processes for local development, the “framework” can support the structure of the work in a policy process. In different stages of the policy process, input from target groups can be collected, from politicians' visions to the individual's needs. The participants reasoned also that the “framework” could be used by the project management for planning and follow-up of individual projects. Thus, they also pointed at practical difficulties for using the framework in a project implementation phase that has an agile approach. On the other hand, the participants perceived the framework to be very communicative and useful as a basis for disseminating results and reporting findings (considering openness as one key principle in LL activities), e.g., using it as a guide for disseminating the results of successful LL projects. The framework could also support an increased understanding of how to carry out societal processes or projects with different stakeholders.

Table 1. The Rural LL and urban LL

	Urban LL	Rural LL
Nature and Philosophy	ULL is a context, which is usually associated with a physical setting	RLL is an approach that facilitates digital transformation
Scope of living lab (time-wise)	Long-term	Short-term



Innovation development phases	Planning, exploration, co-creation, experimentation, evaluation and adoption	One or multi phases of innovation development
ICT and digital innovations (maturity level)	ICT as a supportive tools (the focus is on NBS not digital transformation) – relatively mature technology	Digital innovations and ICT infrastructure are intertwined - immature technology
Governance level	More structured. The development plan is well established based on pre-defined steps.	Flexible, Rural LL objectives are defined based on the specific case (pilot)
Actors	Quadruple helix	Quintuple helix
Living lab vision	Future: Set up and run an urban living lab as an organization in the city context	Current: Facilitate DT process in the current situation

This study also opens several directions for future research. An interesting topic for future research is to study how a Rural LL can be seen as a “model” which 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 affected by the 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 Rural LL 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 the real-life context.



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