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A roadmap to becoming a smart village - experiences from living labs in rural Bavaria

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Abstract: This paper illustrates the measures and digital integrations being made in the course of digitalization, using the example of existing rural pilot communities in Bavaria, Germany. The participating communities were selected as part of the government-funded project "Digitales Dorf" (Engl. digital village). Since 2016, digital solutions as well as complementary actions have been identified and implemented to make everyday life in the community equal to that in the city: the main intention is to push digitalization to create equivalent living conditions to urban areas. This paper is intended to provide an overview of the requirements and steps that need to be taken in digital transformation, in order to develop a generalized blueprint for other communities. Furthermore, it introduces the pilot projects, provides an insight into best practices to promote digitalization in traditional rural areas, and focuses on the transformation process rather than on digital solutions.

Keywords: Rural development, digitalization, digital transformation, bottom-up, citizens' dialogue

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1. Introduction: the need of pushing smart rural areas

This article discusses the problem of the adoption of digital technologies in rural areas in Bavaria, Germany. It is important to define the geographical scope: the level of digitalization is not equal within a country or its society, but varies in different regions, as it depends on various factors, such as geographical location and level of technical education. According to an annual study on digital society in Germany conducted by the Initiative D21, around 15% of the population still does not use the internet.[1] Further, regional diversities have been noted: metropolitans (cities with 500,000 inhabitants and more) use digital applications more frequently and competently than the rural population (up to 20,000 citizens in a community) and are more open to technological change.[2]

This attitude is not necessarily inherent, but can be attributed to different structural conditions: undoubtedly, rural areas face many challenges due to poor public and private infrastructure and consecutive funding problems, as examples show in section 2.1.2. Despite well-intended governmental support for e.g. broadband expansion[3], rural areas are still at a disadvantage, which is reflected in lower transmission speeds and poorer mobile phone coverage, particularly in border regions[4]. This makes it more difficult to implement digital innovations with higher transmission requirements, but must not lead to rural areas being disadvantaged and consequently left behind. Nevertheless, it is fact that there is a kind of prioritization for areas for implementing digitalization and technological adoption due to lacking capacities and budget. One could state that urban areas should be preferred because of their higher economic and demographic relevance. But the consequences of leaving behind rural areas are undesirable: the rapid digital transformation will open up an even wider gap as described in the study mentioned above.

The requirement for equality for rural areas is very normative and leads to further discussions. The possibility of having an equal, i.e. simultaneous and uniform adoption of any technology across a given territory should be examined. In addition, a transformation must also be supported by the respective society, the question arises if it is expected that some areas are left behind. A deeper insight to the citizen's role is given below.

Despite trends such as urbanization and rural exodus, the following conditions illustrate the significance of rural areas for Germany with its 83.2 million inhabitants[5]: rural areas represent more than 90% of Germany's territory, but are the habitat for less than 60% of its citizens.[6] In other words, more than 40% of the German population live in less than 10% of the country's territory, which illustrates the increasing overload in big cities like Munich. To compensate for that, rural areas need empowerment, which is equivalent to increasing their attractiveness, to stop rural exodus. Digitalization can play a significant role, if it is not used only in urban areas but if it also serves rural areas to meet the challenges there. Aside from "Smart Cities", society needs "Smart Villages", too.

1 cf. Initiative D21 e.V. (2019), pp. 8, 22 f., 42 f.
2 cf. Initiative D21 e.V. (2019), pp. 8, 22 f., 42 f.
3 cf. Bundesministerium für Verkehr und digitale Infrastruktur (2019).
4 cf. Bundesamt für Kartographie und Geodäsie (2016).
5 cf. Statistisches Bundesamt (2021).
6 cf. Bundesministerium für Ernährung und Landwirtschaft (2019), p. 5.

This paper aims at sharing information gained from the living labs in the project "Digitales Dorf Bayern"[7] (digital village Bavaria; the latter is a federal state in Germany) in order to support similar digitalization projects in rural areas with lessons learned. For this purpose, an overview of digitalization and rural areas including their challenges forms the theoretical basis of this paper. This is followed by a short description of the pilot project "Digitales Dorf" and a view onto a successful and sustainable digitalization transformation process in rural areas. In addition, it is shown how demand-oriented digitalization in rural areas can work in practice, and which benefits these "living labs" bring.

Digitalization in rural areas

2.1. Rural Areas in digital context

2.1.1. The term "rural area"

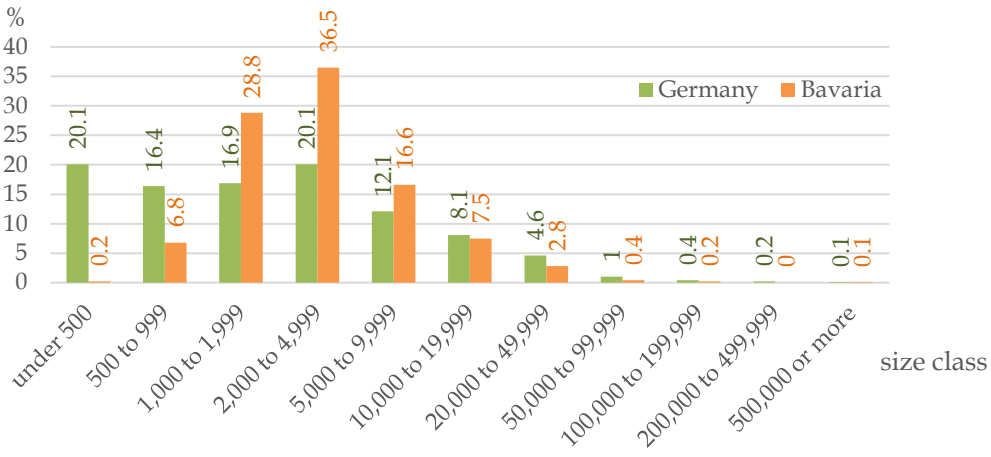
There is a lack of recent research papers regarding universal or exact definitions for rural or peripheral areas. Existing research shows numerous indicator-based approaches, some of which differ significantly.[8] Even if a common, approved definition of rural areas in politics, science and society is still missing,[9] various quantitative and qualitative criteria or characteristics apply:[10]

- village and small town settlement structure
- low building and population density
- agriculture and forestry as the economic sector shaping the townscape
- poor accessibility and inadequate infrastructure and supply facilities
- low job density with resulting negative commuter balance
- closer and more manageable interpersonal relationships
- a landscape characterized by natural and semi-natural elements.

Thresholds for the metric indicators that would clearly describe rural areas are missing. At least the above criteria allow a categorization and thus a comparison. Initiative D21, on the other hand, uses the number of inhabitants below 20,000 in a community as the criterion for "land".[11] This applies to 96% of communities in Bavaria (see Figure 1). Also, in practice, it proves difficult to create a single definition of "rural area". Instead, there are many different types of rural areas with special potentials and challenges.[12]

7 cf. Funded by Bavarian Ministry of Economic Affairs, Regional Development and Energy.
8 cf. Maier, J. (2008), p. 15.
9 cf. Maier, J. (2008), p. 15.
10 cf. Magel, H. (2007), p. 6.
11 cf. Initiative D21 e.V. (2019), p. 33.
12 cf. Wiechmann, T., & Terfrüchte, T. (2017), p. 10.

Figure 1: Distribution of communities according to size classes (communities with ... inhabitants), graph based on data of Deutscher Städtetag (2019)



2.1.2. The (digital) challenges faced by rural areas in Bavaria

The terms *digitization* and *digitalization* are often mixed up in their meaning, especially among non-native English speakers. It should be noted that there is only one German phrase for both English terms, which are well described in Gartner's glossary[13]. *Digitization* is understood as the transformation of an analog process or artefact into the digital form of zeros and ones. Looking up the term *digitalization*, Gartner (2020b) suggests the following explanation, which states that *digitization* is a subtopic of *digitalization*:

> "*Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business.*"[14]

The implementation of digital measures offers opportunities to cope with the key challenges of rural areas that we described above. Digitalization can support and enhance the citizens' accessibility to many daily life services.[15] According to a population forecast for Bavaria for 2038[16], an overall increase of 4% of the population (equal to an increase of 520,000 citizens) starting 2018 is expected, with a significantly larger increase for urban areas, where infrastructure and services are better developed.

Although the "Bayern Digital II"[17] initiative, which was started by the Bavarian government, will promote and accompany infrastructure expansion throughout Bavaria, in accordance with the related resolution, there is a lack of practical solutions in rural areas compared to most cities, which

13 cf. Gartner (2020a) in Gray, J., & Rumpe, B. (2015), p. 1,319.
14 Gartner (2020b).
15 cf. Anttiroiko, A.-V., & Valkama, P., & Bailey, S. J. (2014), p. 325.
16 cf. Bayerisches Landesamt für Statistik (2019), p. 21.
17 cf. Bayerische Staatsregierung (2017).

would make the digital and infrastructural offerings location-friendly and rural areas even more worth living in. Despite the fact that rural areas have many benefits such as a high sense of belonging, a healthy environment and lower rent or land costs[18] it still suffers from disadvantages: the lack of medical specialists[19], accessible mobility[20] and modern equipment in schools[21], for example, does not measure up to the offerings in the cities.

As a result, rural area citizens face the problem of how to travel long distances in order to use highly distributed services, which are generally difficult to manage without a car or public transport. The latter is usually limited and offers only moderately frequent timetables. The increasing number of elderly people in rural areas[22], in combination with its already aging society, are dependent on public transport services[23]. For instance, the district Freyung-Grafenau, where one of the digital villages is located, has the worst situation within Germany:[24] only 15% of the inhabitants there have sufficient access[25] to public transport. Alternatives such as car sharing or on-call buses, which could represent a demand-oriented extension to existing routes, have so far tended to be located in cities [26]. This is one reason for the economic structural weakness in rural regions and the high number of commuters[27], who often seek better earning opportunities or a job offer fitting to their qualification in cities. For local companies in rural areas, this means that skilled labor potential is lost, which further aggravates the already tense situation. In the long term, this closes the circle of migration from the countryside into the cities and their agglomerations, which constitutes the rural exodus.

The current growing generation of "digital natives" also requires increased attention to digitalization in order to prepare them pedagogically and professionally for upcoming job market changes. For this reason, the field of education is also an important element in increasing the attractiveness of the rural area. Aging primary schools in small communities, as well as suffering from outdated teaching methods and equipment, have missed connections to modern school systems[28]. There is a need for action here in order to offer students in rural regions an equivalent educational foundation to that found in most cities. However, dealing with modern media and technologies is not optimal in the digitally unequipped classrooms[29] in rural areas.

In addition, rural public authorities have to transform their public services into digital ones, as defined by the Online Access Act: the German federal government made this law called "Onlinezugangsgesetz - OZG", which seeks to create unified standards to make public city hall services

18 cf. Maier, J. (2008), p. 15.
19 cf. Bertelsmann Stiftung (2015), p. 2; Bundesinstitut für Bau-, Stadt- und Raumforschung (2016).
20 cf. Allianz pro Schiene e.V. (2019).
21 cf. Deutscher Bundestag (2018), p. 30.
22 cf. Henger, R., & Oberst, C. (2019).
23 cf. Stentzel, U., & Piegsa, J., & Fredrich, D., & Hoffmann, W., & van den Berg, N. (2016).
24 cf. Allianz pro Schiene e.V. (2019).
25 Which is defined as follows: sufficient accessibility is given if a resident lives no more than 600 meters as the bee line from the nearest bus stop or no more than 1,200 meters from the nearest railway station, each with at least 20 travel opportunities per day; cf. Allianz pro Schiene e.V. (2019).
26 cf. Böhler, S., & Wanner, M. (2015), p. 56f.
27 cf. IHK Niederbayern (2017), pp. 20, 26.
28 cf. Sailer, M., & Murböck, J., & Fischer, F. (2017), p. 12.
29 cf. Wetterich, F., & Burghart, M., & Rave, N. (2014), p. 9.

accessible digitally for citizens by the year 2022[30]. In contrast to modernized urban infrastructures, as well as better hard- and software conditions that already exist in cities, a technological modernization of the systems in rural authorities is largely necessary. Outdated computers, document-intensive processes and the lack of IT expertise[31] held by the few administrative employees, delay the processing of citizens' concerns and lead to a standstill in administration. The adjustment from conventional processes to a digital everyday life requires not only the use of new technologies, but also the learning and then the common establishment of new structures and mindsets[32].

The scope of challenges of digitalization often differs tremendously between rural, peripheral localities and urban areas. The term "digital divide" or "digital gap" refers to the fact that different access to information and communication technology causes a kind of gap between demographic regions[33]. However, one should treat this term and corresponding statement with caution: not all rural communities likewise need the same fundamental preparation in digitalization. Indeed, rural areas cannot be compared to each other since they suffer from different structural problems and they all have a different initial situation regarding their digitalization knowledge. The term "gap" should also not suggest that city residents are all digital experts in contrast to rural dwellers. Digitalization and its usage are more prevalent in cities because of better conditions such as network access and (public) infrastructure [34]. Nevertheless, there are also city residents that have no or few touch-points with digitalization, and there are simultaneously, rural citizens who are more technology-oriented. Instead of a polarization between, for example, developing and industrial countries or between cities and rural areas, one should consider the existence of a kind a continuum on both sides: it includes digital laggards, followers, evaluators, adopters and leaders,[35] that one can find both in rural and urban areas.

Nevertheless, the described issues, which mainly concern rural areas, remain to be resolved to level up struggling parts of the country to urban conditions through digitalization. Modern life revolves around digital platforms and solutions. It is not about turning villages into large busy cities, but bridging the gap is crucial for easing the challenges of rural citizens' life and creating a blueprint containing best practices for rural communities with similar difficulties.

2.2. Digitalization initiatives in rural areas

From the above, it is clear that digitalization is a challenging field. The development program of the Bavarian state government categorizes structurally weak rural areas as ones with a special need for action[36]. It aims for the reduction of existing disparities and prevention of the emergence of new ones through digitalization measures. In addition to the obvious obstacles listed in section 2.1.2, there are also barriers that are not immediately apparent in the communities; some only become

30 cf. Bundesministerium des Innern, für Bau und Heimat (2020).
31 cf. Rüchardt, B. (2015), p. 13.
32 cf. Prognos AG & Behörden Spiegel (2019), p. 16.
33 cf. Steele, C. (2019).
34 cf. Bundesamt für Kartographie und Geodäsie (2016).
35 cf. Dell Technologies (2016), p. 8.
36 cf. Bayerische Staatsregierung (2013), pp. 28-32.

evident during the initial contact of the community with the topic of digitalization. In contrast to cities, digitalization is rarely present in the everyday life of citizens. The rural aging of society means that the proportion of citizens actively participating in digital life is low. Findings by Currie and Philip (2019)[37] support these observations. The lack of an urge to try out new things, partly due to the very traditional social structure, makes the introduction of new technologies considerably more difficult in rural areas than in cities. Statistics from the IW-Report 2019[38] show that the proportion of academics in rural areas is very low, which suggests that, from a professional point of view, there is very little knowledge of modern technologies.

Various projects throughout Europe have set themselves the goal of pushing digitalization. A concluding project brochure released by the European Network for Rural Development[39] briefly introduces twelve projects that contribute to improve digital services in rural areas. When comparing their approaches it becomes apparent that the concept of digitalization in rural areas pivots around adapting digital solutions according to the requirements of the local community[40]. For instance, Belgium reconsidered the problem that citizens are not sufficiently supplied with physical mobility offers by establishing a "Village Hub" in form of a community center that provides different mobility services.[41] Beside Co-Working Spaces in Spain[42] and ambient assistant living (AAL) technologies in Sweden[43], Austria has used digitalization to highlight its strengths in the agricultural sector by providing training for farmers via webinars[44]. France uses its social strength in rural areas to establish a platform for carpools.[45] Comparing the assumptions of all these projects, it is obvious that similar fields of action, namely concerning everyday life areas, are defined to support digitalization. It turns out that pushing digitalization in rural areas means putting citizens and their issues first, testing digital technologies for their suitability, creating links throughout the community life and supporting village and community associations. If one refers to the above-mentioned project findings, or to the digital villages in Rhineland-Palatinate[46], it is suggested that digitalization as a concept is well known, but far from being practical[47]. The project "Digitales Dorf Bayern" has achieved similar results as described above. It is introduced in the following section.

37 cf. Currie, M., & Philip, L. (2019), p. 3.
38 cf. Burstedde, A., & Werner, D. (2019).
39 cf. European Network for Rural Development (2018a).
40 cf. McGlynn, D. (2018), p. 3.
41 More information available at: https://www.delovie.be/dorpspunt-in-beveren/
42 More information available at: https://www.cowocatrural.cat/
43 More information available at: http://improve.interreg-npa.eu/
44 More information available at: https://oe.lfi.at/e-learning+2500++1287229
45 More information available at: https://www.rezopouce.fr/
46 More information available at: https://www.digitale-doerfer.de
47 cf. European Network for Rural Development (2018b), p. 3f.

The project "Digitales Dorf Bayern"

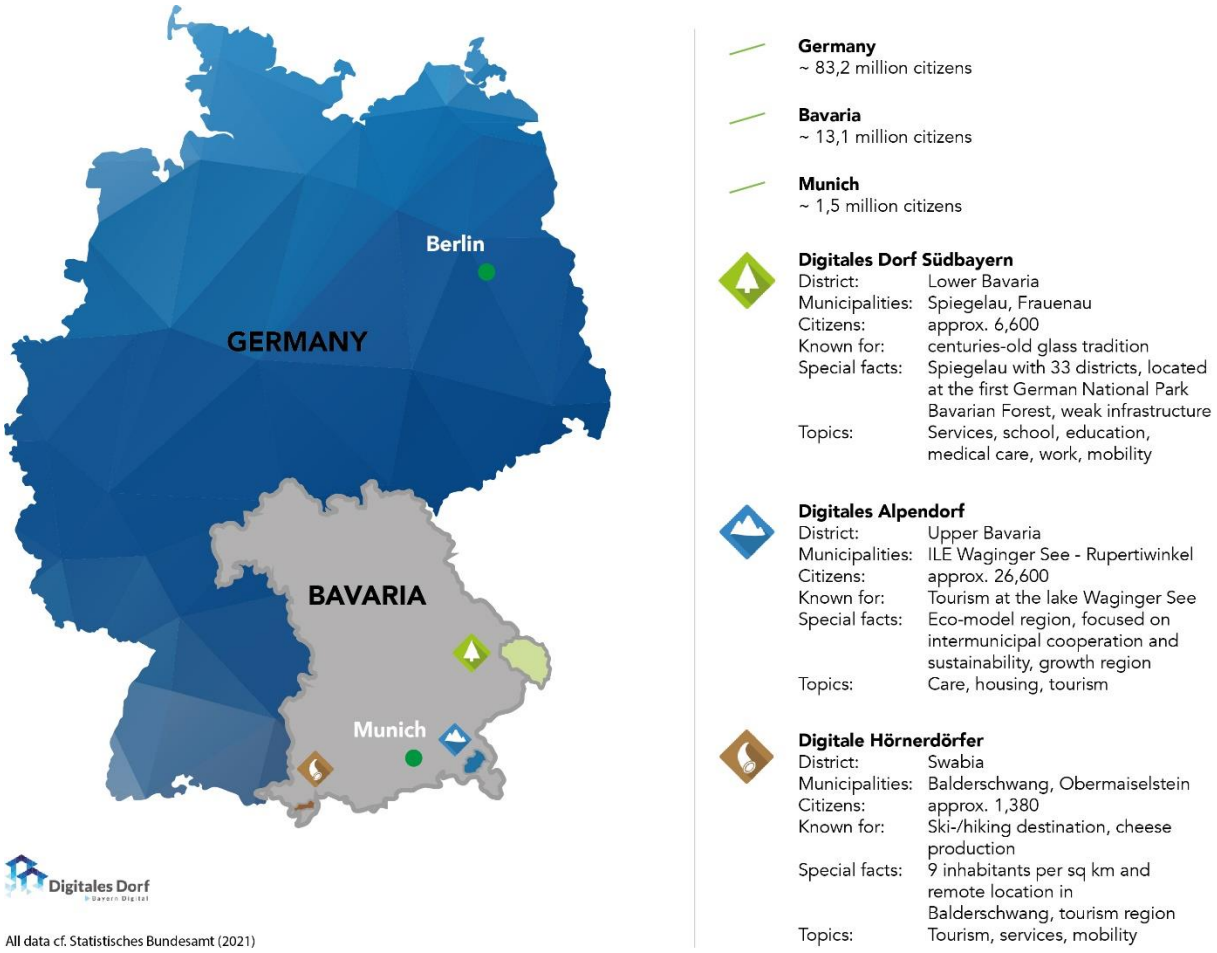
3.1. Overview: context and aim of the project "Digitales Dorf Bayern"

Under the leadership of the Bavarian State Ministry of Economic Affairs, Regional Development and Energy (StMWi), the project "Digitales Dorf Bayern" was created to deal with the consistent mastering of given problems with the help of modern communication and information technologies as the key to sustainable rural areas and social life. Appropriate future concepts and developments need to bypass the mistakes of previous approaches, which have failed to address rural conditions and specific needs directly. In contrast to urban areas, structurally weak areas are particularly in need of digital connectivity. The aim of the "Digitales Dorf Bayern" project is therefore to work together with local citizens to find adequate solutions for better community life, with transferability to other communities with little effort and without in-depth expertise.[48] The project uses, along with consideration of comparable initiatives, the digital potentials and developments of recent years as an opportunity to test new technologies and, if necessary, to use and evaluate already existing solutions in the communities, if available.

Selected scientific institutions support the pilot areas. The Deggendorf Institute of Technology (DIT) is responsible for three pilot villages respective regions in Southern Bavaria. Figure 2Figure 2 briefly characterizes these three pilot villages.

[48] cf. Bayerisches Staatsministerium für Wirtschaft, Landesentwicklung und Energie (2019).

Figure 2: Location and short description of the pilot areas mentored by Deggendorf Institute of Technology



If one considers the specific context in this work, digitalization has to be understood as kind of a digital revolution[49] caused by the implementation and increasing use of the internet, digital technologies and devices in public life, business and private everyday life. Therefore, the digital revolution has different dimensions: a social, a political, an economical, a technical and an ethical.[50] For the project "Digitales Dorf Bayern" the focus is on the social one, since research concentrates on the interaction between digital technologies and citizens with respect to their participation. In the present paper, digitalization in rural areas is therefore specified as follows:

> *Digitalization is the use of digital technologies to improve communal services of general interest and to support social interaction. Primarily it affects the social dimension in the process of implementing and using digital technologies and services, and learning how to deal with it. Its aim is to improve social interaction and everyday life for citizens in challenging rural areas.*

Indeed, rural areas cannot be likened to each other since they suffer from different structural problems and they all have a different initial situation regarding their digitalization knowledge.

49 cf. Deutscher Bundestag (2018), p. 3.
50 cf. Kollmann, T., & Schmidt, H. (2016), p. 154.

3.2. The two keystones of the living labs

Two aspects illustrate the successful approach in the project "Digitales Dorf Bayern": the holistic approach and the *living lab*-approach.

Holistic in this context refers to finding digital solutions for all areas or spheres of life. This is important because real and sustainable benefit for the citizens is only created if the developed solutions are connected. For example, it is not enough for sensors in an apartment to report that a lone senior citizen has fallen; only the triggering of the rescue chain, e.g. by neighborhood assistance, will bring relief: the acute warning system will inform a neighbor, for instance via his or her smartphone, about the senior citizen's possible need for assistance. Therefore, during the setup of the project by government, the consideration of which everyday life topics to focus on was discussed. Being aware of the potential for generating added value through linking the spheres of life, various fields of action were examined for the potential to catch up and for digitalization options, to achieve improvements for citizens in rural areas. **Error! Reference source not found.**Figure 3 shows the selected spheres of life in the project "Digitales Dorf Bayern", all digitalization activities in the pilot villages and their state of development.

The example above also shows that digitalization alone cannot solve all problems: analogue togetherness is still essential for a healthy, functioning society. On the other hand, there are often orphaned town centers, as stationary retail cannot stand up to online traders such as Amazon. The project's vision is to use this vacancy to establish analogue "community centers" with the aim of linking the digital and the real. The overall objective of an analogue community center and the associated implementation of digital measures is to increase the attractiveness of rural areas by reactivating infrastructure, networking with public institutions (e.g. public transport) and expanding care facilities for children and relatives requiring care. Further, all developed solutions are now easily and digitally accessible with one account for the citizens via the so-called Dahoam 4.0® platform, distributed as a web-application and several mobile apps.

Figure 3: Defined topics aka spheres of life in the living labs, source: own illustration

To solve the problem of developing either over abstract or ill-fitting existing solutions, which would lack acceptance, this project strives to develop solutions according to the citizens' needs. Therefore, the pilot villages operate as so-called, *living labs*, which means that development, implementation and testing takes place within the pilot communities, i.e. in real life. This is done through the bottom-up approach, in which concepts are developed and mutually created in direct dialogue with the citizens: a methodology which is known as co-creation[51]. This is important, because many digital innovations suffer from significant problems, if they are oriented exclusively to the technical possibilities. These resulting solutions are often unusable for the average "Joe Sixpack", or do not (yet) contribute to an improvement of the basic challenges in rural areas. Microsoft HoloLens serves as an example. The mixed-reality head-mounted display projects 3D objects into the wearer's field of vision.[52] Though, in the current version, it is not yet suitable for everyday use due to the additional, unhandy hardware. Further, the new mobile phone standard 5G could also raise false expectations. Since the standard was introduced, mobile phone providers like Telekom advertised all their mobile phone tariffs including 5G. However, this technology can only be used with newest 5G-enabled devices and, according to information given by the provider, it was only available in eight major cities within Germany[53] to that time (and then in some cases not area-wide, but only along certain

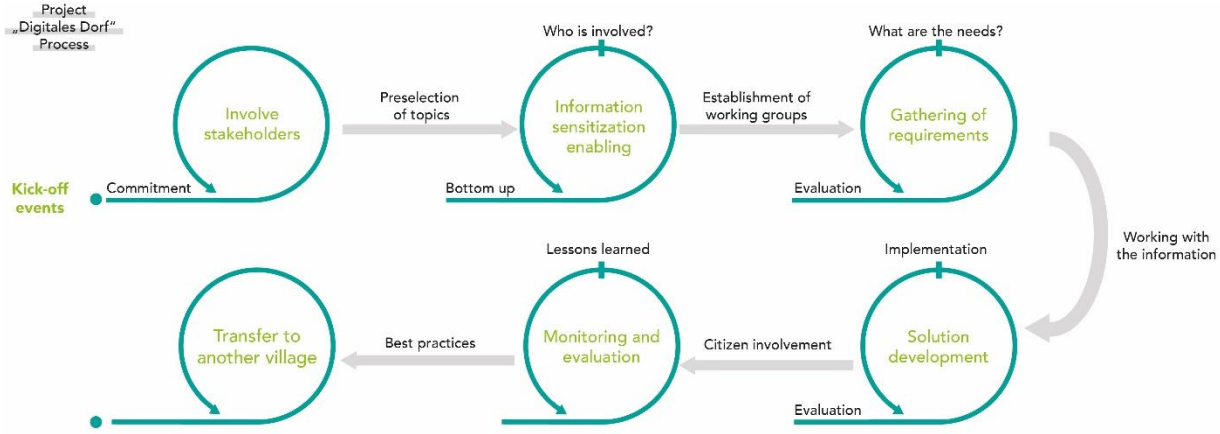
51 cf. Bhalla (2010), p. 20 ff.
52 More information available at: https://www.microsoft.com/en-us/hololens
53 cf. Telekom Deutschland GmbH (2020a).

roads[54]). The living lab approach that we propose identifies a way to solve the problems stated above. Therefore, the following section emphasizes the *living lab*-approach when explaining the project's roadmap.

3.3. Approaches and findings out of the living lab "Digitales Dorf Bayern"

In the following, the process steps for developing and implementing digitalization measures presented in Figure 4 will be described on the basis of the experiences from the three pilot villages. Positive evaluated methods and lessons learned are equally reflected. One should distinguish between two roadmaps, the "microeconomic" one, how the projects are successfully and sustainably implemented within a pilot village, and the "macroeconomic" one, which aims to transfer the living lab tests and results. In this work we focus on the latter.

Figure 4: Digitalization process in the living lab "Digitales Dorf Bayern"



Involved Stakeholders

All pilot villages provide a so-called core team, which ideally works together for the entire duration of the project. The core team is comprised of the following stakeholders:

- Mayor of the community: supervises and takes care of the final project decisions
- Scientific advisors (in this case the Deggendorf Institute of Technology): monitoring by the scientific advisor turned out to be an advantage for the project regarding the guarantee of professional input concerning digital innovations, advice and overall help with hard- and software implementation. The advisor can initiate the formation of topic-specific working groups and moderate their meetings.
- On-the-spot caretaker: represents the interface between the local citizens and the scientific team. Ideally, he or she is already known and recognized in the region before the project begins. He or she is familiar with the specific conditions in the pilot village, can coordinate on site at short notice and supports the core team with organizational skills. It is his or her

54 cf. Telekom Deutschland GmbH (2020b).

task to communicate the matters of the project to the citizens and to always have an open ear for ideas, criticism and reservations. Due to on-site networking, he or she can involve other people if necessary, whom will ensure the progress and success of the project.

Information, sensitization and enabling

To raise awareness of the project and to generate motivation it is important to have an official "kick-off". In the pilot villages (see Figure 2) in Spiegelau-Frauenau and in Hörnerdörfer, this was achieved by a publicity-creating presentation of the funding notice in the presence of ministers of state. These events attract public attention and illustrate the importance of the topic with the presence of political celebrities. In the "Digitales Alpendorf", citizen dialogue showed that the inhabitants there had less knowledge about the project. On the one hand, this is due to the higher number of residents (which requires more intense public relations work). On the other hand, there was no official or politically powerful starting signal. An official kick-off is also important because it means that all those present make a commitment: common approval of the forthcoming project and the willingness to meet the challenges.

After the kick-off, the working groups were formed on the basis of the previously defined fields of action. Their task was to identify the respective challenges in the region and to develop measures with the support of the scientific team. It was important to give all interested citizens the chance to co-create within a working group and to inform them about suitable technological possibilities in order to spin ideas and to develop a concept with the other stakeholders. This again requires public relations work: flyers and posters in shops fulfilling daily needs and public institutions inform publicise evenings organized by the core team. The aim of this stage was to inform about the "Digitales Dorf" project and to recruit working group members.

This step needed several repetitions to raise citizens' awareness of the use of digital media by sensitizing them with implemented prototypes and services. This led to continuous training and encountering with digitalization and made those involved internalize the topic.

Gathering of requirements

One of the most important lessons learned from the project work to date is that the development of measures should not be based on technical possibilities, but rather on the region-specific challenges. This is shown by the following example: at the working group meeting for the living area "services" in the pilot village Frauenau, a building yard employee stated a problem with the wooden boards used for official announcements and event information regarding the increasingly more difficult removal of the rusty staples. Bavarian communities are required by law to maintain a notice board in every district and to publish notices there for 14 days.

Fortunately, this concern was not simply dismissed, but taken seriously. A digital and sustainable solution to this problem was developed. The idea of digital billboards was born, which would replace the wooden boards. It soon became apparent that this alternative would have several advantages: the communal employee can display the latest information and announcements on all the billboards with few mouse clicks. The citizens are well-informed and can interactively participate.

Another plus is that the building yard employees do not have to get annoyed with stuck staples or repairing the boards any more.

This example illustrates two findings: instead of high-flying developments, low-threshold solutions are required for the success of such projects. They can be implemented quickly, are visible to citizens and associated with immediate benefits. In addition, this illustrates how the gathering of requirements should be addressed. In the application phase, the communities had to outline project ideas. When municipalities and their citizens are asked what they would like to achieve in terms of digitalization, it often appears that there are no concrete ideas and therefore no useful (i.e. realizable) output: there is usually a lack of understanding of the technical possibilities that can be implemented within a municipality given the existing conditions. The popular knowledge that one can only get well by attending to where it hurts, can be seen here: if one starts from specific challenges and problems, solutions that offer real benefit are created. This is why the actively moderated bottom-up approach is so essential: it guarantees that the people who are most affected by the challenges are involved in the generation of ideas and therefore benefit directly from the solutions. This has positive impact on acceptance and usage of the solutions later on. In other spheres of life, such as education, it was helpful to perform surveys, as different user groups with specific views of a digital platform come together (students, parents and teachers).

Solution development with citizen involvement: co-creation

After idea-development comes implementation, which must meet various requirements. One must not be discouraged by any obstacles that may arise during this phase of co-creation: sometimes it is necessary to fight against headwinds. This can happen within the working group or arise from outside (suppliers, funding agencies, other parties concerned), as the following example of the digital billboards in the "Digitales Dorf" Frauenau shows.

The working group agreed to replace the wooden boards and display cases for the paper posters with digital devices. It was found that supposedly small digital innovations can also represent a novelty. Frauenau is thus taking a pioneering role, as a previous inquiry at the responsible district administration office showed. Initially, there were doubts about the legality of this plan which was why the inquiry was passed on to the State Ministry of the Interior in Munich. There, the legislator initially declared the idea unworkable: in the event of a power failure or (willful) damage of the screens, the communal posting obligation could no longer be fulfilled.

However, after being asked again for a detailed examination, the official bodies granted the approval (under certain conditions regarding visibility, readability and availability of the official news). With the installation of the digital "bulletin boards", Frauenau took another step towards a digital future. A total of five of these display walls, distributed throughout the entire communal area, were renewed. In the future, citizens and tourists will receive information in digital form and hence in a contemporary and attractive way.

Returning to the development of solutions, it is important to meet various requirements. All options are developed according to the following criteria:

- the use of already proven existing solutions takes priority over in-house programming

- building upon existing structures: ideally, a solution builds upon already existing systems to avoid parallel systems or isolated applications that need to be maintained separately
- easy-to-use for users: 1) development and programming are carried out according to determined requirements, not technical possibilities. 2) design follows function
- low-cost transferability to other communalities: the purpose of testing the measures in the pilot regions is not to implement specific solutions for unique problems. Ideally, it should be possible to transfer the solutions to many other rural areas with similar situations.
- cost-efficient respective with low time required.

Monitoring & evaluation

The meaning of monitoring and evaluation should be particularly emphasized as it is often neglected. The reason for this is that it is often seen as bothersome, time-consuming (during that time one could develop a new solution, for example) and perhaps even delivers an undesirable outcome (if results say that people do not use the solution or it does not show the hoped-for results like time or cost-savings).

Monitoring and evaluation can assume different proportions. The usage of the digital billboards can easily be reviewed by analytics systems. However, if one wants to learn about detailed cost- and time-savings, more effort is necessary. In the pilot region Hörnerdörfer there is a development of an application that helps foreign tourism employees to register their residence in Germany. The former process was very complicated: people who wanted to register had to do a lot of paperwork with two involved agencies and struggled with complicated German terminologies. In future, the process will be available digitally with a tablet computer, and people will be able to choose their native language. Furthermore, staff in the registration office will benefit from proper and completed forms in a digital format. To find out if administration staff save time because they do not need to follow up, one must track time spent for handling every single registration file. This requires documentation, both before and after introducing the new digital process. Results will be reliant on the affected staff's cooperation for documentation.

It is not just the developed solution itself that needs monitoring and evaluation. The scientific team at DIT started to record steps and techniques of software development in order to make it easier to reproduce these when changes and further developments are required. This is also important in case of changes of employees or third-part companies taking over such work.

Learning from mistakes is one of the best options for further development and getting better. To gain from these benefits in the long term it is necessary to record also these issues as lessons learned.

3.4. Overview of the learning effects

The periods of the project, described above are crucial to a long-term successful digitalization project. As trivial as it might sound, underestimating the significance of these easy steps might doom the project to failure. For instance, the project "Digital India" has failed due to the poor infrastructure

and connectivity problems that have simply been overlooked and not addressed to the full.[55] Furthermore, the aggravating circumstance that citizens had not been sufficiently included in the process might have steered the project in the wrong direction.

Undertaking a digitalization project that strongly influences the social and everyday life in rural areas needs to involve affected people. Interdisciplinary stakeholders with different backgrounds in sectors such as informatics, socio-economics and local citizens prove to be valuable for a holistic project team. The caretaker on the spot turns out to be a key contributor to the projects' success.

The ability to identify root problems in local peoples' daily lives and discussing them continuously simplifies the identification of requirements. The research shows that public participation in the form of working groups tend to pave the way to an open dialogue around the topic. At this point, it is helpful to use creative minds that go through existing processes with those responsible and provide ideas. It turns out that there are usually lateral thinkers in most communities who can expand and support these ideas, as the idea generation of the digital billboards in Frauenau shows.

To this point, solutions created within living labs have been tailored to citizens' needs. It is important to keep residents informed about developments to ensure that problems, misunderstandings or worries by the citizens are settled in an early stage. There will always be critical opinions of people who are scared and / or avoid topics of digitalization. In addition, there is often a lack of awareness of improvements and modernization. Simple explanations can usually solve that. Here, the technologies and solutions should be introduced and promoted by adequate communication channels according to target groups. This includes the use of material in digital and (even if it seems obsolete in modern times) analogue form.

If software solutions are not yet available and so have to be developed, particular attention should be paid to use systems that provide good interfaces in order to produce holistic applications. The minimum principle also applies to the development of associated user interfaces: less and simple is often more. Citizens should be able to access their information quickly with just a few clicks. Therefore, complicated user interfaces should be avoided: low-threshold solutions are required. In addition, the solutions should be easy to maintain and be able to operate without knowledge in software development for the communities.

Nevertheless, established techniques need background support, e.g. regarding the update of the frameworks or because of changed technological requirements such as software updates and security issues. To appoint a responsible person in the community is recommended, in order to deal with this issue, which is sometimes a problem in small municipalities due to low staff numbers. This issue has been notified to the funding authority, stressing the need for change from a temporary project funding to permanent (infra)structure sponsorship. Since digitalization can still cause a number of challenges, work should be continuously carried out in the form of further funding projects or initiatives to develop the overall digital competence of rural areas. Only through continuous work and improvement of processes can a long-term digital future reduce the digital divide between town and country.

[55] Indian National Congress (2017).

The applied concept has proved its worth in many ways: the usage of the developed software and established services meet with very positive responses. Implemented and already available applications such as the "Dahoam 4.0 - Rathaus" app in Frauenau has been able to acquire 366 users within ten months (relative to ~2,700 citizens). Also the distributed "Dahoam 4.0 - Schule" app currently has 226 active users (teachers and parents) operating within two elementary schools (with ~240 students and 13 full-time teachers in both schools).[56]

Summary

This paper is about digitalization in rural areas. We emphasized that digitalization is not only about robotics and artificial intelligence, but in the context of everyday life and conquering infrastructural challenges especially in rural areas, it is about the people: about citizens that are affected by specific challenges and, as a consequence, the resulting digitalization measures. Living lab results show that interaction with cititzens throughout the entire process is crucial to a successful implementation. Mayors are mostly unaware of the meaning of citizens' dialogue and therefore appreciate the project's strategy. To generate ideas, one should look for challenges the area and its inhabitants face, not for their "digitalization wishes". It's very important to consider the individual digitalization level which differs between urban and rural areas, and inside these groups, too. Not only people, but also rural areas are individual in as far as that the latter have all their special initial situation, challenges and needs.

Government should support rural areas not only with a workforce, but also with sufficient infrastructure (e.g. broadband rollout, mobile phone network) and funding not only to create the basic requirements for digitalization, but also to develop digitalization measures and then to maintain them. To gain real benefit for citizens, one should strive to connect them across various spheres of life and with analogue infrastructure.

This research field offers possibilities for more in-depth examinations. A more precise analysis of the stakeholders, their expectations, their identification of the needs and knowledge held by each actor would provide data for a social analysis of the problems that digitalization in rural areas bring along. As this is very extensive it requires further research that deals more intensively with the subject matter.

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