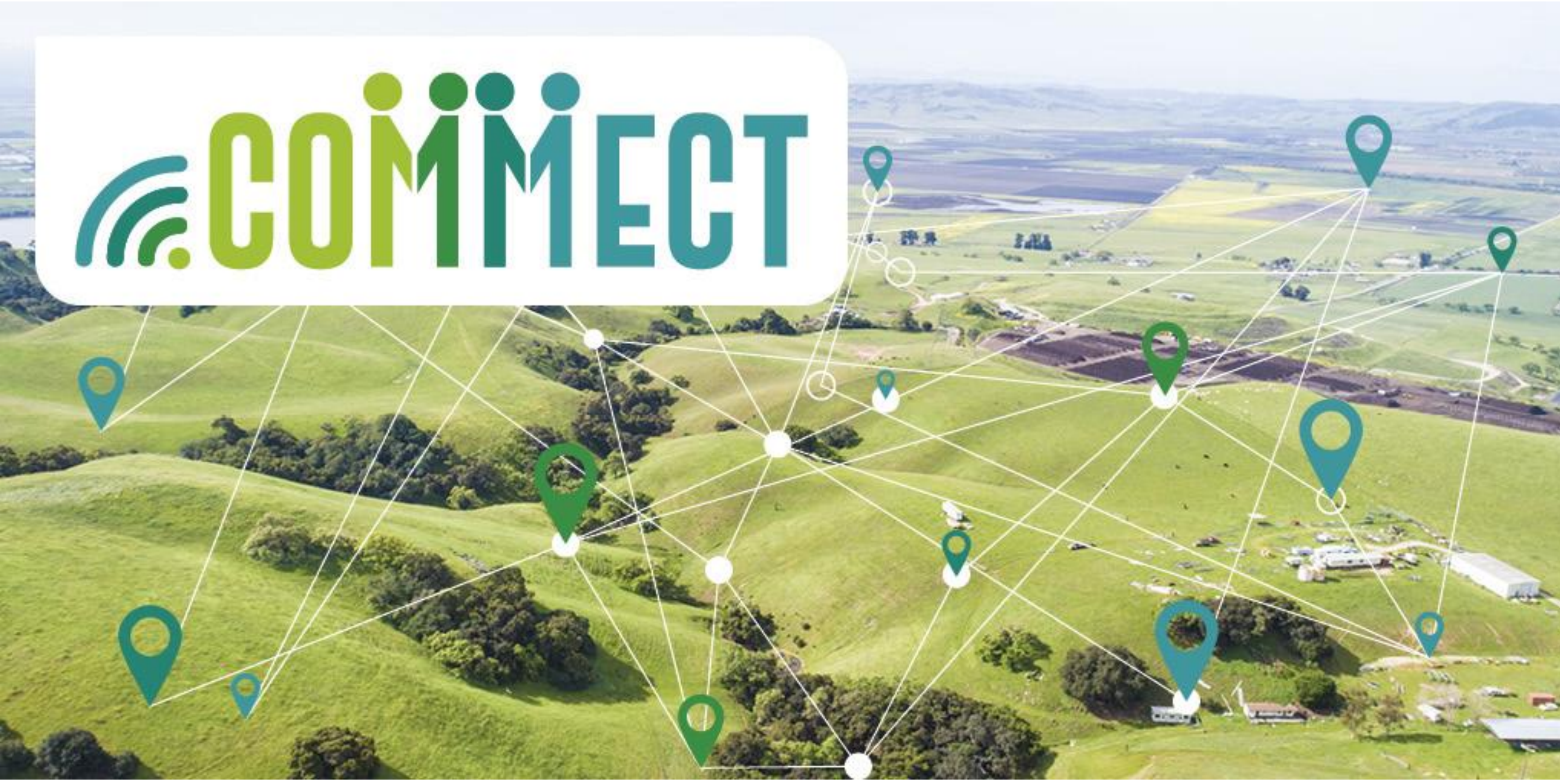
Bridging the digital divide and addressing the need of Rural Communities with Cost-effective and Environmental-Friendly Connectivity Solutions



Deliverable 3.2
COMMECT Reference Business Models

30.11.2023

PUBLIC

This project has received funding from the European Union's Horizon Europe Research and Innovation Programme under grant agreement no. 101060881.

COMMECT

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COMMECT Reference Business Models

WP3 Impact Assessment Framework and Business Models

Deliverable ID	**D3.2**
Deliverable Name	**COMMECT Reference Business Models version 1**
Lead Partner	TNO
Contributors	TNOR, LIST, INN, KI

PUBLIC

COMMECT Project Abstract

Over the last years, the importance and need for broadband and high-speed connectivity has constantly increased. The Covid-19 pandemic has even accelerated this process towards a more connected society. But this holds mainly true for urban communities. In Europe a 13% lack access persists, and mainly concerns the most rural and remote areas. Those are the most challenging to address since they are the least commercially attractive. COMMECT aims at **bridging the digital divide**, by providing quality, reliable, and secure access for all in rural and remote areas. The **goal of extending broadband connectivity in rural and remote areas** will be achieved by *integrating Non-Terrestrial Networks with terrestrial cellular XG networks, and low-cost Internet of Things (IoT). Artificial Intelligence, Edge and Network Automation will reduce energy consumption both at connectivity and computing level.*

Participatory approach with end-users and ICT experts working together on development challenges will be the key **for the digitalization of the sector**. To ensure the rich exchange of best-practice and technical knowledge among the actors of the agricultural, horticultural and-forestry value chain, COMMECT will set up **five Living Labs across and outside Europe**, *where end-users "pain" and (connectivity) "gains" will be largely discussed, from different perspectives.*

COMMECT aims at contributing to a balanced territorial development of the EU's rural areas and their communities by making smart agriculture and forest service's accessible to all. COMMECT will facilitate that, by developing a **decision-making support tool** able to advise on the best connectivity solution, according to technical, socio-economic, and environmental considerations. This tool, incorporating collaborative business models, will be a *key enabler for jobs, business, and investment in rural areas, as well as for improving the quality of life in areas such as healthcare, education, e-government, among others.*

Document Information

Document Name	COMMECT Reference Business Models
Version No.	0.5
Due Date Annex I	30-11-2023
Report Date	30-11-2023
Number of pages	36
Lead Authors	Rick Gilsing, Tamara Oukes, Virág Szijjártó, Andrea Kerstens (TNO)
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Dissemination Level	PU

Document History

Version	Date	Description	Authors	Reviewed by
0.1	01-09-2023	General outline	Same as above	-
0.2	08-11-2023	Initial draft completed	Same as above	-
0.3	17-11-2023	Review comments added	Same as above	Nis Valentin, Sofia Davidson (KI), Bard Tronvoll (INN)
0.4	29-11-2023	Updated draft based on feedback received	Same as above	Tamara Oukes (TNO)
0.5	30-11-2023	Final version	Same as above	Maria Rita Palattella (LIST)

Document Approval

Version	Name	Role in the Project	Beneficiary	Date
0.4	Maria Rita Palattella	Coordinator	LIST	29/11/2023

Executive Summary

In this deliverable, we describe the approach we follow to support the design of business models for connectivity solutions in rural areas. It is part of Task T3.3 on the design of business models for the Living Labs in COMMECT. In addition, we present an initial version of *a reference framework for connectivity business models in rural areas* that can be used to support the realization of connectivity (also referred to as digital) solutions in practice towards creating socio-economic and environmental impact.

The reference framework describes generic configurations or options of stakeholders, end-users, and activities and resources involved in the deployment and use of connectivity solutions in rural contexts. The framework explicates what connectivity solutions may be considered, as well as the values that end-users or providers can focus on. As a result, the reference framework can be used as a starting point for selecting between connectivity solutions to consider, depending on the characteristics of the respective use case in the Living Lab, and the goals and objectives that stakeholders intend to achieve.

We developed the reference framework through two information sources. First, we conducted a literature review on connectivity- or digitally-enabled business models. Through this review, we identified generic configurations and options in terms of investment and payment structures as well as stakeholders and roles to be involved in supporting connectivity solutions in practice. It also unveiled important barriers and challenges to consider when realizing connectivity solutions in practice, which are offered as guidance for using the reference framework.

Second, we interacted (and will interact) with the Living Lab to support the design of business models for connectivity solutions in rural areas for their respective contexts. To do so, we organized three interactions with the Living Labs. First, we conducted interviews with Living Lab stakeholders to elicit their understanding of the goals and objectives for the proposed connectivity solutions and the needs of potential end-users. This helps us to better understand what each LL is trying to realize in terms of connectivity and helps shed light on the solutions at play and the intended use cases.

Next, we organized (and are organizing) working sessions with the Living Labs to delve deeper into how the use cases will be supported through connectivity solutions. This will help us to understand what value is created, how the connectivity solutions will be realized in practice (and by whom) and investigate how the connectivity solutions will be financed. For example, we observe that for the Turkish LL, the role of the (local) government will be key in fostering the deployment of the connectivity solutions in practice. They can support the investments needed for these solutions and are interested in supporting olive tree farmers to support the economic performance and attractiveness of the area. Conversely, for the Danish Living Lab, the truck companies will likely make investments for the deployment of connectivity solutions as these will enable them to optimize their business processes and provide an improved service proposition to their own customers (i.e., to be able to track the condition of piglets when transported).

This information will feed into the final set of working sessions which will focus on the business model design for the Living Labs. Through the application of the reference framework, we intend to guide this activity but also collect learnings to further improve the reference framework.

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Abbreviations

AI	Artificial Intelligence
BM	Business Model
ICT	Information and Communication Technology
IoT	Internet of Things
IT	Information Technology
LL	Living Lab
OEM	Original Equipment Manufacturer
TCELL	TurkCell (company)
UC	Use Case
WP	Work Package

1. Introduction

Over the past two decades, digitalization (i.e., the proliferation and exploitation of digital opportunities in society) has significantly affected how we structure and conduct our day-to-day activities. It opened opportunities for businesses to strive for great efficiency and effectiveness and enable entirely new value propositions and business models (Rachinger et al., 2019). Ubiquitous, digital connectivity has given rise to new (digital) service or product propositions that can create value for consumers in accomplishing tasks related to their job or daily activities. For example, *Internet of Things* (IoT) solutions can help households in connecting appliances to create a seamless user experience (e.g., interconnecting music and TV appliances). Similarly, IoT solutions can help households in better managing energy consumption through collecting and aggregating data generated through sensors at different household appliances (such as washing machines, TVs or lamps).

Digital service propositions are enabled by connectivity solutions such as Wi-Fi or 4G networks. As connectivity can contribute towards more sustainable use of energy resources, it can help users to achieve sustainable impact (Ahmed et al., 2021). Alternatively, digital connectivity has enabled or fostered the formation of communities which can help end-users feel connected and contribute to their overall well-being. Access to the internet enables users to access platforms such as Twitter, Facebook or Google to connect to other users and to share and create information, demonstrating the value of connectivity for our society.

Although connectivity is prevalent in urban settings (given its density in terms of businesses and potential end-users), access to connectivity solutions is far less common in rural areas (Salemink et al., 2017). Although governmental and market effort in Western societies has increasingly been geared towards advancing connectivity in rural areas, it is still often considered as immature and not contributing to bridging the digital divide (Kilpeläinen & Seppänen, 2014). Limited connectivity in rural areas can stem from an apparent lack of service or connectivity providers (as there is limited market to compete for or a lack of a business case), difficulties in accessing vital infrastructure such as energy grids, and geographical and topological challenges which require more catered solutions in terms of connectivity (Salemink et al., 2017).

Here, a community level perspective on how connectivity can elevate the (rural) area and bring societal and environmental benefits is worthwhile. This can accelerate the penetration of connectivity in such areas as well as to support the develop of business models / business cases to support their deployment (Salemink et al., 2017). It calls for customized solutions (in contrast to generic solutions applicable to urban settings) which consider the characteristics of the area to realize connectivity access in these environments. It also calls for guidance on how business models can be shaped from a community perspective to create value for all stakeholders involved. More so, this calls for a deeper understanding of the drivers, incentives and barriers that are relevant to consider for these stakeholders to support the deployment of connectivity solutions: " *Why are stakeholders (not) interested in making investments for connectivity? How can we create incentives or remove barriers to facilitate this? Besides a focal industry or sector under consideration, what other sectors may be able to benefit from access to connectivity, and how can they support the subsequent deployment and realisation of these solutions in practice?"*

To provide guidance on the design of business models to support the deployment of connectivity solutions in rural contexts, this deliverable presents a *reference framework for connectivity business models* that can be used as a starting point for concrete business model design. This reference framework can be considered as a template which describes general stakeholder roles, end-users, activities and resources, and value creation and capture mechanisms that can be used for the deployment of connectivity solutions. It therefore captures the *options* available to users to support the use of connectivity solutions in practice. Accordingly, the reference framework can help users better understand how a connectivity solution can be realized for their respective LL setting and what stakeholders and end-users should be considered in doing so. Alternatively, it can inspire users to identify different business model configurations to solve challenges or address barriers regarding the deployment of connectivity solutions.

This deliverable is the first iterationof D3.2, presenting an *initial version of the reference framework*. We intend to validate this reference framework as part of work carried in collaboration with the COMMECT Living Labs, in WP5, using it as a basis for the development of concrete business models supporting them in practice. Through the interactions with the Living Labs, we intend to collect feedback on the validity and usability of the reference framework in practice. This feedback will be used to further improve upon the reference framework proposed (which results in the *final version of the reference framework for connectivity business models*). This will be described in the second version of the deliverable D3.4, due at month 30.

The resulting business models generated subsequently can serve as further inspiration or guidance to practitioners on how the pursuit of connectivity solutions in rural areas can be tackled through new business models. Therefore, the business models designed through the Living Labs (in addition to the reference framework) serve to complement the work conducted in this deliverable.

The remainder of this deliverable is structured as follows:

- **Chapter 2** describes the research methodology employed to support the development of the reference business model. It describes the sources of information used and working sessions and meetings planned with Living Labs to ideate, iteratively develop and evaluate the reference business models.
- **Chapter 3** describes the literature background of our work, which is the result of a literature review on connectivity-enabled or digitally-enabled business models. It offers important considerations in terms of stakeholders, value creation and capture mechanisms and challenges to consider when deploying digital solutions.
- **Chapter 4** describes the initial version of the reference framework to support the deployment of connectivity solutions in rural areas. It describes what options are available to stakeholders wishing to realize connectivity in rural areas, and how users should navigate the set of options available.
- **Chapter 5** provides initial results generated from working session one with the Living Labs. These results help to support business model development for connectivity solutions per Living Lab.
- **Chapter 6** concludes this deliverable and lists the next steps as part of COMMECT in terms of business modelling.

2. Research methodology

In this section, we detail the research methodology followed to develop *the reference framework for connectivity business models* in COMMECT. Specifically, we delineate the search strategy followed in our literature review and present descriptives on and preliminary results generated by the interviews and working sessions held with Living Lab participants.

2.1. Overview of research methodology

Our research methodology is illustrated in Figure 1. We develop our reference framework and the business models based on two information sources:

1. Findings from relevant literature on connectivity-enabled or digitally-enabled business models (desk research)
2. Interactions and learnings with the Living Labs for COMMECT (interactions with LLs)

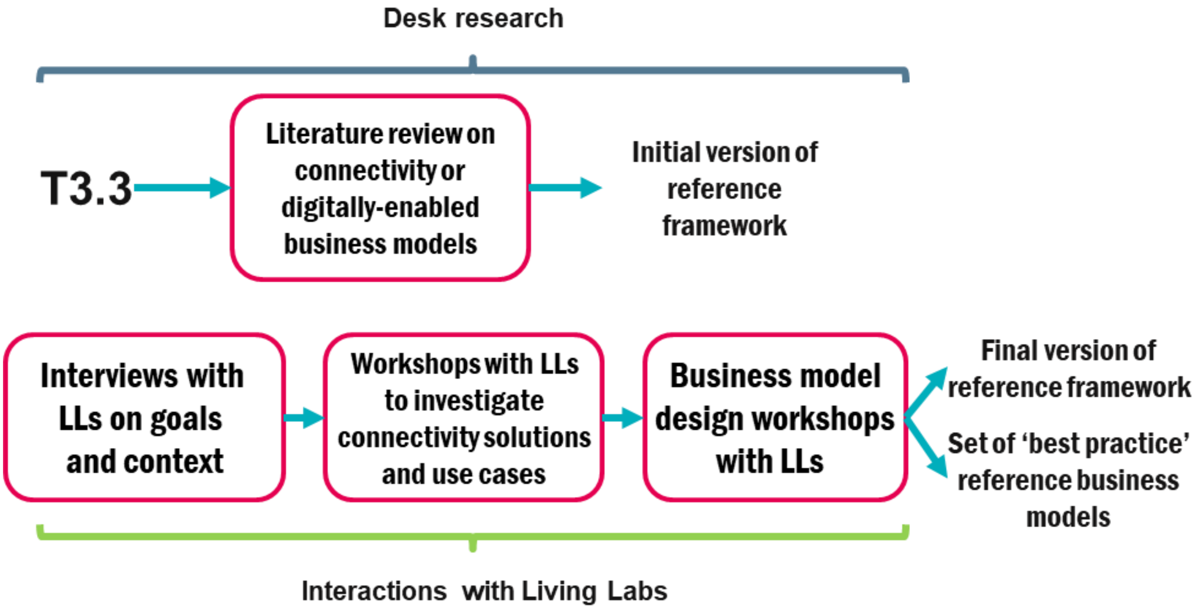

Figure 1: Research methodology followed to develop reference business models for COMMECT.

The reference framework describes the generic stakeholder roles, activities and resources, and value creation and capture mechanisms to consider. Figure 1 shows that this deliverable documents the *initial version of the reference framework*, which is subject to formal evaluation and improved upon throughout the COMMECT project. The usefulness and ease-of-use of the framework will be validated as part of WP4 and WP5 (implementation and validation in the Living Lab), where we apply the reference framework to develop concrete business models for the Living Labs.

We expect the Living Labs to build upon the options and insights offered through the framework to concretize their respective business models and realize their connectivity solutions in rural areas. In this process, we will collect feedback on the positive and negative aspects of using the reference framework and use these learnings to improve the reference framework. For example, new options or categories may be added (i.e., additional stakeholders, different types of values or different investment structures to consider) or unclarities between category options will be addressed (i.e., stakeholder options referring to the same stakeholder, not helping the selection between these options). Ultimately, this should result in the *final version of the reference framework*, accompanied by *reference business models* generated through application of the framework in the Living Labs. These will be disseminated as part of final activities for COMMECT. In the following, we detail each of the indicated information sources.

2.1.1. Literature search on connectivity-enabled business models

To support the development of the reference framework (accompanied by the reference business models), we build upon existing literature on digitally-enabled business models. We identified state-of-the-art articles on how such business models are configured, what type of stakeholders are included and what challenges are faced for the deployment of connectivity solutions. These insights served as the foundation for developing the reference framework, identifying different variants that can be applied, providing 'categories' and 'options' to users to consider when ideating new business models for their respective Living Lab or -use cases setting. Our research question for our literature search was as follows:

"What can we learn from the state-of-the-art literature on digitally-enabled business models about how such business models should be configured to support the deployment of digital solutions in practice?"

To structure our literature search, we used the following search strings:

'ICT AND business models' OR 'connectivity AND business models' OR 'digitally-enabled business models'.

As the terms ICT, connectivity and digitally-enabled are often used interchangeably, we include these terms as part of our search string, focusing on articles which consider both connectivity solutions as well as business models as part of their research focus. We leveraged academic libraries such as Google Scholar, ScienceDirect and Scopus to support our search efforts. Two researchers were involved for this literature search, comparing identified articles.

Through this search string, we were able to identify research articles that discuss the deployment of connectivity solutions as well as their interrelationship with business models (addressing the design and analysis of business models to support the deployment of such solutions in practice). We complemented this body of knowledge with literature on collaborative business models to offer a collaborative perspective on such models.

Through this literature search (further detailed in Chapter 3), we identified the following categories to consider, building upon characteristics of business models, collaborative business models and connectivity-enabled business models:

- Type of stakeholders: Literature on business models and connectivity-enabled business models
- Type of solution: Literature on connectivity-enabled business models and WP2
- Purpose of solution: Literature on connectivity-enabled business models and WP2
- Access to solution: Literature on connectivity-enabled business models and WP2
- Investment structure: Literature on collaborative business models
- Type of value end-user: Literature on business models, connectivity-enabled business models and collaborative business models
- Means of value capture by providers: Literature on business models, connectivity-enabled business models and collaborative business models

2.1.2. Interviews with Living Lab stakeholders for COMMECT

To work towards the validation of the reference framework and develop the reference business models (using the framework) based on the Living Labs, we organized (will organize) interviews and working sessions with Living Lab stakeholders of COMMECT to learn from real-life, practical settings. We used these learnings to improve the initial version of the reference framework and develop (reference) business models based on real-world examples of rural connectivity solution deployment (i.e. the context of the Living Labs).

We orchestrated (and will orchestrate) three interactions with the Living Labs. For the first interaction, we held interviews that took place around June 2023 (see Table 1). These interviews served a dual purpose. On the one hand, it provided insights on the current use cases foreseen for the Living Labs and the stakeholders addressed by or involved in enabling these use cases. It also helped to generate insights on what value the Living Labs intend to create as part of their efforts. On the other hand, it helped to get a good understanding of the maturity of the LLs in COMMECT regarding business decision making. For example, it helped to shed light on the degree to which use cases were clear, to what extent Living Lab stakeholders already considered the financialization of the connectivity solutions in practice and what scale of deployment they foresee.

Table 1: Interviews with Living Lab stakeholders

Living Lab	Date of occurrence (2023)
Living Lab 1 Luxembourg	26th of June
Living Lab 2 Norway	13th of June
Living Lab 3 Denmark	20th of June
Living Lab 4 Turkey	14th of June
Living Lab 5 Serbia	15th of June

2.1.3. Working sessions with LL stakeholders to investigate use cases

The second interaction concerned working sessions with the Living Labs to further concretize the value creation process for their intended use cases, and to understand the role of connectivity solutions in enabling these use cases. It helped us to better grasp to what extent use cases rely on certain connectivity solutions (for example, the need for connectivity solutions that can support a large geographical distance or increased amounts of data transfer), and subsequently what implications these connectivity solutions would have for the respective business models. This enabled us to further concretize the reference framework and to work towards a (preliminary) understanding of what the business models for the Living Labs would look like (e.g., what type of investment structure is considered, who will be involved and why, who will be the primary orchestrator and end-user). It also provides input towards the decision-making process for selecting one or more reference business models. The characteristics and needs of a Living Lab in enabling certain use cases may make some of the options in the reference framework not applicable (when, for example, a government party is absent or certain stakeholders are not present).

Table 2 presents an overview of the working sessions orchestrated with Living Labs in COMMECT. As explained, these insights contribute to our initial set of reference business models supporting connectivity solution deployment, as well as helps the maturation of the Living Lab.

Table 2: Working sessions (planned) with Living Lab stakeholders to explore role of connectivity solutions to enable value creation for end-users

Living Lab	Date of occurrence (2023)
Living Lab 1 Luxembourg	14^{th} of November
Living Lab 2 Norway	January 2024 (planned)
Living Lab 3 Denmark	28^{th} of August
Living Lab 4 Turkey	6^{th} of October
Living Lab 5 Serbia	2^{nd} of October

2.1.4. Business model design working sessions with Living Labs

The third interaction with Living Labs is planned for 2024 and focuses on the development of collaborative business models supporting the Living Labs in practice. Here, we focus on the design and concretization of the business models for the respective Living Labs in a collaborative business modelling working session, building on the insights generated during the first two interactions. These working sessions are planned as part of WP5.

3. Literature background

In this section, we detail the literature background relevant to support the development of the reference framework and to support the design of collaborative business models for rural connectivity. Specifically, we first explain the concept of business models and the role of collaborative business modelling. Next, we go into the state-of-the-art on connectivity or digitally-enabled business models and present the learnings identified.

3.1 Business models and collaborative business modelling

A business model defines the logic of how an organization (or network of organizations) aims to create value for a specific customer or end-user segment and how it intends to capture value in return (Osterwalder & Pigneur, 2010). Typically, a product, service or technology is central to a business model design, which is offered to enable the value creation logic. For example, a business model may revolve around the introduction of a new mobile phone sold to customers or entail the provisioning of a streaming service which creates value for end-users. Typically, a revenue model is employed to capture value in return (Morris et al., 2005). For the given examples, customers may pay a purchase price to become owner of a new mobile phone and pay a subscription fee to use a streaming service. In addition to how value is created and captured, a business model also explains how this business logic is supported by means of an organization's activities, resources and capabilities employed (Zott & Amit, 2010). Therefore, it describes how stakeholders collaborate, commit resources and make investments to support the business logic. Logically, the subsequent survivability (or profitability) of the business model depends on whether stakeholders can capture sufficient value in return through this logic.

Traditionally, business models are considered from the perspective of a single organization (Brehmer et al., 2018), featuring a supplier-customer relationship between the owner of the business model and the customer or end-user (Kindström, 2010). As a result, stakeholders are likely to work towards conflicting or opposing objectives, as the exchange of goods or services between leads to reciprocal costs and benefits (meaning a decrease in costs would lead to an increase in benefits for the other stakeholder and vice-versa). Accordingly, such business models are often geared towards profit maximization. To support the long-term survivability of business models, we focus on the *co-creation of mutual value* to ensure that the objectives of stakeholders in business models are aligned as much as possible. In this way, stakeholders can collectively and collaboratively work towards value creation and capture (Rohrbeck et al., 2013). Therefore, **collaborative business models aim to provide a structure in which all stakeholders benefit (long-term) through participation, moving away from profit maximization.**

To do so, a systemic, networked perspective on business models is needed, which considers the needs, drivers and perspectives of individual stakeholders as well as considers how stakeholders collaborate to co-create and capture value (Evans et al., 2017). It calls for a holistic consideration of the stakeholders involved in the business model design and should ensure that each stakeholder (from their perspective) is 'better off' through participation. To facilitate this task, we consider different tools to support business modelling. In contrast to the prominently used Business Model Canvas (which takes an organization-centric perspective) (Osterwalder & Pigneur, 2010), **we leverage the Business Model Radar which supports the modelling of how multiple stakeholders co-create, exchange and capture value** (Turetken et al., 2019).

Both the Business Model Canvas and Business Model Radar are illustrated in Figure 2 respectively. One can see that the Canvas offers depth in terms of the business model design for a *single organization* by specifying key activities, resources and cost structure for a given organization. Although key partners are part of the Canvas, it reasons from the perspective of the respective organization and lacks depth in terms of *how* and *why* stakeholders collaborate.

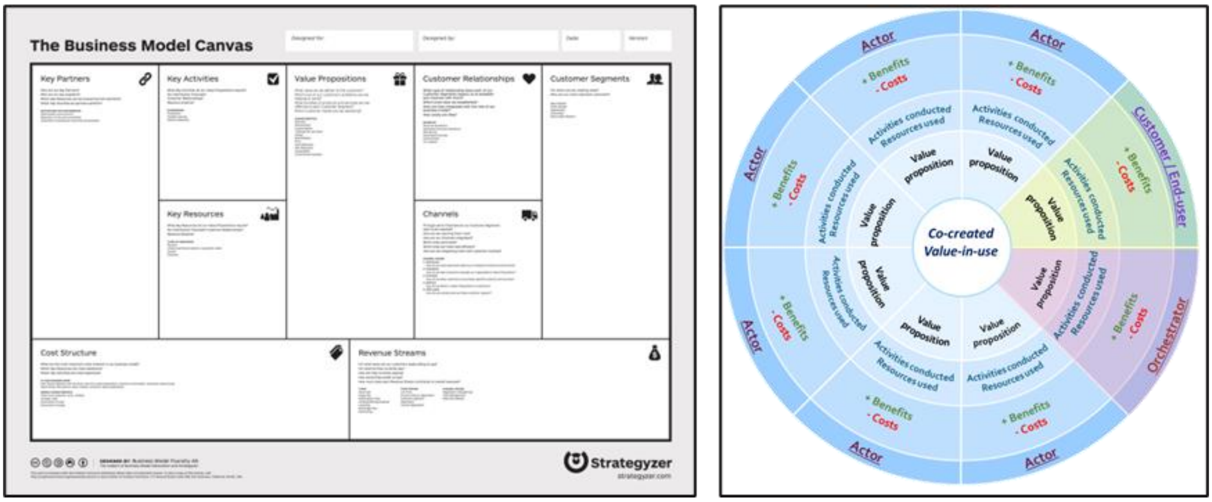

Figure 2: Comparison between Business Model Canvas (left) and Business Model Radar (right)

Reflecting on connectivity / digitally-enabled business models, we see that a plethora of stakeholders (e.g. telecom operators, platform providers, ISPs, end-users) are working together to enable connectivity. It highlights the interdependencies between stakeholders to enable such solutions in practice. For sustainable deployment of these connectivity solutions, it is therefore valuable to ensure that *the business models supporting them are collaborative in nature and consider the various needs of stakeholders involved*. To account for this, the business model radar allows these multiple stakeholders to be 'mapped': it enables the design of business models that features multiple stakeholder roles which come together to co-create value. Through this structure, it can be made explicit how stakeholders are involved and how they contribute to value creation and capture. This is important for connectivity-enabled business models for rural areas because they often call for community-based investments or joint investments to support the deployment and operation of connectivity solutions.

3.2 Advances on connectivity or digitally-enabled business models

New business models are needed to bridge the digital divide and offer high-quality, reliable, and secure internet access to rural and remote areas in Europe. One of the significant challenges in deploying broadband internet infrastructure is the lack of return on investment for network operators operating in these regions (Cavalcante et al., 2021). Addressing this challenge demands new business models that generate substantial economic benefits, while capitalizing on the potential of enhanced internet access to create social and environmental value. Given the network operator's limited financial incentive to establish and maintain broad connections (Cavalcante et al., 2021), a broader examination of the entire ecosystem is necessary to reveal novel value creation opportunities for improved connectivity in rural settings (Parida et al., 2019).

The ecosystem of internet connectivity in Europe encompasses the following stakeholders: (1) network developers; (2) infrastructure investors; (3) users and customers; (4) platform developers; and (5) government (Lee, 2019; Metallo et al., 2018). Network developers, such as telecom operators and connectivity platform developers, are responsible for providing network connectivity by installing and maintaining the required infrastructure (Lee, 2019). The installation of this infrastructure is usually financed by infrastructure investors (Cavalcante et al., 2021). The customer base compromises various users, such as individual households, local business, governments, and other organizations (Lee, 2019). Local businesses can significantly benefit from improved internet access because leveraging Internet of Things (IoT) solutions can improve their business operations. The ecosystem also involves software, hardware and IoT solution developers that together provide the IoT platform required to collect, share, and analyse data (Lee, 2019). Providing access to connectivity for individual households can improve the attractiveness of rural areas to others, supporting migration to rural areas. Finally, the government, which is often neglected in the literature, plays a crucial role in facilitating the installation of internet connectivity, especially in rural areas, through investments and regulation, among others (Cavalcante et al., 2021).

In rural and remote areas, two additional actors contribute to the ecosystem: (6) digital innovation hubs (Stojanova et al., 2022); and (7) rural mobile infrastructure operators (Cavalcante et al., 2021). Digital innovation hubs offer digital infrastructure and skills aligned with the needs of a rural community by offering an internet access point, incubation activities, advise and education, and/or sector-specific technology (Stojanova et al., 2022). Rural mobile infrastructure operators take on the responsibility to deploy and operate the internet access and transport network relieving mobile network operators of this task. They remain responsible for client interfacing, product control and the core network. This allows operators to deploy networks more efficiently, optimize asset utilization, and reduce the running operation costs (Cavalcante et al., 2021). See Figure 3 for an overview of the general ecosystem.

The actors can play three different roles in the ecosystem: orchestrator, contributor, or enabler. The orchestrator operates the IoT platform and delivers the solution to the end customer. It also works with the other ecosystem actors to set common technology standards and business rules as well as determine how to distribute value among the participants. The contributors provide unique data sets, software, hardware and/or IoT applications for the platform as well as engages in joint research and development with the orchestrator. Enablers supply essential infrastructure (e.g. connectivity, security, billing) that supports the ecosystem (BCG, 2020).

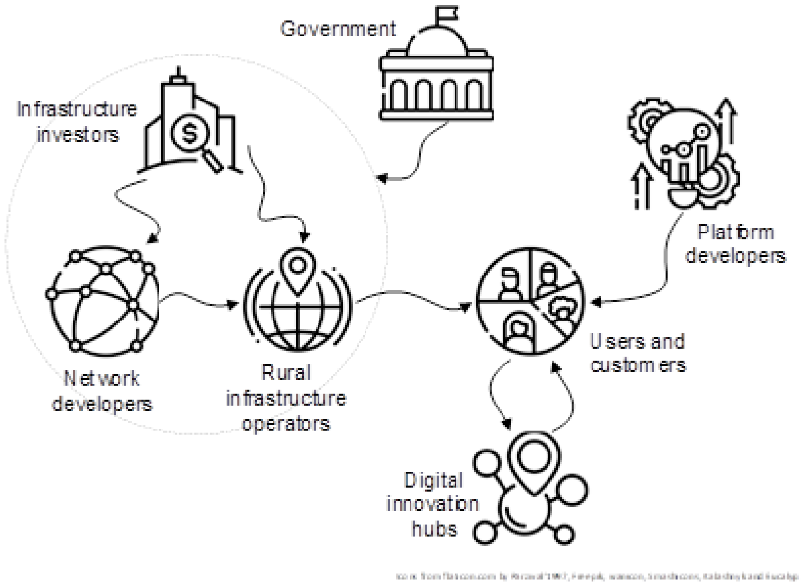

Figure 3: Overview of the internet connectivity ecosystem in rural Europe

Data collection, sharing and analytics constitute the primary value creation mechanisms within the ecosystem. The first mechanism is the collection of operational data through sensors, enabling hardware to sense and capture information with minimal human intervention. The second mechanism is efficient data sharing among digital units via wireless communication networks. The third mechanism is the ability to transform the available data in valuable insights and actionable guidelines to inform decision-making (Parida et al., 2019).

To achieve this, the ecosystem participants provide a range of operational, analytical, and collaborative solutions. Operational applications are used to assist or enhance enterprise users' daily activities, including tasks such as monitoring and control, automation, and process management. Analytical applications diagnose issues or make predictions through data analysis, supporting local businesses to improve customer satisfaction or respond to changing market conditions. Collaborative IoT applications allow diverse IoT devices to interact and collaborate, working together to attain a common objective (Lee et al., 2019).

To deliver these solutions, the ecosystem must establish a five-layer IoT architecture. In the perception layer data is gathered trough IoT devices; in the network layer, data is transferred across diverse networks; in the process layer, data is cleaned, stored, analysed, and processed; in the application layer, problem-specific applications and solutions interact with the user; in the service management layer, IoT services are selected and delivered. Each layer of the architecture is essential for providing valuable operational, analytical, and collaborative solutions (Lee et al., 2019).

The solutions are delivered to the local business through three main models (Palattella et al., 2016). The first is the 'Bluetooth' model in which the equipment is delivered by the IoT developer, whereas as the connectivity (e.g., short range technologies) is provided by the consumer via a mobile network operator. The second is the 'Wi-Fi' model in which the IoT developers offers both the equipment and the connectivity (e.g., LPWA). The third is the 'cellular operator model' in which the equipment is delivered by the IoT developer and the connectivity by a cellular IoT provider (e.g. 5G) (Palattella et al., 2016).

Although Parida (2019, p. 10) highlight that "it is evident that limited attention has been given to the value-capturing dimension of digitally enabled business models", there exists a diverse range of revenue models for offering IoT solutions to local business in rural areas (Lee, 2019; Metallo et al., 2018). These models include:

- Platform: creating a marketplace that connects suppliers and buyers with benefits for both.
- Subscription: delivering continuous value to customers in exchange for regular fee.
- Pay-per-usage: charging customers based on the amount of time a product is used actively.
- Asset sharing: collaborating with other businesses partners to distribute equipment costs.
- Asset tracking: utilizing connected devices to identify, monitor and track assets in real time.
- Outcome-based: shifting the payment focus from the product itself to the achieved outcome.
- Compliance: enhancing responsiveness to change to reduce compliance-related costs.
- Data-driven: collecting data for potential use in other products or for sale to a third party.
- Service-adjacent: offering supplementary services that enhances the product's utility.

Local businesses express a willingness to invest in IoT solutions because of their potential to collect, share and analyse (big) data from customers. Thereby, they enable the development of value-added services and novel offerings which, in turn, creates new revenue streams (Lee, 2019; Metallo et al., 2018; Parida et al., 2019). In addition, these solutions help them to build closer customer relationships and create a favourable brand image, ultimately boosting competitiveness and elevating profit margins (Lee, 2019; Linde et al., 2023). Furthermore, real-time data monitoring can accelerate productivity, driving improved cost efficiency (Palattella et al., 2016; Parida et al., 2019).

Beyond these advantages, IoT solutions hold the potential to enhance environmental and social sustainability (Lee, 2019). For example, they support ecosystem actors to engage in effective communication, collaboration, and orchestration (Lee, 2019; Parida et al., 2019).

Additionally, they contribute to optimized resource management, increased energy efficiency and improved waste management.

The expenses that arise within IoT ecosystems encompass aspects such product and service development, hardware production, marketing and sales, personnel, and IT costs (Lee, 2019; Metallo et al., 2018). The needed investments can be made in all IoT simultaneously or incrementally, guided by factors cost efficiency or risk mitigation. Scholars have advocated for a micro progression logic where many small changes to the business model are made to create a large impact (Linde et al., 2023). The investment strategies in the latter two scenarios adhere to a similar rationale. However, the temporal dynamics of IoT investments remain an underexplored domain.

3.3 Identified research gaps

The preceding paragraphs indicate multiple avenues to create, deliver and capture value from increased connectivity in rural settings through IoT solutions. This raises the crucial question: What options are most fitting under different circumstances? We currently build predominantly on insights generated through research on connectivity-enabled business models positioned in urbanized or geographically dense areas. However, we know that rural areas are generally characterized by low population density and diverse end-user groups (Yaacoub & Alouini, 2020), making it more difficult for current business models to work as intended. Additionally, rural areas often lack basic infrastructure (such as power or energy sources) for connectivity solutions to be deployed, putting further pressure on to what extend such business models are applicable in rural areas.

Presently, a definitive answer to how such business models should be shaped to support the deployment of connectivity in rural areas remains elusive and is the focus of our work. However, a range of factors that is being discussed in research warrant consideration. The extent of connectivity is greatly influenced by the amount of energy consumption, area coverage and required data rates (Lee, 2019; Palattella et al., 2016). Other considerations include terrain topography and population density, which indeed affect the degree to which connectivity solutions can be operated (Cavalcante et al., 2021). Furthermore, we observe from research that IoT solutions should be useful to end users and include open and API-software (Lee, 2019). Particularly in rural areas, the digital literacy of the users, often constrained, requires user-friendly IoT solutions and additional support. Moreover, the selection of a suitable business model is influenced by labour, installation, operation, and maintenance costs alongside company size (Stojanova et al., 2022).

In the development of IoT business models, organizations frequently integrate functions that customers are unwilling to pay for. Furthermore, they often delay the introduction of new solutions which allows competitors to gain an edge in data capture and analysis against lower prices. They also tend to underestimate security and privacy risks while overestimating internal capabilities. Additionally, they often fail to anticipate competitive threats. This allows new entrants with superior products and services to emerge quickly and reshape the competitive boundaries of the industry. As IoT products usually create new entry points to internal corporate systems, a careful assessment of capabilities to be develop in-house and those to be developed by new partners is very important.

Beyond these common mistakes, there are key challenges associated with bringing IoT solutions to rural areas through increased connectivity. IoT revenues tend to be uncertain and modest in rural settings, while the operational and maintenance costs rise (Stojanova et al., 2022). Moreover, the upfront investments required for IoT implementation are often substantial, exceeding available funding and organizational financial management capabilities (Palattella et al., 2016). In addition, IoT solutions are frequently unreliable, unscalable and not interoperable, stemming from time constraints, a lack of technological capabilities and a dearth of skilled personnel for IoT development (Lee, 2019; Linde et al., 2023). Owing to data privacy, security and trust issues as well as digital and IT illiteracy in rural areas, there is also a lack of customer demand for IoT (Linde et al., 2023; Palattella et al., 2016; Stojanova et al., 2022). Further, inadequate infrastructure and technology hamper the operation of IoT systems in rural settings (Stojanova et al., 2022).

Overcoming these challenges and uncovering new value creation opportunities necessitates an ecosystem perspective on business modelling. Collaborative business modelling presents such as perspective. It facilitates the establishment of new collaborations among parties with the goal of accelerating societal transitions. The approach involves an iterative process to introduce sustainable innovation to the market and transform existing value networks at the necessary scale (Turetken et al., 2019). In this way, it can assist local businesses in developing and applying new capabilities, revising operational process and adjusting roles and responsibilities in the ecosystem – all crucial in the transition from conventional to IoT-enabled business models (Metallo et al., 2018; Parida et al., 2019). In addition, it equips them to shift from a traditional business mindset to an IoT mindset characterized by responsiveness to real-time needs, recurring revenues and an ecosystem perspective (Metallo et al., 2018).

This perspective should be combined with insights generated through applications of connectivity in rural areas in practice: *How do the Living Labs in COMMECT intend to support the deployment of connectivity solutions? What business model decisions will they take? To what extent can the insights generated through state-of-the-art literature be applied to support their decision making? What options work and which ones do not? To what extent can we explain this because of deployment in rural areas? How can we overcome this?* These questions serve to guide the development of the reference framework for business model development for connectivity in rural areas. It intends to offer guidance to users (the Living Labs and other innovation initiatives in rural areas) on how business models can be shaped to support the deployment of connectivity solutions in practice. This will contribute to research in this field by highlighting how rural barriers can be overcome through (collaborative) business modelling solutions.

4. Overview of framework to support reference business models

In this section, we introduce the initial reference framework (supporting the design and development of reference business models) for the deployment of connectivity solutions in rural areas. As indicated, our reference framework is built upon state-of-the-art insights on connectivity solutions generated through our literature search complemented with advances on collaborative business modelling. The framework offers a spectrum of options and categories to consider when designing novel business models to support the deployment of connectivity solutions in rural areas. We intend to validate this framework as part of the Living Labs, understanding why certain options may sense given their characteristics. Alternatively, barriers faced by the Living Labs can help us to identify solution directions that can extend the current options listed in the framework.

First, we introduce the framework and the generic categories included as part of this framework. Next, we briefly describe the options per category available to decision makers to design and concretize their respective business model design.

4.1. Initial framework - for reference business models design

Table 3 presents the initial framework to support the design of reference business models for connectivity solutions in rural areas. Seven categories are distinguished that are the key cornerstones in defining business models for connectivity solutions, namely:

<u>Type of stakeholders.</u>

This category offers options in terms of potential stakeholders that can be considered, ranging from end-users to government bodies (i.e. municipalities, local government, ministries) to infrastructure or connectivity service providers (i.e. telecom operators, platform developers). Stakeholders selected should contribute to facilitate or support value creation for new business models. The following options are identified:

- **End-users, such as households, farmers, rangers, schools, or public services.** These stakeholders can be characterized as the main beneficiary of the connectivity solutions or IT services enabled through connectivity. Note that multiple options can be selected depending on which end-users are available per Living Lab.
- **Telecom operators.** These stakeholders arrange the telecommunication services as part of the business model. Often, they are also coordinating the installation of connectivity solutions.
- **Service providers or platform providers.** These stakeholders provide services enabled through connectivity solutions. This may concern services which tie into the operations of end-users (e.g. agricultural farming services or viticulture services) but could also take shape as communication solutions (i.e. platforms to support digital integration between end-users).
- **Government bodies (local government, municipalities, ministries).** These stakeholders are associated to the government and have an interest in the wellbeing of local inhabitants or the attractiveness of the rural area.
- **Investors.** These stakeholders are involved in the business model by investing in the solutions to be deployed. A distinction can be made between private and government investors. Thus, a government body can sometimes act as an investor.
- **Cooperatives / associations.** As part of cooperatives and associations, we observe that end-users (such as farmers) come together to join forces and to create a separate entity (the cooperative). This cooperative can contribute towards value creation by aggregated investments as well as networking, education and advice services.
- **(rural) Infrastructure providers / technology providers.** These stakeholders are concerned with the infrastructure deployed to support connectivity in rural areas. It may concern the developers of connectivitysolutions, solutions that support data collection or the grid needed to support connectivity solutions.

- **Value chain stakeholders (operators, retailers, contractors).** These stakeholders are not necessarily the main beneficiary of new connectivity but may benefit from others having access to connectivity (for example, a farmer possessing smart farming solutions may be able to produce higher quality products, which in turn benefits other value chain stakeholders). As a result, such stakeholders may be willing to support the deployment of connectivity in rural areas as part of new business models.
- **Regulators, certifiers or insurance companies.** These stakeholders offer additional services on top of the connectivity solutions offered. For example, connectivity access may enable the traceability of farming operations because data can be collected and transferred on crop or product performance. This data can also be valuable for regulation or certification purposes. Alternatively, such data can also help in providing insurance services to farmers. Therefore, this group of stakeholders complements existing connectivity solutions.
- **Knowledge institutes (universities, research partners, advisors).** These stakeholders are involved to contribute knowledge to a new business model but also use data or insights generated through connectivity solutions. These insights can help the end-user to reap additional value and in return benefit knowledge institutes by further improving their knowledge base.

Connectivity solutions used

This category describes the general digital solutions that are deployed as part of reference business models. The solutions offer forms of connectivity through which value is created for stakeholders involved in the business model design. These digital solutions are linked to the options researched and developed as part of WP2. The following connectivity and computing solutions are considered:

- **5G connectivity platforms**. These solutions deal with 5G/6G connectivity to support the transfer of data for end-users and the infrastructure needed to support such platforms in practice.
- **Local 5G private networks**. These solutions concern private networks (enabled by 5G) which (groups of) end-users may use to support data transfer within the boundaries of the network.
- **IoT and Edge computing solutions**. These solutions concern technology applications in which edge computing (i.e., computing close to where the data is collected) to reduce the amount of data that has to be transferred through connectivity solutions.
- **AI and Network Automation**. These solutions deal with AI technology to support connectivity in rural areas and help to configure and automate the networks needed to do so.

Purpose of solution

This category offers descriptions of the reason why the Connectivity solution is deployed. It relates to how connectivity is used to create value, either by enabling the *sharing* of data, the *collection* of data or the *analytics* of data. Understanding this purpose can help in motivating what value creation and capture logic can be considered for the business model. The following options are considered:

- **Purpose is data sharing**. This means that the connectivity solutions are focused on data sharing for end-users.
- **Purpose is data analytics**. This means that the connectivity solutions are focused on supporting the analytics of data, meaning that sense-making of the data is included.
- **Purpose is data collection**. This means that the connectivity solutions are focused on data collection for end-users (which can be used for follow-up services).

Table 3: Initial framework to support the design of reference business models

Type of stakeholder	Connectivity solutions	Purpose of solution	Access to data	Investment structure	Types of values to consider by end-users	Means of value capture by providers
End-users (households, farmers, rangers, schools, public services)	5G Connectivity Platforms	Data sharing solution	End-users	Individual investment by end-user	Connectivity / digital inclusion	Value capture through need for services / compliance
Telecom operators	Local 5G Private Networks	Data analytics solution	Shared responsibility	Collective investment by end-users	Reduced emissions / increased sustainability	Value capture through data collected
Service provider / platform provider	IoT and Edge Computing Solutions	Data collection solution	Rights at the provider	Investment by association or cooperative	Reduced inputs needed	Provisioning of new services
Government bodies (local governments, municipalities, ministries)	AI and Network Automation			Investments by government body	Data-driven insights / improved decision making	Payment for connectivity solution
Investors				Investments by private organization	Provisioning of new services	Expanding market segment
Cooperatives, Associations					Productivity / efficiency	Increased social and environmental well-being
(Rural) Infrastructure Provider / technology provider					Reduced costs	
Value chain stakeholders (operator, retailer, contractor)					Value through compliance	
Regulator, certifier, insurance					Improved safety	
Knowledge institutes					Improved competitive position (reputation, brand)	
					Increased ease-of-use / technology adoption	

Access to data

Access to data determines the options related to who owns the data from the connectivity solution, which influences the value creation and capture logic. For example, data collected at the end-user can remain owned by the end-user but can also become property of the stakeholder in charge of operating the connectivity solution or shared among multiple stakeholders. The following options can be considered:

- Access to the data remains at the **end-user**
- Access to the data is shared between **multiple stakeholders** (e.g. service providers, value chain stakeholders, insurance providers)
- Access to the data is transferred to the **service or telecom provider**

Investment structure

The investment structure offers options (see examples in Figure Figure 4) related to *how* the connectivity solutions are financially supported. End-users can make (individual) investments in deploying a connectivity solution (i.e. an end-user pays a connectivity service provider for deploying and operating the connectivity solution) but other (collaborative) investment structures can also be considered. For example, end-users can make collective investments for the deployment of connectivity solutions. Such investments could also be made by a cooperative or association to which individual end-users belong. Alternatively, government bodies can make investments *for* end-users as the positive benefits achieved by having access to connectivity solutions can be worthwhile for them as well. Lastly, private organizations could fund the deployment of these solutions if data collected can be reused or prove to be valuable to them.

The following options are considered:

- **Individual investment by end-user.** In this structure, the end-users (solely) pay for access to connectivity / deployment of connectivity solutions.
- **Collective investments by end-users.** In this structure, a group of end-users makes joint investments in accessing connectivity / deployment of solutions. This can be the case for a *heterogeneous* set of end-users recognizing that connectivity may benefit them (albeit for different purposes).
- **Investment through association or cooperative.** In this structure, an association or cooperative (which represents a typically *homogeneous* set of end-users) makes investments in accessing connectivity / deployment of solutions. This is often the case when the association deems it worthwhile for its end-users to access connectivity because it will benefit them in terms of operations (e.g. improving the quality of crops produced, in turn benefiting the cooperative).
- **Investments by government body.** In this structure the government body makes investments in accessing connectivity / deployment of solutions. This is often the case when the government intends to support the wellbeing of inhabitants, to stimulate economic opportunities or performance, or to increase the attractiveness of an area.
- **Investments by private organization.** In this structure a private organization (or set of) makes investments for accessing connectivity / deployment of solutions. This can be the case when data collected through access to connectivity is of interest the private organization as well.

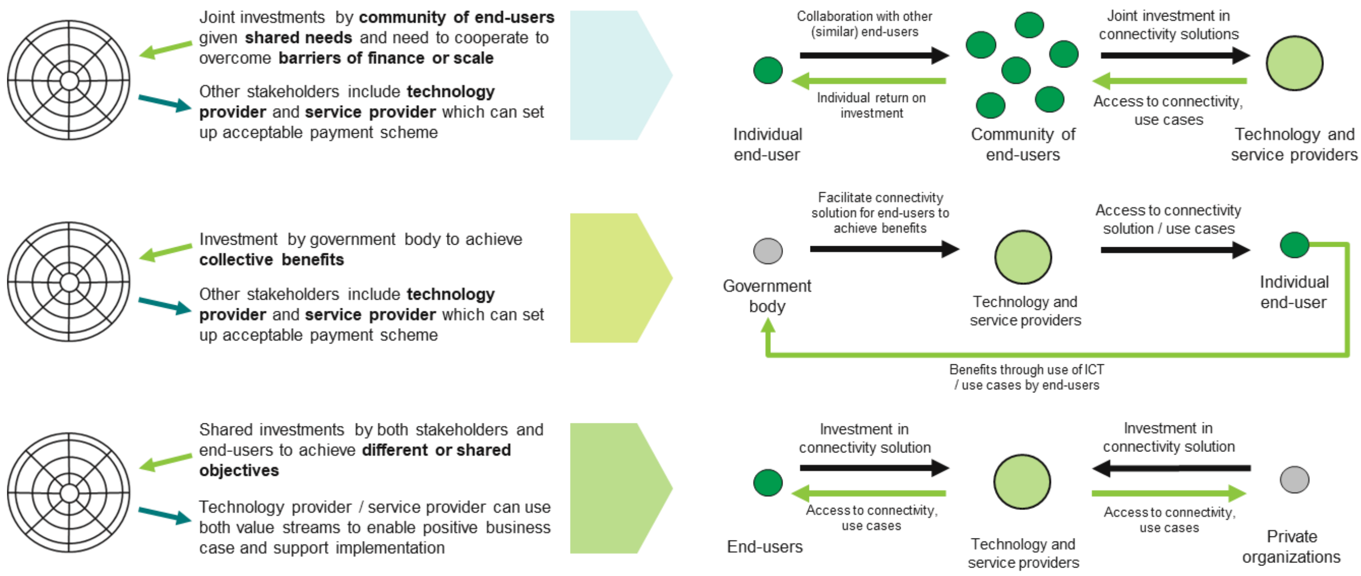

Figure 4 – Examples of collaborative investment structures for business modelling

Type of value to consider for stakeholders

This category offers reference values that can be considered by stakeholders in rural areas participating in the to-be designed business models. These values overlap with the work presented in D3.1 related to socio-economic, environmental, and business aspects. For example, for business type stakeholders, value can be related to business performance, increased productivity or improved product quality. Similarly, environmental effects such as reduced emissions or reduced fertilizer usage can be considered as positive environmental effects for some stakeholders. Lastly, end-users may value access to connectivity for fostering digital inclusion or job creation. The following values can be considered for end-users:

- **Digital inclusion** is a sense of (increased) belonging by end-users of a broad community, providing the ability to communicate with others more easily.
- **Reduced emissions** are related to improved business operations (e.g. less transport).
- **Reduced inputs are** related to a reduction in inputs needed to support business operations (e.g. reduction in fertilizer or water usage for farming or viticulture).
- **Improved decision – making** by using data to help end-users in structuring and optimizing their decisions.
- **Provisioning of services** through connectivity, enabling end-users to provide new services through data collected or transferred.
- **Productivity** involves reducing time spent or more efficient handling of day-to-day operations.
- **Reduced costs** relate to a reduction in costs because of connectivity / data driven insights / increased performance or productivity / reduction of inputs.
- **Value through compliance** relates to end-users being able to be transparent about activities (as data can be collected and transferred). This is often relevant in use cases that deal with regulation or certification.
- **Improved safety** by connectivity aiding end-users in avoiding accidents or injuries.
- **Improved competitive position** by connectivity supporting the business performance of end-users.
- **Increased ease-of-use / technology addition** by reducing the barrier towards new technologies for end-users.

Type of value capture mechanisms for providers

Lastly, this category presents options available to stakeholders on how providers may offer their solution to end-users. It delineates how value capture can be structured and what this implies for potential costs for end-users (or other investors). For example, connectivity solutions can be offered to end-users through subscription models but can also take form through fixed investments. Alternatively, providers can consider offering additional services in addition to connectivity solutions to further create value. The options available serve to inspire the to-be developed business models and can guide providers on how solutions should be marketized. The following options are currently considered:

- **Value through compliance**. For providers, compliance can also be considered as an important driver, for example to have access to data to be transparent on product quality (such as in the agricultural domain). Although the provider is offering connectivity, it also directly benefits when end-users use the services offered.
- **Value through data collected**. Data collected by stakeholders can help such stakeholders to improve their current services. For example, usage data from end-users can offer insights on what features / aspects of services are used and why they are used. This can help stakeholders to target where services can be improved.
- **Value through additional services**. If connectivity exists for end-users, this may also enable stakeholders to offer additional services. For example, advisory service providers may build upon connectivity solutions to offer smart farming solutions to farmers. Through these services, additional value can be captured.
- **Direct monetization of connectivity**. The deployment of connectivity solutions itself can be a source of value capture, in which a service model can be considered for using connectivity solutions.
- **Expanding market segments**. Supporting the deployment of connectivity solutions may open or expand the market segment for stakeholders involved because additional end-users will start using these solutions.
- **Increasing social and environmental wellbeing**. In addition to end-users, stakeholders may also value contributing towards social and environmental impact through access to connectivity (i.e. end-users being able to contribute towards such impact as a result of connectivity access). Therefore, whilst not necessarily being an economic driver, it can be considered as a source of value capture for stakeholders.

4.2 Using the framework to support the design of reference BMs

Figure 5 describes the process that can be followed to use the framework supporting the design of business models for connectivity solutions in rural areas. Starting from the left (Step 1), we see that the reference framework provides options to stakeholders to concretize their business model supporting connectivity solutions in practice. Accordingly, stakeholders select options which make sense in the context of their Living Lab, given – among others –the type of stakeholders involved, the connectivity solution deployed, the potential value created and clarity of the investment structure.

Here, users may build upon the descriptions per option listed above (to understand what would work for their respective Living Lab). The starting point for business model design is to identify what stakeholders (first column from the left in the reference framework), solutions and their purpose (2nd, 3rd and 4th column), finance model (5th column) and values for end-users and stakeholders (6th and 7th column) would make sense in the context of the Living Lab. Note that there is no order in which the categories should be concretized: users of the framework can start at the right side first (value created) if this is desirable. Conversely, from a more technical perspective, it could be relevant to start from the left side (understanding the connectivity solution first and stakeholders which should be involved).

In Step 2, the reference framework helps to provide the basis for designing collaborative business models for rural connectivity solutions. Thus, the options from the reference framework 'paint' the elements of the business model radar template:

- The circle at the centre (co-created value-in-use) captures the goal of the business model design; it describes the collective value created. This would capture the purpose the Living Lab has with regards to realizing connectivity access for its rural area.
- The outer circle describes the stakeholders involved for the business model design. Each 'pie slice' represents a stakeholder in the model. These stakeholders should be mapped as real-world organizations or partners. Here, the list of options available in the reference framework serve as inspiration or as a means to 'match' who could be involved (as well as their general role).
- Working from the centre circle towards the outer circle, the next circle (actor value proposition), describes what each individual stakeholder brings to the table to support the business model design. This ring can therefore be populated by means of the role that each stakeholder fulfils for the to-be business model design: why are they involved in the business model? What do they fulfil in the context of the deployment of connectivity solutions or IT-enabled services?
- The middle circle (actor co-production activity) captures the resources, activities and capabilities needed to support the business model design. It describes how the stakeholder mapped for the business model design will realize its role in practice. This can relate to the provisioning of services, the installation of (connectivity) infrastructure, the support in terms of financial investments (depending on its role considered for the business model design). Logically, these aspects influence the costs that are incurred for an individual stakeholder.
- Lastly, the final ring (actor costs and benefits) details what value each stakeholder captures through the business model. Note that for all stakeholders, this should be positive for a viable business model design. Obviously, this depends on the individual objectives and goals of stakeholders. Here, users can leverage the values indicated for the reference framework as inputs on what types of values can be considered. Users can also assess what values are relevant together with the respective stakeholders involved for the Living Lab.

After the elements of the business model radar are 'painted', the business model design is concretized by ensuring that a sound business logic is obtained. Here, it is crucial to involve stakeholders that are relevant to the specific use case at hand or the initiatives for which connectivity solutions are to be realised. The stakeholders mapped for the business model design should jointly discuss whether the business model design would work given its current description. General questions to consider are:

- Are all necessary roles fulfilled for the business models, which stakeholder for the Living Lab fulfils which role? Is this correct?
- Is it clear how the deployment of the connectivity solutions is financed and how it will be deployed?
- Is it clear how each stakeholder captures value? Is there at least a cost and benefit modelled per stakeholder?

Once the business model design is concretized, evaluation of the business model design for each stakeholder can take place (Step 3). Stakeholders involved for the business model design should collaboratively evaluate to what extent the business model design addresses their needs (desirability), creates sufficient value (viability), is executable or realizable (feasibility) and incorporates flexibility to be adapted or to respond to changes in the market (robustness). This evaluation can be supported through qualitative (guiding questions) and quantitative means (business case calculations on socio-economic and environmental impact).

This evaluation should offer insights into whether the business model generated using the reference framework can offer a *(perceived)* acceptable scenario for all stakeholders involved (i.e., all stakeholders would be willing to continue this business model design and support its realization in practice – this would be the ideal scenario for the deployment of connectivity solutions). It can however be the case that the business model design is deemed *infeasible* (i.e. cannot be realized) or *inviable* (i.e. it is not acceptable or sustainable for a given stakeholder included for the business model design).

If this happens, a new iteration of the business model design cycle needs to take place. In doing so, stakeholders may revisit the reference model to understand how potential challenges identified – for example, a business model which is infeasible – can be solved using the reference framework. This may entail selecting additional stakeholder roles to include and identifying who could fulfil this role in practice. Alternatively, different investment schemes can be collected or additional values for stakeholders can be considered to work towards a viable business model scenario for *all* stakeholders.

This loop is continued until either an acceptable business model design is found, or the innovation initiative / Living Lab considers that no suitable configuration can be found to support the realization of a certain connectivity solution (e.g. it offers too little benefits for stakeholders involved, it is too costly or risky, or it cannot technically be realized).

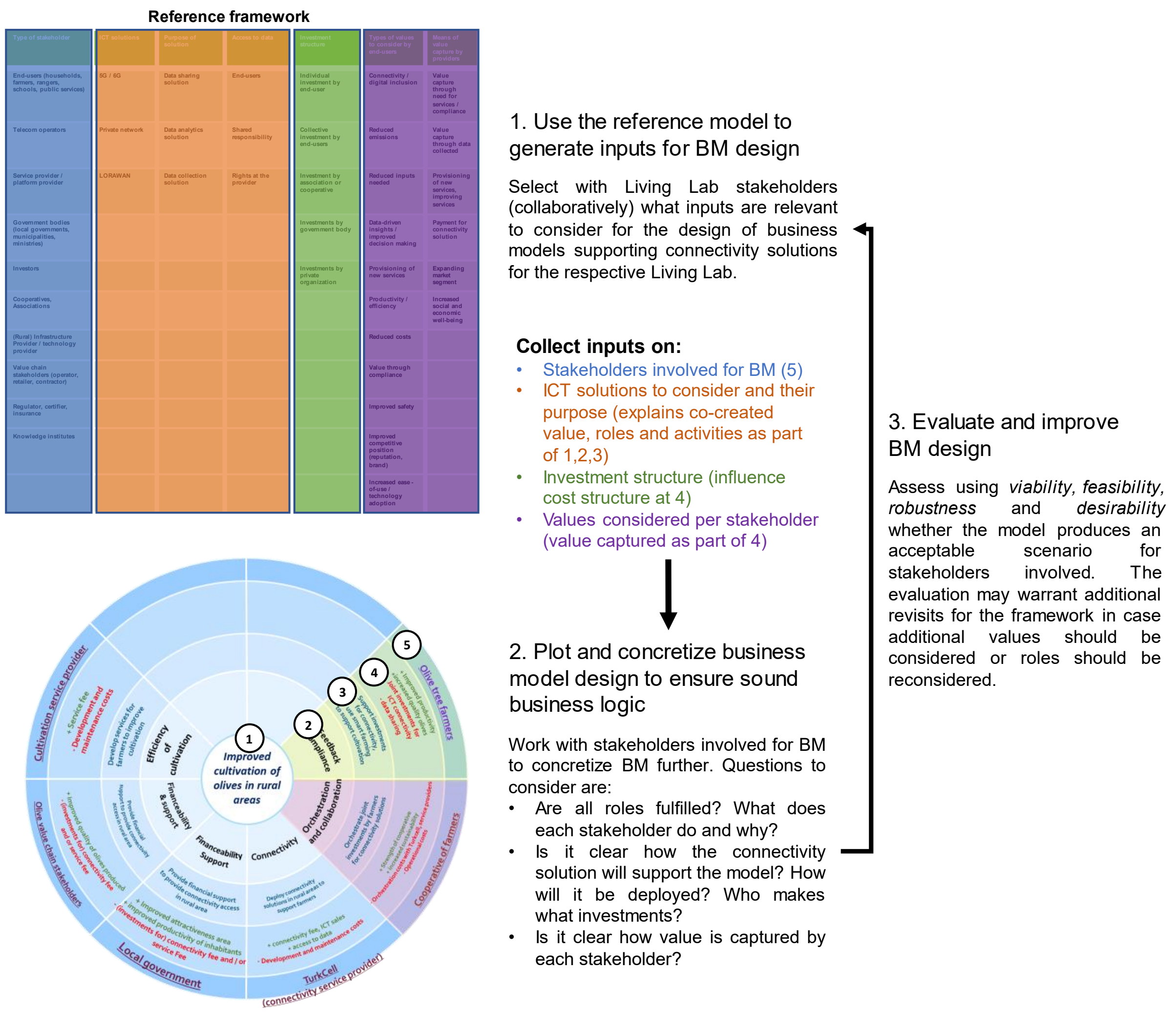

Figure 5: Sequence of using the reference framework to support business model design for connectivity solutions

5. Application of framework to COMMECT Living Labs

In this chapter, we illustrate the use of the framework to support the development of business models for connectivity solutions in rural areas. We do so by reflecting on the Turkish Living Lab, also using the outcomes from the working session (reported in Chapter 6.3) and demonstrating how the different options presented for the framework can help in defining the business model for realizing connectivity solutions in practice. Note that at this stage of the project, the business model serves as an example of how the framework can be applied because it still needs to be validated with on-site stakeholders.

5.1 Living Lab Türkiye: key stakeholders

The Living Lab Türkiye is centred around olive farmers that can benefit from connectivity solutions to support their farming operations. Specifically, smart farming solutions could be employed that can support Turkish farmers to improve the quality and quantity of the olives produced. In turn, this contributes to increased business performance and efficiency.

The potential solution offered constitutes a mobile connectivity solution which can be charged through solar power. This connectivity solution is offered by TCELL, on top of which smart farming services can be deployed. The solution is geared towards facilitating data sharing and data collection, such that complementary (agricultural decision making) services can be provided. The additional services can also be provided by TCELL but other technological service providers can be considered as well.

In addition to the provider and olive farmer, the cooperatives of olive farmers and the municipality also play a role in the business model. The cooperatives are dependent on their farmers to do well, hence there is an interest of such cooperatives in ensuring that farmers have access to digital solutions (which can help them in doing so). The municipality takes a stewardship role and focuses on supporting households living or working in the municipality and safeguards the ‘quality’ (i.e., attractiveness, access to resources, economic sustainability) of the area. Logically, access to connectivity can be beneficial to both companies and households and thus can be worthwhile to invest in (providing additional resources to its inhabitants to flourish, in return improving the quality of the municipality). Therefore, both the cooperatives as well as the municipality may be keen on making investments for the deployment of connectivity solutions for olive farmers.

Lastly, value chain stakeholders for the production of olives have a stake in facilitating the deployment of connectivity solutions. Similar to the cooperatives, value chain stakeholders have an interest in supporting olive farmers as these olives ultimately become part of the value chain, and thus affect the performance of value chain stakeholders as well. Improving the quality of the olives produced (through smart farming services requiring connectivity solutions to be operated) can help stakeholders to improve their business performance. Obviously, this may warrant investments for the deployment of these solutions.

5.2 Application of the framework

Based on the description above and using the framework, the following options can be highlighted (as depicted in Table 4) for the LL Türkiye. In terms of stakeholders, we see that end-users (farmers), a telecom operator / rural infrastructure provider / technology provider (represented by TCELL that has a dual role), service providers / platform providers (to provide applications to agricultural service providers), government bodies (e.g. local government wishing to support its inhabitants) and value chain stakeholders (interested in improving the quality of the olives), and certifiers (to guarantee the quality of the olives) come together as part of the business model design. In terms of connectivity solutions, a 5G based solution can be provided by TCELL to meet the needs of the farmers in supporting the cultivation of olives complemented by IoT solutions which help in data collection and analysis for smart farming applications.

Table 4: Use of framework to support initial business model design for LL Türkiye

Type of stakeholder	connectivity solutions	Purpose of solution	Access to data	Investment structure	Types of values to consider by end-users	Means of value capture by providers
End-users (households, farmers, rangers, schools, public services)	5G Connectivity Platforms	Data sharing solution	End-users	Individual investment by end-user	Connectivity / digital inclusion	Value capture through compliance
Telecom operators	Local 5G Private Networks	Data analytics solution	Shared responsibility	Collective investment by end-users	Reduced emissions / increased sustainability	Value capture through data collected
Service providers, platform providers	IoT and Edge Computing Solutions	Data collection solution	Rights at the provider	Investments by association / cooperative	Reduced inputs needed	Provisioning of new services
Government bodies (local governments, municipalities, ministries)	AI and Network Automation			Investments by government body	Data-driven insights / improved decision making	Payment for connectivity solution (service fees, subscription fees)
Investors				Investments by private organization	Provisioning of new services	
Cooperatives, Associations					Productivity / efficiency	
(Rural) Infrastructure Provider, technology providers					Reduced costs	
Value chain stakeholders (operators, contractors, retailers..)					Value through compliance	
Regulator, certifier, insurance					Improved safety	
Knowledge institutes					Improved competitive position (reputation, brand)	
					Increased ease-of-use / technology adoption	
					Increased attractiveness of area	

The purpose of the connectivity solution is to collect and share data but also facilitate the analysis and subsequent use of the data. Farmers will share data through 5G connectivity to the agricultural service provider, which in turn can transform and analyse their data to support decision making purposes. Based on this, farmers can improve their cultivation practices. Note that for this example case, the responsibility or access for this data is shared; both TCELL and agricultural service providers can use the data collected at the farmers. This can be considered as a benefit for TCELL and agricultural service providers but also as a cost to farmers.

To support the realization of the connectivity solutions (and subsequently the smart farming services offered) in practice, three investment structures can be considered. Since the farmers in Türkiye often belong to a cooperative, investments by the association or cooperative can be considered: here, end-users typically pay a subscription fee to be part of the cooperative that can be (partially) used to finance the connectivity solutions in practice. The local government may also support the deployment of the connectivity solutions because it is beneficial for the productivity of the olive tree farmers and could help in improving the attractiveness of the area. Lastly, telecom providers or agricultural service providers might be interested in data collected through the deployment of the solutions in practice (which can potentially be monetized or used elsewhere). This may warrant some investments in the connectivity solutions to overcome financial barriers faced by end-users (olive tree farmers). Logically, it should be further explored how the distribution of investments will take place, but we see that multiple (collaborative) options are available to stakeholders to select from.

In terms of values, different perspectives are considered. For olive tree farmers, the value of having access to connectivity solutions is that farmers can support their cultivation processes and increase their productivity. In addition, the quality of the olives is expected to increase (which may warrant premium prices when sold to the market). Obviously, investments (as explained) are needed to support these connectivity solutions (and by extension smart farming solutions). This means that subscription or investment costs are expected for farmers. Additionally, some data sharing is required which could be considered as a cost.

For the cooperative, the value of connectivity may be connected to productivity of its associated farmers. The cooperative can benefit from its individual farmers performing well by being able to negotiate better prices for olives distributed or by increasing the predictability of the yield produced. Additionally, cooperatives may also value the decrease in emissions which can potentially result from using smart farming services. Naturally, investment and orchestration costs to set up connectivity and smart farming solutions with TCELL are expected. These investments are done by individual farmers of the cooperative but can also be fulfilled by the government or other value chain stakeholders.

The local government will benefit from improving the attractiveness of the area; access to connectivity can enable businesses (such as farmers, but also other types of organizations could be considered) to operate, in turn benefiting the local economy. It can also contribute to addressing digital inclusion and societal wellness of inhabitants in a particular area. This may justify investments in connectivity and smart farming solutions by the local government.

As indicated, other value chain actors will benefit from increased quality of olives produced. This may warrant additional investments for the connectivity solutions, to ensure that farmers are able to improve their cultivation practices.

For the cultivation service provider (offering farming services to the olive tree farmers), its benefits primarily pertain to being able to offer additional services and to expand on its user base. Additionally, data can be collected on farmers which can help these service providers to continuously improve their services offered. Again, this may warrant working with olive tree farmers to ensure that the smart farming services are catered to the needs of the farmers.

For the regulator, the main benefits are related to receiving a fee for assessing / certifying the quality of the olives produced. It is expected that through access to smart farming solutions, the quality of the olives will increase. This quality increase can be made explicit by regulators or certifiers, such that farmers can likely sell their produce at a premium price. Costs related to validation and certification activities are expected for this role.

The resulting business model design is illustrated in

Figure 6. The collaborative business model design maps the stakeholders indicated for the reference framework, as well as maps the values (and costs) each actor will generate through this business model design. This business model design subsequently serves as the starting point for further concretization; stakeholders involved determine the *quantification* of costs and benefits obtained to understand whether the selected structure is *viable*. Moreover, stakeholders should reflect on whether the design decisions made are desirable (for example,

are lock-in effects created, are stakeholders able to support the business model design in practice).

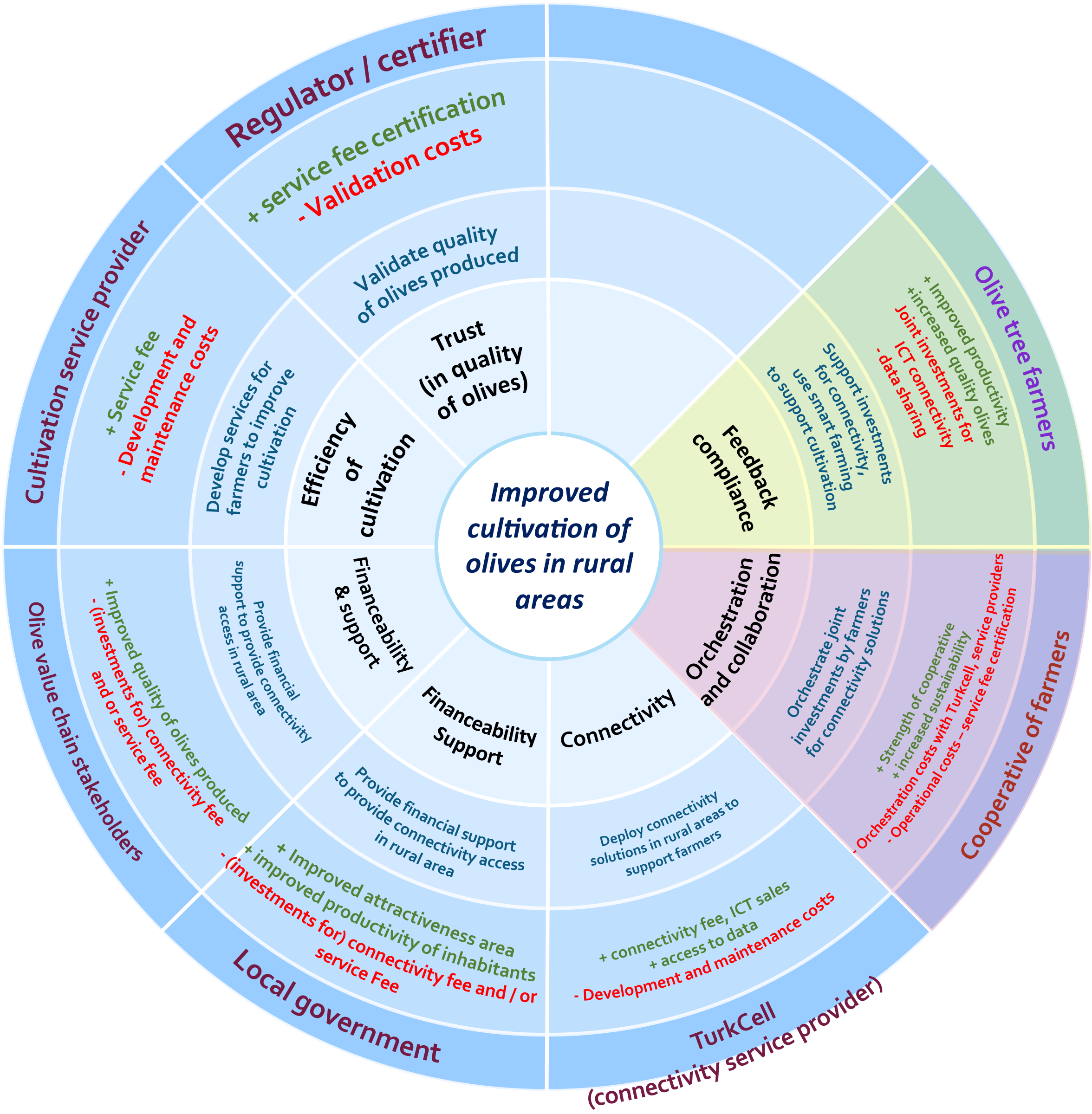

Figure 6: Preliminary collaborative business model design generated for LL Turkey (using framework)

6. Results from 2nd set of business model working sessions

In this section, we detail the results obtained through the 2nd set of business model working sessions. For the first set of results (objectives of LLs and deeper understanding of stakeholders involved and drivers and barriers), we refer to COMMECT deliverable 3.1. At the time of writing, the business model working sessions with the Danish, Serbian and Turkish LL have been conducted, and the results for the planned Norwegian and Luxembourgian working session will be added to the next version of this deliverable.

The goal of the working session was to generate an understanding of how the connectivity solutions create value for stakeholders involved, why it is needed and what options are available to finance the solutions (and why). The results for the Danish Living Lab are summarized through Table 5 presented below.

6.1 Results for Living Lab Denmark

Table 5: Working session outcomes for LL Denmark

	Use case 1: pig transportation	Use case 2: loading and unloading
Data requirements	Ensure easy compliance to regulations	Ensure easy compliance to regulations
Value proposition	Improved monitoring of driver conduct to improve animal welfare	Avoid problems and accidents while loading and unloading pigs
Collaboration	Leading actor: OEMs	Leading actor: farmers associations
Finance	Subscription Scalable to other types of transport	Subscription Scalable to other types of transport

For the Danish Living Lab, the need for connectivity solutions are geared towards two use cases, namely monitoring of livestock transport along rural routes (UC1) and monitoring of livestock loading/unloading processes (UC2). We see in Table 5 that the data requirements for both use cases serve the same purpose, namely to ensure that stakeholders can comply to regulations such as animal welfare (to protect the pigs during transfer and loading) or transparency of operations (what pigs are transported and what are their conditions). However, the value propositions associated to each use case differ; for the former, access to connectivity enables truck drivers to monitor the welfare of the animals being transported. Based on actual data (such as temperature, video imaging of the pigs), the truck driver can improve its (real-time) decision making to ensure that the animal's health is supported. For the latter, the value proposition is linked towards avoiding problems and accidents during the loading / unloading of pigs. This can for example be related to communicating with the driver (to ensure that the timing of unloading is correct) or can in general help the farmer gain access to connectivity (some farmers do not have access to connectivity currently in place).

From these value propositions, we see that there is a difference in terms of the *leading actor* or *main beneficiary*. The truck drivers are responsible for the adequate transportation of pigs; hence, there is an added-value for solutions that help drivers (and by extension the truck companies or OEMs) to improve their decision making. In contrast, UC2 aids farmers (or by extension, farmer associations) in supporting the unloading and loading of pigs. As a result, they can improve the effectiveness and efficiency of their operations.

In terms of exploring investment structures (finance), both use cases could be provided through a subscription fee paid by the lead actor (OEMs / truck companies and farmers associations). The connectivity solution for UC1 would help truck companies offer higher quality services, which may warrant investments in terms of a subscription fee. A challenge here is that the logistic market is typically highly competitive, characterized by low margins. This may make truck companies reluctant to invest if the value is not clear. For UC2, farmers benefit from improved efficiency / effectiveness of loading and unloading pigs. However, farmers are not always tech-savvy, which may generate a barrier for investments.

6.2 Results for Living Lab Serbia

Table 6: Working session outcomes for LL Serbia

	Use case 1: Energy, computing and communication via shared rural infrastructure	Use case 2: Shared environment monitoring platform	Use case 3: Shared digital agriculture platform	Use case 4: Shared community platform
Data requirements	Input for other use cases, collection of relevant data to enable other use cases	Data on weather conditions, noise levels and water and air quality	Data on farming operation, irrigation and disease management	Data sharing on agricultural practices between farmers
Value proposition	Enable mobile connectivity for farmers to offer decision making support	Support well -being of neighbouring forests through data-driven insights	Decision making support for farmers on how to improve effectiveness and efficiency of farming operations (agroNET)	To support decision making based on community generated and external data, sharing of best practices and agricultural data
Collaboration	Farmers association	Farmers association, rangers, government	Farmers association	Farmers association
Finance	Financial lease of equipment	Subscription for platform, support by government	Subscription for platform	Subscription for platform

For the Serbian Living Lab (described in Table 6), the need for connectivity solutions is related to four interdependent use cases (UCs). UC1 describes the infrastructure needed to enable connectivity (and to foster the collection of data) and provides the basis for UC2, 3 and 4 to function. In terms of data requirements, various data sources are needed. For UC2, which is geared towards monitoring the environment, data on weather conditions, noise levels and water and air quality is needed. For UC3, data is collected on farming practices as well as data on irrigation levels and spreading of diseases. For UC4, this data is shared as part of a community-based platform to which stakeholders can contribute.

In terms of value propositions, we see that access to connectivity enables different value propositions to (different) end-users. UC1 enables connectivity for farmers to enable services which help contribute towards decision making. This can help improve efficiency and effectiveness of farming operations through agricultural services (UC3), or can enable farmers to share best practices and support (and receive support through) the community of farmers (UC4). These value propositions are relevant to both farmers and extension farmers associations. Data collected can also contribute towards monitoring the conditions of the environment, which is relevant to rangers and government bodies responsible for managing the nature park conditions.

In terms of financing options, a financial lease of equipment by farmers can be considered to enable UC1. It should be noted that farmers do not have access to large financial investments. Here, a community-based investment or support through government bodies is likely needed. Subsequently, subscription models can be employed to access services through the platforms offered. This depends on the specific needs of the end-users (farmers, rangers) addressed. As the solutions are platforms, there is a need for supply and demand of users to make interactions or data collected as part of the platforms ‘valuable’ (e.g., its value grows with the number of users associated to the platform). This is a challenge to overcome in terms of business model development.

6.3 Results for Living Lab Turkey

Table 7: Working session outcomes for LL Turkey

	Use case 1: Microclimate monitoring for early disease and pest detection	Use case 2: machine vision pest monitoring
Data requirements	Data collection from weather stations and soil sensors, analysed to become actionable	Regular visual recording of pest trap, with quantity and type of pest visible
Value proposition	Better spraying strategies and orchard management based on data-driven insight	Timely and targeted pesticide use on olive trees to avoid excess usage of pesticide and minimize olive loss
Collaboration	Farmers associations with government	Farmers associations with government
Finance	Mainly governmental investment	Mainly governmental investment

As the Turkish Living Lab was used to demonstrate the use of the business model design framework, its contents have already been described in Chapter 5.1. The initial business model for this Living Lab, which was presented in Chapter 5.2, is party built on the outcomes of the working session which are described here. The summary of the hands-on working session results with the Turkish Living Lab is described in Table 7.

As for data requirements, it is clear that raw data collection is not enough in these use cases to create value. The data needs to be analysed and be translated into insights which are useful (understandable, actionable) for olive farmers. Data can be collected with the sensors, traps and devices and transferred using the connectivity that will be provided by Turkcell. As the data also needs to be analysed by a party, the working session was concluded with the assumption that the government will be most likely the party who will conduct the analysis.

The value propositions from both use cases are well supported with end-user needs and are described in detail in Chapter 5.2 and Deliverable 1.1. The main beneficiaries of these use cases are the olive farmers but indirectly also the farmers associations (better yields of their members) and the local government (better economic performance) benefit.

Although the main benefit lies with the individual farmers, they would not be the leading actors in setting up these use cases and the collaboration around them. They are following the recommendations of the farmer association they are part of. The farmer associations would represent their members when making an investment decision around this, and the government would also play a central, stimulating role.

The full financing structure for the use cases is not yet designed, but it is certain that the government will play an important role in the investment. The individual farmers might have to pay a service fee or a subscription fee, but they will – most likely – not buy the equipment themselves. Besides the government, other organizations who gain benefits from these use cases could also join the investment. Telecom providers, agricultural research institutes and service providers could be interested in the data which will be collected, and might join in on the investment in exchange for gaining access to the collected data.

7. Conclusion

In this deliverable, we have presented the initial work conducted in the context of Task T3.3 on supporting the design of business models for connectivity solutions in rural areas. Based on a literature review of the state-of-the-art for connectivity-enabled (digitally-enabled) business models, we propose an initial reference framework to support the development of these business models. Stakeholders in the Living Labs can use this framework to support their business model design.

The next step is targeted towards finalizing the first set of working sessions (regarding the use cases and impact on value creation) for the Living Labs. Afterwards, we will orchestrate collaborative business modelling working sessions to go into the actual design of business models for the respective Living Labs. These working sessions are planned to be held around May 2024. The resulting business models should help the Living Labs in deploying the connectivity solutions in practice. The business models may also serve as further inspiration (complementing the reference framework) to others working on realizing connectivity in rural areas.

Working with the Living Labs should also help to improve the reference framework. Learning from what options are selected and why combinations of options are selected, we can further provide guidance on how the reference framework is used. For example, he following aspects are indicated as relevant to consider for adding to the reference framework by Living Labs. We intend to further explore what options can be considered here:

- Category related to the deployment of the solution: who will provide the solution and how will this be provided? Will a single organization provide the solution or will this be the result of a collaboration between stakeholders? How will this collaboration be structured (alliance, joint venture..).
- How can elements in the categories be improved? For example, what stakeholders are missing in its current category, or what stakeholder types should be refined to better reflect the needs and design choices relevant for the LLs?

These questions will be addressed in version 2 of this deliverable, due in month 30.

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