DELIVERABLE 2.3.1
ECOSYSTEM ORCHESTRATION TOOLBOX

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Northern Periphery and Arctic Programme 2014-2020

EUROPEAN UNION
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Abstract:
The deliverable presents the results of activity AT 2.3 Ecosystem tools analysis. The report starts with theoretical background of business ecosystem concept and tools and describes the tool for ecosystem mapping available at project official website (https://huge-project.eu/ecosystem-mapping-tool/). The report also describes the application of the tool with the examples from project case studies.

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1. Introduction

The objective of the current report is to presents the results of project activity AT 2.3 Ecosystem tools analysis. The concept of "ecosystem" offers the opportunity to explore the interdependencies and interactions between various organizations in business innovation (Autio & Thomas, 2014). The emphasis in an ecosystem is on the way different actors constantly cooperate and interact to co-create the value within the ecosystem (Moore, 1996). In this regard, the interaction between actors which evolves continuous cooperation, conflicts and adjustments leads to shifting positions between actors and creating new roles in the ecosystem (Pellikka & Ali-Vehmas, 2016).

The report consists of two major parts. In the first part we discuss the theoretical background of the business ecosystem, innovativeness, orchestration and outline relevant tools and concepts present in academic literature. The objective of this part is to collect and discuss the best practices for ecosystem development, mapping and orchestration. The second part is devoted to the presentation of the dedicated tool developed to assist the business ecosystem mapping. The tool utilizes theoretical capital from the first part and merges it with the specific project findings and methodology described in prior deliverables (DT 2.1.1 Stakeholder (end-users) value analysis and DT 2.2.1 Ecosystem map). The tool, therefore, can be seen as an instrument for the ecosystem analysis, orchestration and mapping methodology developed in project activities AT 2.1 Stakeholder analysis AT 2.2 Ecosystem analysis. The tool is available at the project website (https://huge-project.eu/ecosystem-mapping-tool/) and consists of two ecosystem mapping templates – online for collaborative work through MIRO board service and downloadable pdf for f2f ideation workshops.

2. Conceptual background

2.1. Business Ecosystem

Based on the ecological point of view, business ecosystem is defined as an economic community in which private firms and organizations co-operate with each other and developing their capabilities. The scope of business ecosystem is beyond the concept of supply chains and includes organizations with shared value on products and services, policies, and stakeholders (Moore, 1996). Ecosystems allow firms to create value that could not be achievable alone (Ander, 2006). Galateanu & Avasilca (2013) claim that a complex and multi-staged process is required to design a business ecosystem including good knowledge about different factors that can be integrated within the ecosystem. Four stages are identified for business ecosystems as follows: birth, expansion, leadership and self-renewal or death. The innovativeness degree of ecosystem is an important factor for the survival of the firms within the ecosystem.

In an innovative ecosystem, strategy making is an iterative process which forces managers to revise their performance expectations and to rethink the preliminary plan. Stages for revising and rethinking innovation strategy are presented in Figure 1.

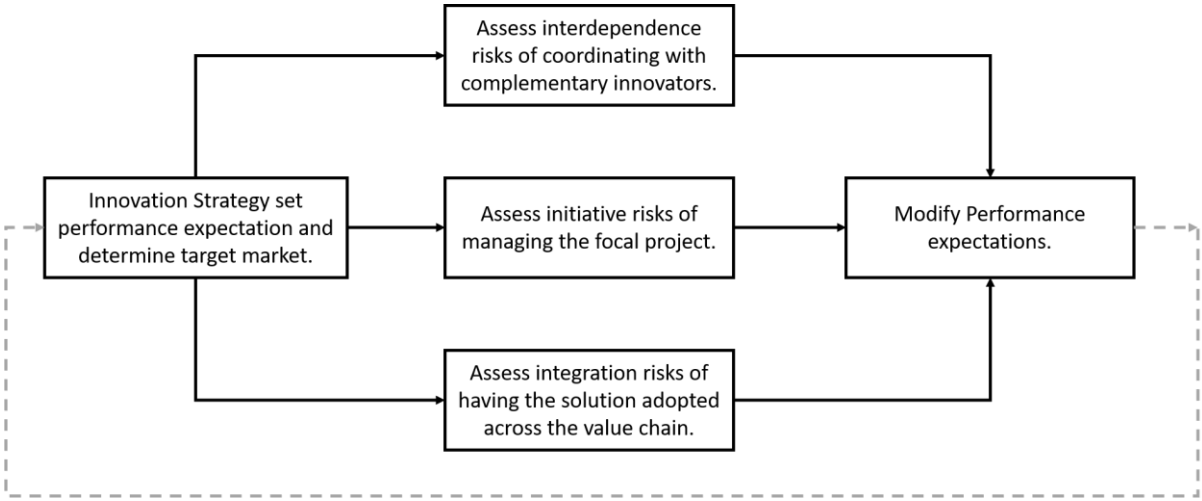

Figure 1. The process of revise and rethinking innovation strategy (Ander, 2006)

Mapping the innovation ecosystem is considered as the best way to determine whether the firm set the realistic performance expectations for innovation strategy or not. Therefore, the following steps are proposed (Figure 2):

1. Identification of all the intermediaries that must adopt the innovation before it reaches consumer.
2. Identification of all the other complements (such as innovations needed for firm's specific innovation) which are required for the firm and each of the intermediaries of the firm so that the offer can move forward to the consumer.
3. Estimating the delays which are caused by firm's interdependence with complementors.
4. Estimating the delays which are caused by the adoption process and by the time it takes each intermediary to integrate to firm's solution into processing time.
5. Estimating the delays which are caused by the intermediaries' interdependence with their own complementors.
6. Base on previous estimations, arrive at "time-to-market" for firm's innovation.
7. After identifying the delays (interdependencies and risks), reassess the initial performance expectations and innovation strategy. If the initial expectations seem unrealistic regarding to the risks, the manger has to consider the options for closing the expectation gap such as changing expectations, markets, partners or strategies.

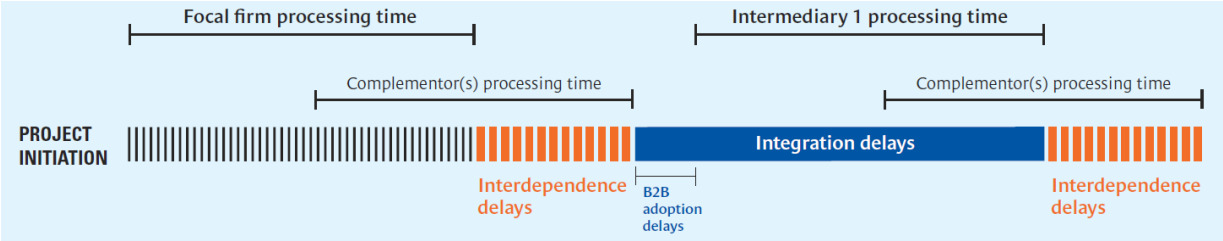

Figure 2. Risk and expectation analysis (Ander, 2006)

Since various target markets are available for innovation, mapping ecosystem for different markets can differ significantly even if the main innovation remains the same. Hence, a holistic understanding of different ecosystems plays the key role in affectively assessing options and prioritizing opportunities. Moore (1996) defines the business ecosystem as " An economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world. This economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organism also includes suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the direction set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments, and to find mutually supportive roles". For ecosystems to be useful, there must also exist a significant need for coordination that cannot be dealt with in markets, but which also does not require the authority structure of a central actor which in turn, arises due to different types of complementarities. Jacobides *et.al* (2018) mention that ecosystems are different in terms of structure when compared to either market-based transactions or supplier-mediated arrangements (Figure 3).

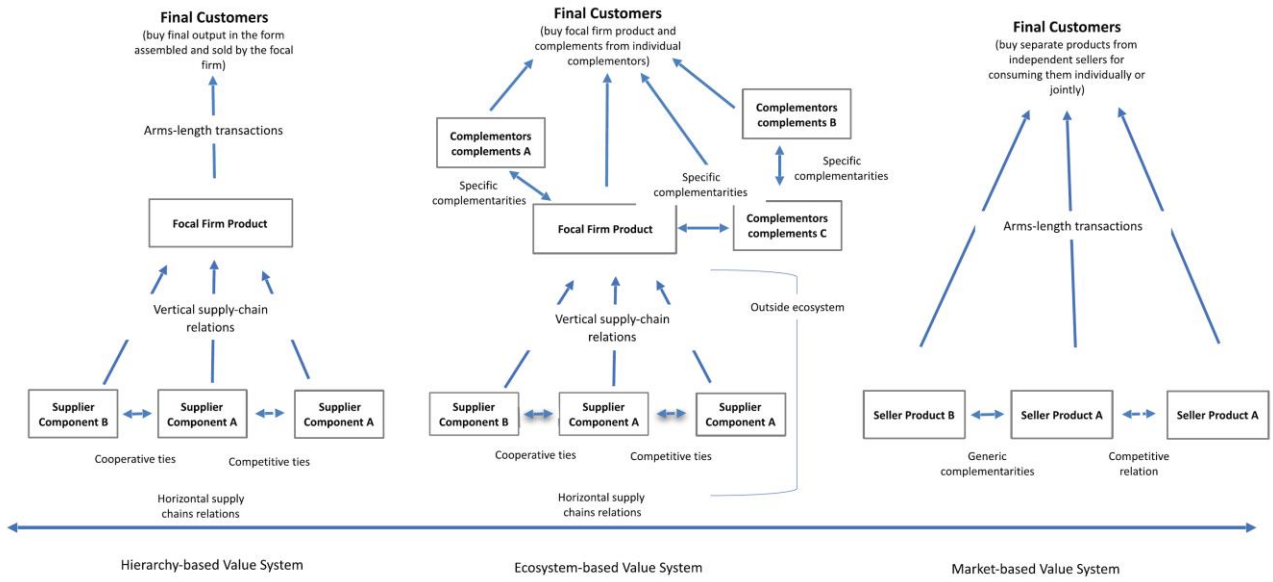

Figure 3. Different value systems (Jacobides *et al.*, 2018)

Modularity is critical in generating ecosystems which results from the key industry participants. The behaviour in an ecosystem and its success is highly affected by the rules of the engagement and the nature of the standards and interfaces. Therefore, the level and form of control in an ecosystem are required to be managed by orchestrators. According to the literature a hub firm works as an orchestrator which can shape the ecosystem indirectly rather than direct control and command (Scaringella and Radziwon, 2017; Williamson *et al.*, 2012). Next section we discuss more in detail on ecosystem orchestration and its capabilities.

2.2. Ecosystem Orchestration

Different organizations of the business ecosystem should follow the ecosystem innovative environment. An innovation ecosystem combines the specialized complementary technologies, knowledge, and other resources across organizational boundaries in unique ways, while presenting a broader and more fluid structure and boundary relative to bilateral partnerships (Williamson *et al.*, 2012). In this respect, Gawer & Gusumano (2014) define "external (industry) platforms as products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their own complementary products, technologies, or services". Hence, firms need to rethink about the management of their external relationships. These processes are beyond the managerial establishment and predetermined relationships (Gawer, 2014).

Accordingly, orchestration of the ecosystems plays an important role to ensure that responsibilities are distributed equally between the actors and that partners have the same share in value co-creation. In other words, in order to ensure the health of the ecosystem, orchestrators should make balance between controlling and enabling/inspiring the ecosystem. Figure 1 illustrates the framework for ecosystem orchestration based on orchestration in innovation networks (Dhanaraj and Parkhe, 2006)

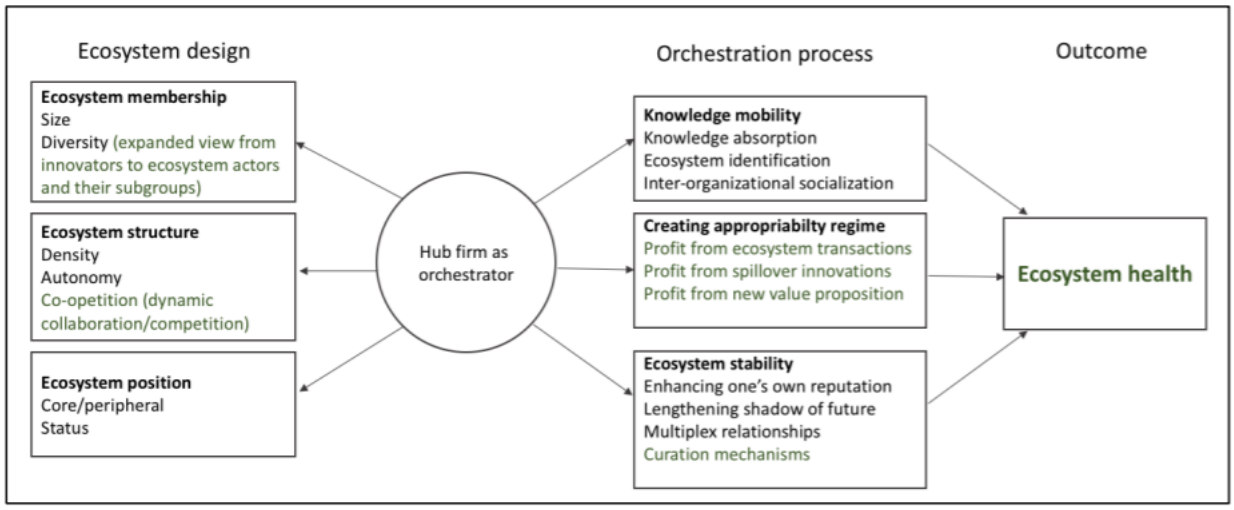

Figure 4. A framework for ecosystem orchestration (Dhanaraj and Parkhe, 2006)

In business ecosystems, hub firms play the key role in "regulating ecosystem health" (Iansiti & Levien, 2004). Dhanaraj and Parkhe (2006) define a hub firm as one of the possesses prominence and power gained through induvial attributes and a central position in the network structure, and that uses its prominence and power to perform a leadership role in pulling together the dispersed resources

and capabilities of network members. The network orchestration is the set of deliberate, purposeful actions undertaken by the hub firms as it seeks to create value from the network. Hub firms are the strong leaders which have power over the network members and play the role as orchestrators within the ecosystem. However, according to the research, a leadership role in ecosystem is challenging since there is a risk of failure in strategies in business aspects required for this role (Gawer & Cusumano, 2008). Ecosystem design is related to what degree members can independently take action within formal or informal network. In addition, how different actors collaborate and compete with external actors is another dimension of the structure of ecosystem. Furthermore, the status and centrality of the ecosystem is identified by how different actors distinguish the hub as an orchestrator (Levén et al., 2014).

On the other hand, orchestration process relates to how the hub firm manages the network. In this regard, knowledge mobility defines that value creation is not achieved in isolation but rather through an open system which can attain trust, absorb knowledge and sets different channels of communications. The hub firm can influence the network operations though different means.

Furthermore, the appropriability regime is related to the way a firm "governs an innovator's ability to capture the profits generated by an innovation", patents, trademarks and copyrights are some examples. Finally, the stability of the ecosystem relates to the positive growth in network and at the same time flexibility for entry or exit of network. Since digital transformation such as digital platforms is influencing and changing how the businesses work. These platforms orchestrate their ecosystems consisting of platform owner, end users and complementors (McIntyre and Srinivasan 2016). From the platform perspective, orchestration effects on the degree to which different actors of the ecosystem innovate novel offerings to develop them incrementally and organize the accomplishment of the transactions. Therefore, to achieve success, platforms should engage in orchestration for efficiency, development and innovation. Platform ecosystems have four linked in common as follows: value co-creation, interdependency of actors, synergy and evolutionary growth (Ceccagnoli et al. 2012; Nishino et al. 2012; Armstrong 2006). In this regard, several firms together with end users co-create value for which actors of the platform ecosystem should be in complementary relationship. Such interdependencies of several actors lead in producing surplus value. Platform ecosystems can expand their environment by adding new actors and components or connecting to other ecosystems. McIntyre and Srinivasan (2016), mention that platform owners play the key role in platform ecosystems in two ways: goal-directedness and happenstance. While goal-directedness processes are based on achieving a common goal for the whole ecosystem, in happenstance processes there is no pre-determined goal; the goal will be developed in an evolutionary manner (Kilduff and Tsai 2003).

The orchestration capability is the capability to purposefully build and manage inter-firm innovation networks (Dhanaraj and Parkhe, 2006). Orchestration capability is especially required in future-oriented value creation, in search for both incremental and radical innovation and new business opportunities (Ritala *et al.*, 2009). The reason is value creation through knowledge and innovation requires the ability to bridge different experts and specialists together. Considering orchestration capability, it is evident that it consists of interaction between various organizations, and also among the individuals associated with those organizations.

Orchestration capability as an organizational level is originated in evolutionary economics and the resource-based theory of the firm. Capabilities consist of repeatable routines which are path-dependent on organizational history, where the successful repetition of specific routines can increase organizational competitiveness. In addition, orchestration capabilities have induvial level equivalent as well which includes the skills and knowledge of individual human beings. Organizational and individual level capabilities are intensely interconnected. Table 1 presents individual and organizational capabilities of orchestration.

Table 1. Individual and organizational capabilities of orchestration

	Knowledge mobility	Innovation appropriability	Network stability
Individual skills	Interpersonal and communication social skills	Balancing skills Negotiating skills Entrepreneurial skills	Influencing skills Visioning skills Motivating skills
Organizational capabilities	Operational capability Collaboration capability Competence leveraging capability	Legitimizing capability Balancing capability Entrepreneurial capability	Visioning capability Influencing capability

Four mechanisms which suggest the interplay of organizational level capabilities and individual skills of innovation network orchestration: 1) execution of organizational capabilities through individuals‟ actions, 2) institutionalization of organizational capabilities through individual actions over time, 3) substitution of organizational capabilities with individual action, and 4) complementation of organizational capabilities with individual action.

Examples of ecosystem orchestrations are platform ecosystems. Platform ecosystems have four interrelated cohesion as: co-creating value, interdependency and complementarity of participants, synergy, and evolutionary growth. Digital service platforms are the orchestrators of platform ecosystems and the ecosystems are interconnected as participants contribute to several ecosystems. Platform ecosystems compete with each other to attract more customers, end users and participants.

Platform owners should be capable of renewing the offerings which is essential to attract end users and stay in competition. From the digital service platforms perspective, most of the processes of value co-creation are social types and provide intangible value and experiences for end users instead of technological performance. According to Smedlund et al. (2018), internal platforms should be orchestrated for efficiency, industry platforms for development and inter-industry platforms for innovation. Orchestration process involvement are essential in order to renew platform offerings and to keep the position in the market.

An example of hydrogen ecosystem orchestrator is LIFTE H2 (https://www.lifteh2.com/ecosystems).

LIFTE is in a position to see the whole picture, to orchestrate the supply chain to fit the ever-changing market, and our partners trust our stewardship of their products for mutual benefit. The company is building an ecosystem of technology and service providers all striving to hydrogen power and mobility while seeking to a catalyst and accelerator of the nascent hydrogen economy.

3. Ecosystem mapping tool

The purpose of this tool is to represent the structure of business ecosystem in a structured manner, so the ecosystem map is easily to understand and communicate to relevant stakeholders. Objective is to map the existing and planned (required) ecosystem players, identified during the prior stakeholder value analysis (reports DT 2.1.1, DT 2.2.1), visualize value streams, resources and expertizes. The tool aims to support the development of hydrogen utilization business model (DT 2.4.1) but can be used on its own for design and analysis of business ecosystem. The tool is available at the project official website (https://huge-project.eu/ecosystem-mapping-tool/). The tool page contains the brief information about the business ecosystem, the description of main elements of the tool and the links to downloadable ecosystem mapping template (in pdf format) and online mapping tool (located at Miro boards services). Depending on their preferences and technical capabilities the users can utilize either online template or use printed canvas for f2f workshops. The page also contains the links to supporting materials (including the following report) where the steps for data collection and preparation as well as the tool application and illustrative examples from project regional case studies are presented in greater details. The screenshot of the tool page is presented below (Figure 5).

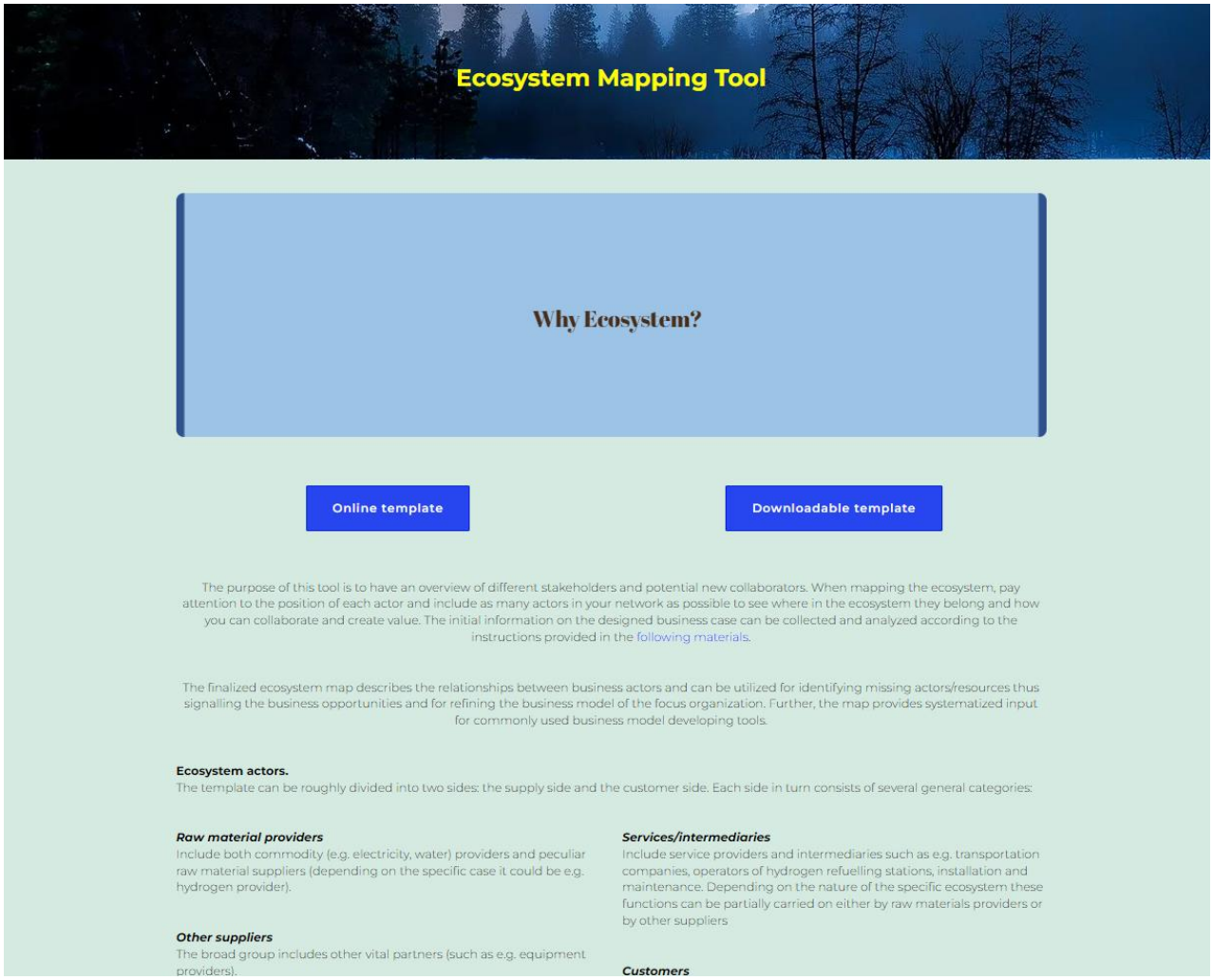

Figure 5. The Ecosystem mapping tool online page

3.1. Templates

The tool is available in two formats: downloadable pdf template for printing (Figure 6) and online template (Figure 7). The downloadable pdf template presents a simple canvas with dedicated ecosystem actors areas (for description of various ecosystem actors groups see the following part). The canvas can be printed (preferably on a large format such as A2-A1) and used during the f2f brainstorm sessions. The actors and linkages between them can be simply drawn by hand or sticky notes can be used. The approach is intuitive and easy to implement and does not require any specific online collaboration expertise and tools, however the modification of once drawn ecosystem is difficult (ideally a new template needed) and opportunities for co-design with remote participants are limited.

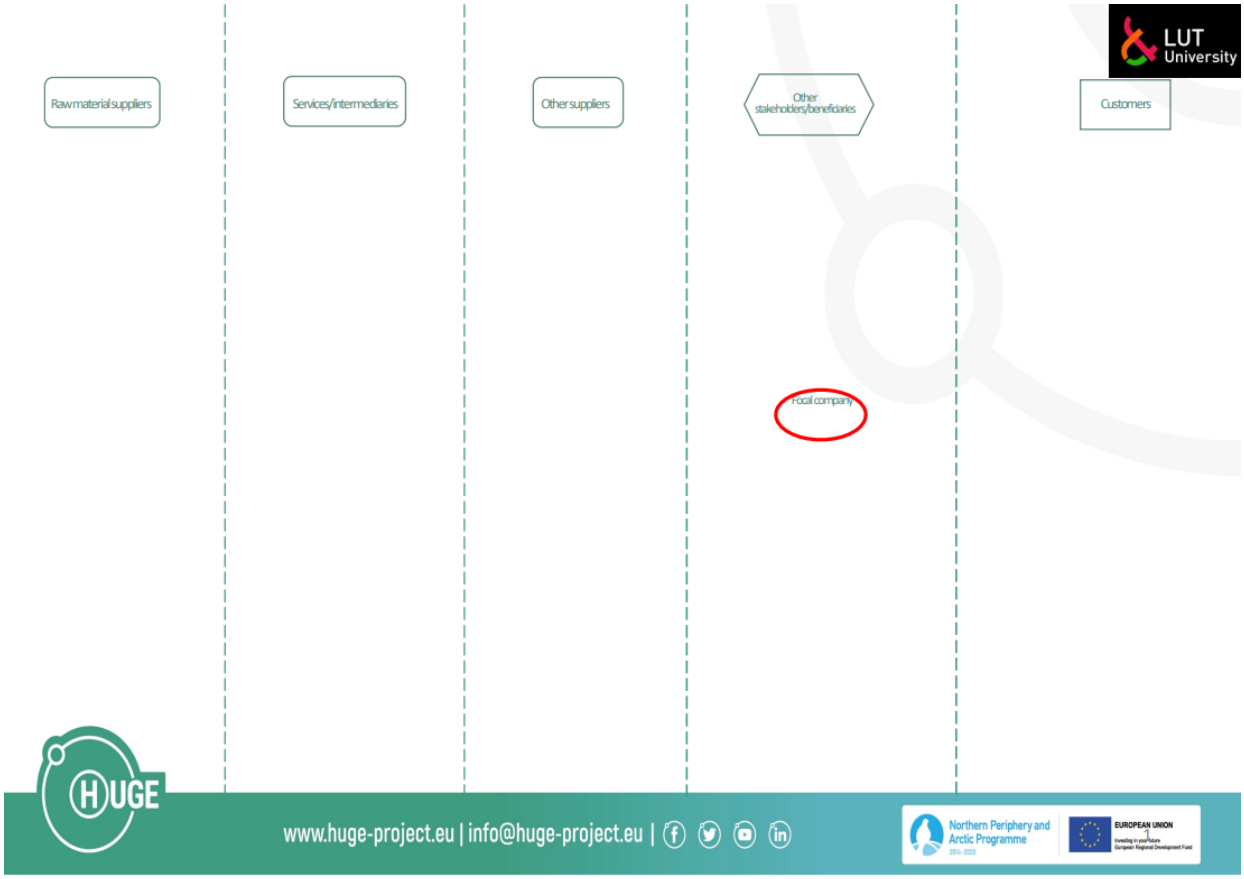

Figure 6. Downloadable ecosystem mapping canvas

To overcome the limitation of simple printed ecosystem map the online template can be used. The template is implemented though Miro boards (https://miro.com/) a whiteboarding platform enabling online communication and co-development. With the use of online Miro template, the distantly located users can simultaneously work on the ecosystem map which can be further shared with other stakeholders. Additionally online tools allow for greater flexibility and modification in the created maps which facilitates the design process even further. Consequently, the online template differs from the downloadable canvas by greater details (since these additional details can be easily removed or changed depending on specific user objectives) and presents the simple generic ecosystem consisting of few actors representing each category. The users can add, delete and relocate the actors following the simple notation guidelines (i.e. colors and shapes for specific actor category).

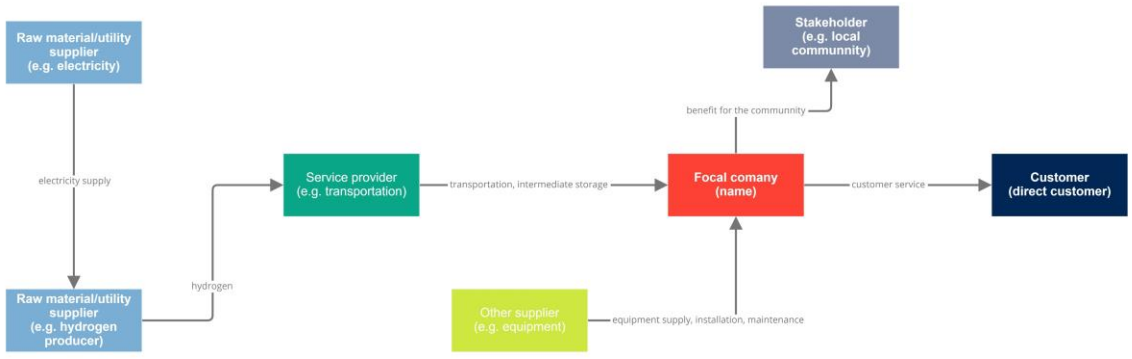

Figure 7. Online template

The provided templates allow various approaches for ecosystem design and mapping both online and offline, individual and collaborative. It should be noted, however, that online template, due to its nature (allowing for easy modification) provides more information comparing to pdf downloadable template. Therefore, it is advisable even for pdf canvas users to get acquainted with the online template in order to get better understanding of ecosystem structure.

3.2. Ecosystem actors

To facilitate the ecosystem mapping (based on results of data collection and analysis described in DT 2.1.1 and DT 2.2.1) the stakeholders (and hence actors of the business ecosystem) can be divided into several partially overlapping categories: raw material providers, services/intermediaries, other suppliers, customers (direct) and other stakeholders/beneficiaries. While this classification can be considered to certain extent as generic in the discussion below, we focus specifically on hydrogen-based ecosystems utilizing examples from regional case studies.

Raw material providers

This category includes both commodity (e.g. electricity, heat, water) providers and peculiar raw material suppliers which can be specific gasses required for technological processes (e.g. CO2) or in cases when the actual hydrogen production is already exists and/or located outside of focal region – hydrogen (see D 2.5.1. Finnish and Scottish examples where in the first case hydrogen (as redundant by-product) is acquired from already operating chemical company and in the second is being imported from the supplier located in another region).

Services/Intermediaries

Include service providers and intermediaries such as e.g. transportation companies, operators of hydrogen refueling stations, installation and maintenance. Depending on the nature of specific ecosystem these functions can be partially carried on either by equipment providers, raw materials providers or by other suppliers. Thus, in Icelandic case the basic maintenance of hydrogen trucks can be performed either by truck operator or by local garages but serious interventions into hydrogen equipment require certified mechanics, manufacturer expertise and special equipment. The very important intermediary for cases focused on hydrogen-powered transportation (such as Iceland, Faroe and Aran Islands) is a hydrogen refueling station operator.

Other suppliers

The broad group including other vital partners (such as e.g. equipment providers). This group primarily includes suppliers of specific hydrogen related equipment (e.g. hydrogen boilers in Scottish case, hydrogen trucks in Icelandic case, hydrogen powered working boat or ferries in Faroes and Aran Islands consequently). However, depending on the desired level of details other (non-hydrogen equipment related) suppliers can be also included. These suppliers might represent already existing actors (and partnership with them), especially in cases where the focal company is already operating in some kind of business ecosystem and therefore after switching to hydrogen solutions the certain part of existing ecosystem may remain intact.

Customers (direct)

This category primarily includes direct customers which can be private, business and public, depending on the nature of specific solution. The project case studies present the high variety of direct customers reflecting the high variety of topics covered by the project and regional specific.

Other stakeholders/Beneficiaries

Include the high variety of stakeholders and beneficiaries which cannot be explicitly designated as customers or suppliers but are nevertheless important for the planning ecosystem (e.g. local government bodies, local community). This category may include also customers for by-products (such as district heating operator in Faroe Islands case benefitting from heat excess during the hydrogen production). Noticeable that in some cases one actor can be a direct customer for the focal firm but also utilize by product of hydrogen ecosystem. Thus, in case of Faroe Islands the fish farm while being the direct customer for working boat owner may utilise also by-products of hydrogen production (oxygen and heat).

4. Conclusion

The report presents a summary of relevant business ecosystem design and orchestration concepts and tools discussed in the current academic literature. While the literature about ecosystem orchestration is abundant, the majority of works focus on online ecosystems orchestration which limits their applicability to project-specific hydrogen-based ecosystems (and other non-digital ecosystems). The report provides examples of some tools, however they were not able to fulfil the project case objectives. Therefore, to support the development of hydrogen utilization business model have been developed an ecosystem mapping canvas which is presented at project official website.

The objective of the tool is to map the existing and planned (required) ecosystem players, identified during the prior stakeholder value analysis (reports DT 2.1.1, DT 2.2.1), visualize value streams, resources and expertizes. The tool, therefore can support the development of hydrogen utilization business model, but can be used on its own for design and analysis of business ecosystem. To address various background and working preferences of users the canvases are provided in two versions: downloadable (in pdf format) and online (located at Miro board service). It should be noted though, that the methodology of ecosystem mapping described in this, and prior deliverables allows for various means of actual implementations. Thus, following the provided guidelines the ecosystem can be mapped in Power Point or, for example Visio tools (as it was done for the project case studies). The choice of the actual software is therefore up to user personal preferences and expertise.

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