BUSINESS
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WORLD-CLASS ECOSYSTEMS IN THE FINNISH ECONOMY

Impact Study

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FOREWORD

The basis of Finnish wellbeing stems from the wealth and jobs created by the success of Finnish companies in the global market. The role of Business Finland is to promote the prosperity of Finland by stimulating the emergence of new and innovative initiatives and by supporting the internationalization of the Finnish industry.

Business Finland's impact and the achievement of objectives will primarily be monitored through impact analyses and studies of individual target areas. At the time of this evaluation, Business Finland had two strategic target areas: 1) Global Growth for Companies, and 2) World-class Ecosystems and Competitive Business Environment. Impact studies implemented in each target area and impact studies presenting their results comprise the actual and official method for monitoring Business Finland's success and impact.

Business ecosystems flourish when different stakeholders and industries meet and collaborate. Business Finland has taken an active role in pushing forward new initiatives that have the potential to grow into ecosystems, and to support the most promising ecosystems to grow into international success stories that renew, grow, and improve the competitiveness of the Finnish economy. Business Finland's ecosystem portfolio currently consists of more than 40 ecosystems, ranging from new emerging ecosystems to mature international business ecosystems.

The main research questions of this evaluation are as follows: How can public sector in Finland improve its ability to build ecosystems in order to attract global actors to Finland? What has been the main value added of the funding and services of Business Finland for promoting business ecosystems in the Finnish economy? What kind of critical obstacles and bottlenecks have affected, or could affect, the ability to achieve these goals? What kind of societal impacts (renewal of economy, environment, well-being, capabilities, company growth, ecosystems) have been achieved and how they could be measured?

The evaluation was carried out by an interdisciplinary team of experts from Technopolis Group and 4Front. Business Finland wishes to thank the evaluators for their thorough and comprehensive work. Business Finland expresses its gratitude to the steering group and all others who have contributed to the study.

Helsinki, April 2021, Business Finland

MANAGEMENT SUMMARY / POLICY BRIEF

THIS IMPACT STUDY

One of the two key strategic impact targets for Business Finland is: *"World-class Ecosystems and Competitive Business Environment"*. Business Finland and the Ministry of Economic Affairs and Employment (TEM) have decided that the realisation of this impact target would be evaluated once every two years. This is the first evaluation that is performed specifically regarding the ecosystem policy.

The overall evaluation consists of two parts: Work Package A (a mapping of high potential ecosystems, identification of potential thematic areas and development of an evaluation plan) and Work Package B, this impact study. The approach used in this impact study of the ecosystem policy consists of a balanced mix of qualitative and quantitative methodologies. Main methodologies used include a mission analysis, electronic survey, impact interviews, data-analysis, case studies, webscraping & network analysis on collaboration, economic modelling and a policy workshop. The study was overseen by Business Finland and a Steering Group of Business Finland and TEM representatives, and executed by independent evaluation consultants Technopolis Group and 4Front.

IMPORTANCE OF ECOSYSTEMS FOR FINLAND

The welfare and prosperity of Finland is strongly linked to sustainable performance of Finnish companies. The success of Finnish companies is highly based on renewal and internationalisation, due to the relatively small size of the Finnish market, the effects of globalisation as well as the speed of innovation. As outlined by the OECD[1] in 2017, Finland should focus on diversification and value creation by creating new sources for growth as well as revitalising traditional industries. Furthermore, it is clear that change should not only come from large but also from small companies, emphasising the role of existing and new SMEs. At the same time, global trends show a

[1] OECD (2017). OECD Reviews of Innovation Policy: Finland 2017.

strong increase in the importance of the UN Sustainable Development Goals (SDGs). The challenges of renewal, internationalisation and SDGs can be better addressed by companies working collectively rather than individually, as these challenges ask for more dynamic knowledge generation and exchange, increased public-private collaboration, stronger involvement of end-users as well as the use of co-creation methods.

Ecosystems are a collaborative structure for companies and other stakeholders to work collectively towards strategic goals by addressing shared challenges. Ecosystems often have a governance structure that consists of a board of representatives of member companies and a neutral body that organises networking within the ecosystem and formal activities in line with the common strategy of the ecosystem. Ecosystems often address key challenges related to for example innovation, internationalisation, human capital, capital and entrepreneurship. Ecosystem development provides a strong avenue for supporting the dynamics and collaboration activities needed to address the challenges of Finland.

IMPORTANCE OF ECOSYSTEMS FOR THE BUSINESS

Ecosystems provide a strong way to foster structural collaboration between companies and other strategic partners, like knowledge institutions. By departing from an analysis of shared challenges, a shared strategy can be defined to support effective collaboration within these ecosystems. Together, companies can take on larger challenges and risks in terms of innovation, entrepreneurship and internationalisation. Collectively, they can build their capacity, meet new partners, work towards industrial transformation and address relevant societal challenges. Ecosystems can support both formal activities, often organised by a central player or neutral body within the ecosystem, as well as informal activities between members through networking in the ecosystem. The core value of ecosystems to companies is that collectively members can achieve more than individually. Practically, the ecosystems provide companies with access to external resources through networking and formal activities, also called the *ecosystem functions*. These external resources may include market intelligence, human capital, R&D and technologies, capital, new markets, etc. As strategies are defined by the members themselves the focus of each ecosystem can be different as the challenges they face will dictate the focus of their activities and prioritisation of specific ecosystem functions.

ROLE OF BUSINESS FINLAND FOR THE ECOSYSTEMS

Business Finland is, as the public agency for innovation funding and trade, travel and investment promotion, an organisation that focusses on generating prosperity for Finland, mainly through supporting companies to

achieve sustainable growth at global level.[2] Stimulating the emergence of new and innovative activities is a key aim for Business Finland, as this is where public intervention is most appropriate. Business Finland sees it as their role to push forward new initiatives and share risks to initiate activities that would not be realised without public intervention. While the portfolio of activities of Business Finland is large, ecosystems are at the core of its work, since innovation flourishes most when different stakeholders and industries collaborate.

The rationale of public policy is often related to certain "failures" to justify public intervention. The most important failures to address in Finland are called "system failures", and concern issues that require higher levels of coordination to solve. Ecosystems can clearly act on these system failures as they add value regarding collaboration, networks and dynamics. Next to that ecosystems also allow for synergies with other policies that target companies directly (like innovation subsidies) or that address large scale and often long-term changes that require effort to increase the urgency and sense of direction (like sustainability or industrial transformation). It should, however, be clear that ecosystem policy does not *directly* address aspects like stimulating innovation. However, it does so *indirectly*, as by addressing collaboration, networks and dynamics it can induce, accelerate, and improve the effectiveness of innovation activities. In that sense ecosystem policy is a prime example of being complementary to existing policies.

Business Finland has many instruments through which it supports ecosystems. Over the past years it has had one instrument that was specifically focused on ecosystem development & functioning (Growth Engines). The support for ecosystem development & functioning is aimed at improving aspects like the governance and coordination within ecosystems. Next to that Business Finland has an array of instruments & services aimed at supporting specific ecosystem functions (like R&D cooperation funding), focused mainly on supporting innovation and internationalisation activities. These instruments are not focused on supporting the development & functioning of the ecosystem, but rather on the performance of companies.

Both types of support, for development & functioning and the specific functions, depend more strongly on financial instruments than on services performed by Business Finland. This can be considered a political preference, as it is preferred that public means are provided directly to companies rather than spent on public personnel costs.

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[2] https://www.businessfinland.fi/en/for-finnish-customers/strategy

RESULTS AND IMPACTS

The ecosystem policy is a relatively new policy initiative showing strong potential for the future of Finland. Ecosystem development is known to be a long-term process in which the operations and governance of ecosystems as well as the trust levels and dynamics between ecosystem members emerge and mature. This impact study was performed after the first two years of the ecosystem policy, which is relatively early given the long-term nature of ecosystem development. At the same time, the conditions under which the ecosystem policy were implemented were quite turbulent given the Tekes and Finpro merger in 2018 and the COVID19-crisis from Spring 2020 onwards. The findings of this impact study show mixed results. On the one hand we found that ecosystems are quite heterogeneous, development levels of the ecosystems differ strongly, and different degrees of engagement and commitment are visible among ecosystems members. It is still too early to make strong statements about the economic and social impact of the ecosystem policy. On the other hand, we also found that ecosystem members show a very strong innovation and growth profile, and some ecosystems already show to be well organised with decent governance models and strong network ties. We also found statistical signs that the length and depth of ecosystem participation of companies is associated with stronger company growth.

In the table below a reflection is given on the ecosystem policy from the perspectives of different types of additionality.

Input additionality: effects of resources put into the ecosystem policy

The overall policy framework of the ecosystem policy fits well with the observed system failures and challenges. System failures concern issues that require higher levels of coordination to solve, which is why ecosystems are a relevant intervention. The implementation, however, does not completely match the framework. Not all ecosystems have the set up and characteristics to develop into the ecosystems Finland needs to meet its long-term objectives. There are both ecosystems that have very dense networks and strong operational structures as well as ecosystems that have neither. Many ecosystems seem to have a strong core of committed members and a shell of companies around their core is often not strongly committed. Capacity building within the ecosystems regarding the operations of the ecosystem is not always secured. The companies in the ecosystems show, however, a strong economic and innovative profile.

Currently, the policy instruments at ecosystem level that support development and operations mainly revolve around the financial Growth Engine instruments by which only some of the ecosystems are supported. Since many of the ecosystems are still in development, they could benefit strongly from non-financial ecosystem services as well to help them taking steps towards maturity. The overall policy framework in Finland, in which the ecosystem policy of Business Finland operates, can be improved to better support stability and coherence between initiatives. A first step for coherence would be to continue the discussions regarding the link between the Business Finland ecosystems and other 'ecosystem-like' directions, like the flagships/competence platforms (Academy of Finland) and urban ecosystems as innovation platforms (TEM with cities). ▶▶

Behavioural additionality: change in the processes of companies and ecosystems

While some ecosystems show very dense networks and strong operations, this is clearly not the case for all ecosystems. The analysis shows that not all ecosystems work based on an analysis of common challenges and a shared strategy. As a result, about half of the members are not very committed to the ecosystems. Many ecosystems show a structure of a core of central members consisting of research organisations and large companies. The role and the incentives of these central players are very important when a board of representatives of all members and a neutral orchestrating body are missing in the ecosystem.

During the development of the ecosystems the role of Business Finland is mainly limited to the Growth Engines since other instruments focus on stimulating innovation or internationalisation instead of ecosystem development. The BF ecosystem leads seem to have a minor role in the development and operations of the ecosystems. Overall the instruments of Business Finland focus on financial instruments, which is a political preference.

Output additionality: the results that are realised due to the ecosystem policy

Overall, the economic performance of the companies has been strong in the past years. Both the turnover as well as employment grew significantly. The overall turnover of all companies combined is very large, but only a portion of this can be deemed relevant to the ecosystems. The rest is linked to activities that have little to do with the ecosystems the companies are involved in. Large companies have a very prominent role in the results as they are the size class with the highest number of companies in the ecosystems and they also have high turnover figures. In general, large companies have a bit higher productivity than smaller companies – but very large companies operate at far higher productivity rates than the rest. We found that exports mainly takes place for medium-sized and larger companies, the exports for smaller companies are very limited. Furthermore, signs were found that ecosystem participation has a positive correlation with the economic performance of the ecosystem participants, which could mean that companies that have been participating longer in ecosystems and use more of its functions show stronger growth figures in terms of turnover and added value (or vice versa).

Impacts to the Finnish Economy and Society

The ecosystems have been set up to stimulate growth. Therefore, the focus is often on increasing the economic activity of the companies in the ecosystems. Renewal is a priority in the ecosystem policy as is shown in the focus of many ecosystems. A handful of ecosystems also focuses on absorbing technologies or entrepreneurship (new firms), but innovation by ecosystem members is the dominant method applied for renewal. Innovation is a key activity within many of the ecosystems, and many members have a strong innovation profile. Results show innovation seems mainly aimed at growth (new business activities), rather than industrial transformation (change of current business activities). Contributions towards other goals like FDI and sustainability will most likely be indirect and in synergy with other policies.

The overall objective of €20 billion plays a strong role in promotion of the ecosystems. Setting ambitious targets is important to activate players at all levels. However, the objectives are not well defined, making it difficult to make any statements regarding reaching this target. Definitions aside, with the companies of the ecosystems ambitious targets are attainable. When looking at turnover that is directly relevant to the ecosystems is seems like 1 Billion Euro growth should be attainable by the 13 ecosystems analysed in this study by 2028. When at a later stage effects of the ecosystem policy will be analysed, the COVID19-crisis will likely distort the analysis. It is key to make sure negative effects of the crisis are not identified as failures of the policy intervention.

CURRENT STATE OF PLAY

Overall, the emphasis on ecosystems could provide strong impacts for Finland given how well the policy intervention fits the faced challenges, requiring systemic solutions through higher levels of coordination and collaboration. The ecosystem concept also fits well with the role of Business Finland as ecosystems allow for strong interaction between Business Finland and collaborating growth-minded businesses that can be challenged to focus on renewal and internationalisation. From this perspective, the ecosystem policy shows great potential, provided that Business Finland further develops its policy design and implementation of the ecosystem approach. While we think there is work to be done, we also recognise that ecosystem policy requires time, stable commitment and continuous learning at policy level on how to reach the best results. To some extent the same holds true for other stakeholders in the innovation landscape, including the Ministry of Economic Affairs and Employment, as more can be gained through policy stability and commitment, better coherence between initiatives and clearly defined strategic and operational objectives.

KEY OBSERVATIONS

- Ecosystems have been set up in recent years, often stemming from earlier collaborations;
- Ecosystems show to have attracted innovative members, economic performance of the companies has been strong in the past years and future growth modelling shows that ambitious growth figures are achievable under normal economic conditions;
- The ecosystem policy was launched during turbulent times for Business Finland, policy and conceptual thinking was still in development and KPIs/objectives were not designed to support policy monitoring and ecosystem development;
- Support for development/operations has been mainly financial, a broad service portfolio was absent (trainings, peer-to-peer learning, standardised methods, templates and platforms for common activities, reviews by international experts, etc.);

▶▶

- Not all ecosystems have received financial support for development and operations. Many have only received support for innovation/internationalisation activities of ecosystem members;
- While some ecosystems show to be well organised this is not the case for all ecosystems. Not all ecosystems show to have key ecosystem aspects in place, like an analysis of shared challenges, a common strategy, a board of representatives, a neutral orchestration body and networking activities to support collaborative dynamics;
- In many ecosystems not all members are strongly committed and engaged, many ecosystems have a strongly connected core and a shell of not strongly connected members. Knowledge institutions and large companies are often (too) strongly represented in the core, SMEs are only well connected in very dense ecosystem networks;
- The role and the incentives of central players are very important, in particular when a board of representatives of all members and a neutral orchestrating body are missing in the ecosystem;
- Ecosystems show a lot of potential for addressing the key challenges of Finland. However, development of ecosystems takes time and requires stable policy and support over a longer period of time;
- Ecosystem benefits can be further enlarged by exploiting coherence with other public policies and activities and using the dialogue with the industry through the ecosystems to gain industrial intelligence to address bottlenecks for instance for innovation.

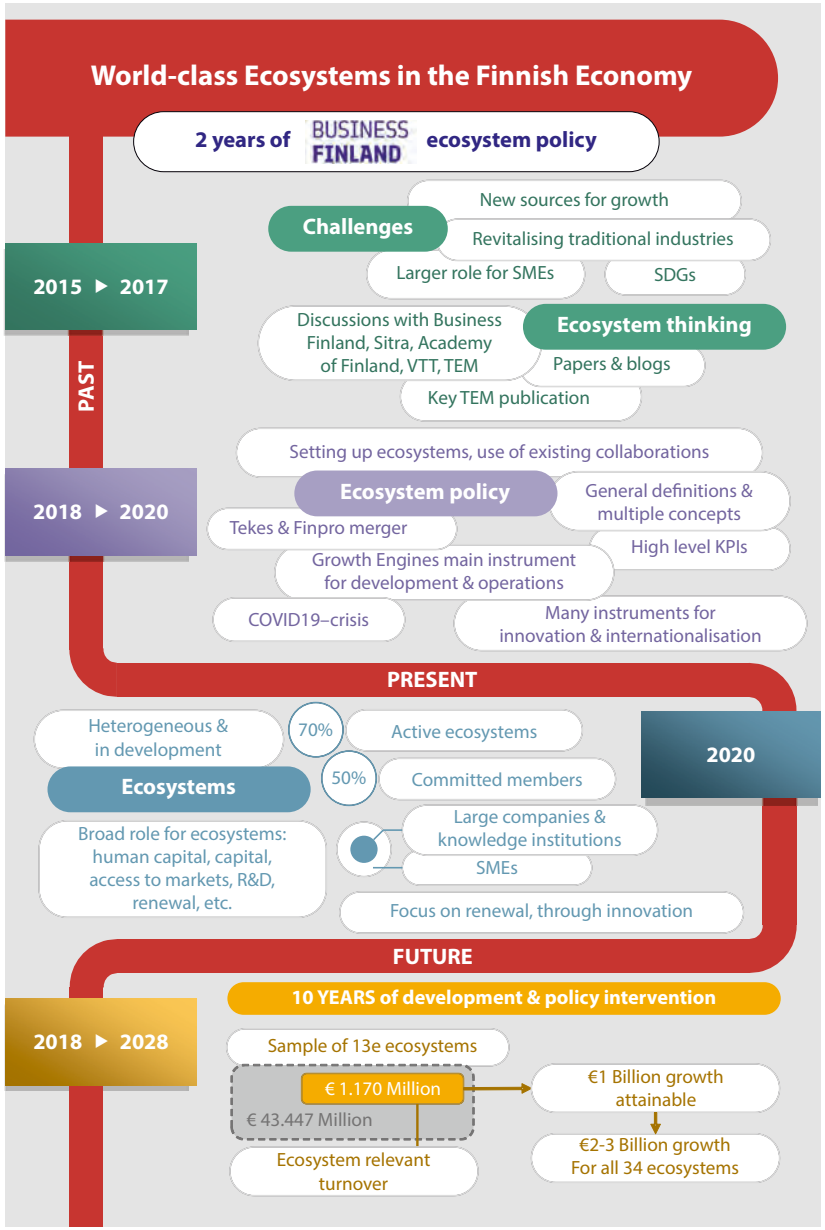
FORWARD LOOKING STATEMENT AND RECOMMENDATIONS

The ecosystem policy of Business Finland could be further developed and tailored, and should aim for stable support of the ecosystems. The impact study provides detailed insights regarding ecosystem thinking, policy making, and sustainability of public investments as well as future monitoring, evaluation & impact measurement.

RECOMMENDATIONS

1. Develop a clear vision, including a clearly defined ecosystem concept
2. Set up a portfolio of ecosystems that fit the definition of the ecosystem concept
3. Review the policy level objectives, KPIs and the timeframe
4. Set up a balanced and stable policy mix of financial and non-financial instruments
5. Develop clear agreements, guidance, monitoring & capacity building
6. Aim for balanced representation of all ecosystem members (including SMEs), in a board of representatives
7. Set up a constructive dialogue with the ecosystems and make use of industrial intelligence

INFOGRAPHIC OF MAIN RESULTS



1 OVERVIEW OF THE IMPACT STUDY

This is the introductory chapter of this impact study regarding world-class ecosystems in the Finnish economy. Here we introduce the reason for performing this impact study and outline the aim of the impact study including the research questions.

1.1 THIS IMPACT STUDY

At the time of this evaluation, one of the two key strategic impact targets for Business Finland is: *"World-class Ecosystems and Competitive Business Environment"*. It was decided, in agreement between Business Finland and the Ministry of Economic Affairs and Employment (TEM), that the realisation of this impact target would be evaluated once every two years by conducting an evaluation, including an impact study. This is the first evaluation that is performed specifically regarding the ecosystem policy.

This impact study is part of such an evaluation consisting of two interlinked Work Packages as outlined in the terms of reference of Business Finland:

- *"Package A includes a comprehensive visual presentation, mapping of the current ecosystems funded by Business Finland, identification of potential future ecosystem areas, and compilation of a plan for continuous evaluation of the impact of Business Finland's ecosystem operations."*
- *"Package B consists of an impact study. The study builds upon the evaluation plan, theoretical model and mapped ecosystems described and defined in package A. The evaluation plan and the impact study are expected to be built upon up-to-date research data on business and innovation environment and impacts of Business Finland's activities, as well as a theoretical frame of reference for assessing the impacts and effectiveness of business and innovation activities."*

This impact study was performed by Technopolis Group in collaboration with 4Front. The core people from both organisations that performed this work package B also worked on work package A. The results of work package A is available in a separate report, in the next chapter specific references to the report are made regarding our methodological framework .

1.2 BACKGROUND BASED ON WORK PACKAGE A RESULTS

The work package A report provides a detailed introduction to the ecosystem policy and the supported ecosystems. Below a few quotes are presented from the work package A report to give a few headlines:

"Business Finland focuses on recognising the seeds of high performing ecosystems (HPEs) and supporting their development towards maturity and billion-euro business. To achieve these aims and support the development of business ecosystems, Business Finland has introduced new specific support instruments, including various pilots, refined Business Finland programmes (merging R&D funding and export promotion services) and the Growth Engines, which have so far provided funding for 15 enterprise-driven business ecosystem seeds."

"The study focuses on 33 business ecosystems, which have been funded by Business Finland through different funding services. In total, 15 ecosystems were selected out of the long list for a more detailed analysis in collaboration with the project steering group to represent the overall portfolio and ecosystems with different industrial base and life cycle phase."

"Examining the ecosystems by their sector group, seven different groups were identified: 1) Bio and circular economy, 2) Health, 3) Mobility and logistics, 4) Energy, 5) Manufacturing, 6) ICT and 7) Other. Seven out of the 33 ecosystems were identified operating in the field of Bio and circular economy. Five ecosystems focused in energy sector, while six ecosystems were operating in the health sector. Both manufacturing and mobility & logistics, as well as the ICT sector included four ecosystems. However, it should be noted that business ecosystems are (by definition) cross-sectoral and in each ecosystem, there are typically companies from many different sectors."

"The majority of the ecosystems focused on Business to Business operations (19 ecosystems), with six ecosystems representing the hybrid model and five ecosystems being purely consumer-oriented. This finding is expected as the majority of largest Finnish companies have traditionally focused on B2B business and there has been relatively few large B2C businesses."

"The ecosystem leads (experts from Business Finland) conducted a 'self assessment' of the ecosystems. At the time of writing, in total of 20 ecosystems were assessed. According to the assessment, the Business Finland-funded ecosystems (on average) rank highest on Innovativeness and Internationalisation (both 1,8 on a scale 0-2), highlighting the novelty, export potential and level of international collaboration of the ecosystems. Importantly, the lowest average score was given to the Solution maturity. This further validates the findings that most Business Finland-funded ecosystems are still in the early phases of their lifecycle."

1.3 AIM OF THE IMPACT STUDY

The main aim of the impact study is to analyse the additionality of the ecosystem policy. As outlined in the terms of reference set out by Business Finland of this study, four types of additionality are to be analysed. These forms of additionality are outlined below, for each form of additionality a set of sub-questions have been outlined:

1. **Input additionality:** This form of additionality describes the effects of resources put into the ecosystem policy. This concerns both the available financial and non-financial resources and capabilities of Business Finland as well as those available within the ecosystems (human resources, orchestration, etc.). Another key input is *"the selection"* of ecosystems, and in case of ecosystems that originate from business initiatives *"the formation"* of the ecosystems. Finally, how does Business Finland need to position itself towards the ecosystem in order to best support their development and success.
   i) Does Business Finland have the appropriate financial and non-financial resources and capabilities in play to implement the ecosystem policy?
   ii) Do the (members of the) ecosystems have the appropriate financial and non-financial resources and capabilities to develop and operate successful business ecosystems?
   iii) Do the (members of the) ecosystems have the ability to take steps in innovation and internationalisation to support overall policy objects?
   iv) Are the right initiatives currently selected to the ecosystem portfolio?
   v) When and how should Business Finland, as a funder and supporter, start and stop being involved in the ecosystems to best support the policy objectives?

2. **Behavioural additionality:** This form of additionality describes the change in the processes of companies and ecosystems as a whole. To some extent this can be called the human factor of policy as it is about a change in the way people (and in this case companies and other ecosystem members) act as a results of policy stimulus. The behaviour of organisations that take a leading position in the ecosystems is of course a very important, especially when it comes to their ability to create successful business ecosystems.
   i) What roles and incentives do different types of ecosystem members have and how does this influence the development and operations of the ecosystems?
   ii) What was the role of Business Finland with regards to the development and operations of the ecosystems?

3. **Output additionality:** This form of additionality describes the results that are realised due to the ecosystem policy. Key economic results regarding employment and turnover will be important, as well as internationalisation factors like export and the role of multinationals and foreign (owned) companies.
   i) What are the key economic results of the ecosystems?
   ii) How do multinationals and foreign (owned) companies play a role in these results?

4. **Impacts to the Finnish Economy and Society:** This form of additionality describes the wider impact of the ecosystems on both the economy as well as the society. In terms of economy key questions revolve around the role of renewal, excellency and ability to attract global actors to Finland. Furthermore, the question is whether there are sufficient resources available to reach the leading objective of *"new world-class business ecosystems of € 20 billion"*. In terms of society, it is important reflect on the role of the ecosystem policy in contributing to societal goals regarding environment and well-being.
   i) Do ecosystems support renewal of industry?
   ii) Are ecosystems able to play a role in attracting global actors to Finland (FDI)?
   iii) How likely is it that the leading objective of *"new world-class business ecosystems of € 20 billion"* will be reached by 2025?
   iv) What kind of impacts with regards to environment and well-being can be expected from the ecosystems?

In addition to the questions regarding additionality, the study will focus on the role of public policy and how this can be improved in the future (recommendations). In addressing this the study will address any critical obstacles and bottlenecks found during the analysis. Finally, specific attention will also go towards recommendations for future impact measurements.

2 METHODOLOGICAL FRAMEWORK & APPROACH

In this chapter we introduce the key methodological concepts and the approach for the impact study. It also outlines the key limitations and the structure of this report.

2.1 THE ECOSYSTEM CONCEPT

Our methodological approach starts with the understanding of the ecosystem concept. While there are many different ecosystem concepts and nuances to be found in literature, many include similar ideas. In the report of work package A of this study a more detailed background is provided on this and for instance the similarities and differences between ecosystems and clusters. In this paragraph we mainly want to outline the theoretical ecosystem concept we will use in our approach, see Figure 1. While many ecosystems will in practise operate in their own way, this model shows a set of key aspects you would expect ecosystems to have, namely:

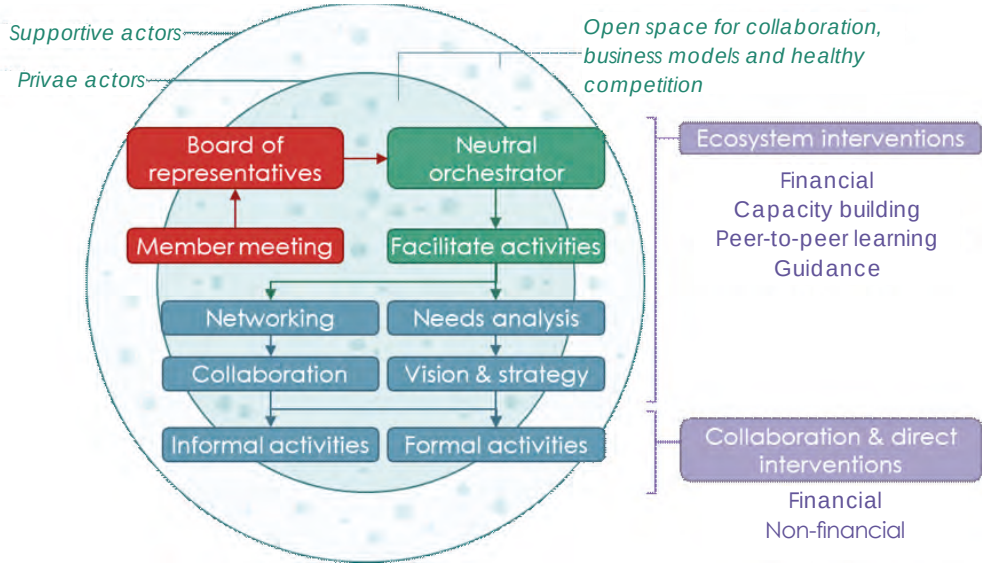
- A core of private organisations, companies, that are intrinsically motivated to participate in the ecosystem and a shell of supportive actors (e.g. knowledge and education institutions, incubators, funders, public bodies, etc.). Both should operate in an open space that supports collaborations, various business models and healthy competition.
- A clear governance model in which all members are represented by a board of representatives and a neutral body provides the day-to-day operations of the ecosystem.
- A neutral orchestrator responsible for facilitating formal and informal activities within the ecosystem. Formal activities are organised by the neutral orchestrator and the members and can include activities like members meetings, networking events, an internship programme, investor matchmaking, etc. Informal activities are activities that take place between individual members at their own initiative as a result of networking and trust within the ecosystem.
- The formal activities will be related to ecosystem development, networking between ecosystem members or the shared strategy of the ecosystem. The strategy of the ecosystem should depart from

an analysis of common challenges experienced by all ecosystem members, meaning the strategy should address these challenges through (various) actions.

Through their formal and informal activities ecosystems can provide access to external resources to their members. We label this as the ecosystem functions. These functions should be directly linked to the common challenges and thus shared strategy of the ecosystem. For instance, an ecosystem that has trouble getting sufficient access to human capital could focus on activities like a dialogue with educational institutions regarding their curricula, an internship programme, attracting foreign talent, etc. Through their functions, ecosystems provide access to external resources such as:

• Renewal/ entrepreneurship • New markets • Suppliers and/or customers	• Market intelligence • Marketing/visibility • Capital	• R&D and technologies • Infrastructure • Human capital

FIGURE 1. Theoretical ecosystem concept. Technopolis Group 2020



Public policies are also shown on the right side of the theoretical ecosystem concept presented in Figure 1. As is shown in the concept, two types of interventions are listed: 1) ecosystem intervention and 2) collaboration & direct interventions. The ecosystem interventions are aimed at the ecosystem level, and thus support the development and functioning of the ecosystems. The collaboration & direct interventions are on the other hand aimed directly at the members of the ecosystems and have strong synergy with the specific functions of the ecosystems – but do not support the development and functioning of the ecosystem.

The development of ecosystems often takes many years and ecosystem or cluster programmes often have a horizon of 10 years for development. In the work package A report four levels of maturity are outlined to provide insight into the state of play of ecosystems. These are 1) emergence, 2) start-up, 3) growth/expansion and 4) maturity/renewal.

2.2 FRAMEWORK FOR IMPACT MEASUREMENT

For analysing the impact of the ecosystems, it is important to distinct between the interventions we try to measure the impact of. What makes ecosystems particularly difficult to analyse is that policy objectives often focus on company results (turnover, export, employment, etc.), while ecosystem policy instruments are targeting ecosystems as explained in paragraph 2.1.

As shown in Figure 2, the effects on companies can be classified as effects of direct and collaboration interventions and effects of ecosystem functions. The effects of ecosystem functions will partly consist of effects due to the strength and activities of the ecosystem itself and effects of the ecosystem that are supported through public interventions. Later in this report we will show that not all ecosystems analysed will have received ecosystem level interventions (support for development and functioning of ecosystems).

FIGURE 2. Impact model for ecosystem policy. Technopolis Group 2020

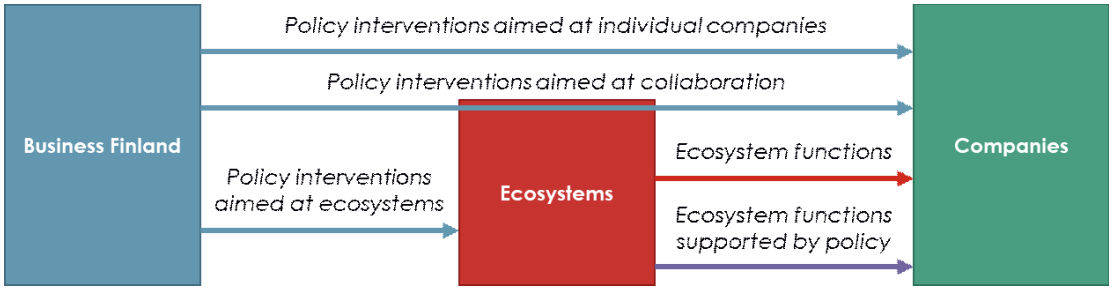
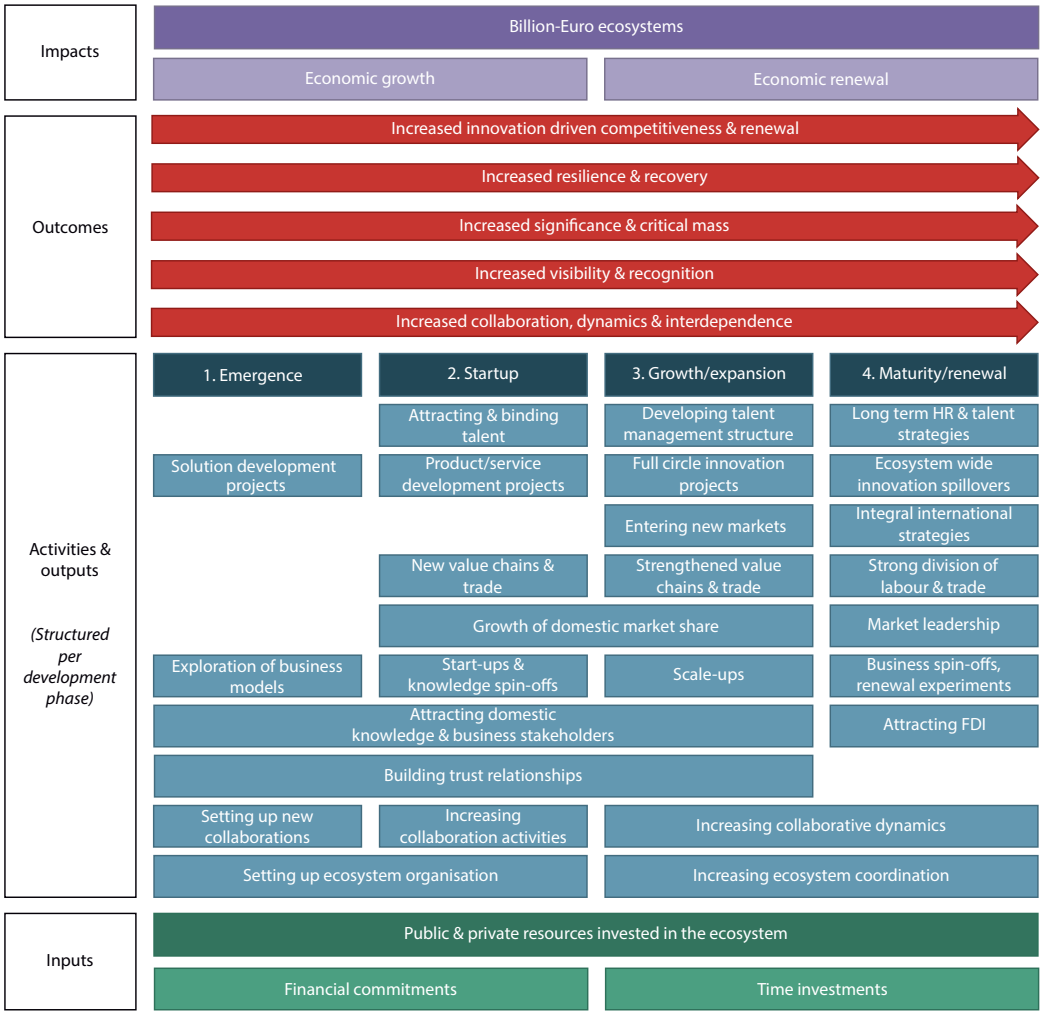


FIGURE 3. Logical Framework of the ecosystem policy. Technopolis Group and 4FRONT 2020



As part of work package A an evaluation framework was developed. The key figure that outlines the intervention logic of the ecosystem policy is the Logical Framework, shown here in Figure 3. In this intervention logic the key functions and development stages of the ecosystems are clearly shown in the activities & outputs of the ecosystems. These should lead to key outcomes like increased competitiveness, renewal, resilience, dynamics, significance, and visibility. At impact level, this should in turn lead to economic growth & renewal in strong billion Euro ecosystems.

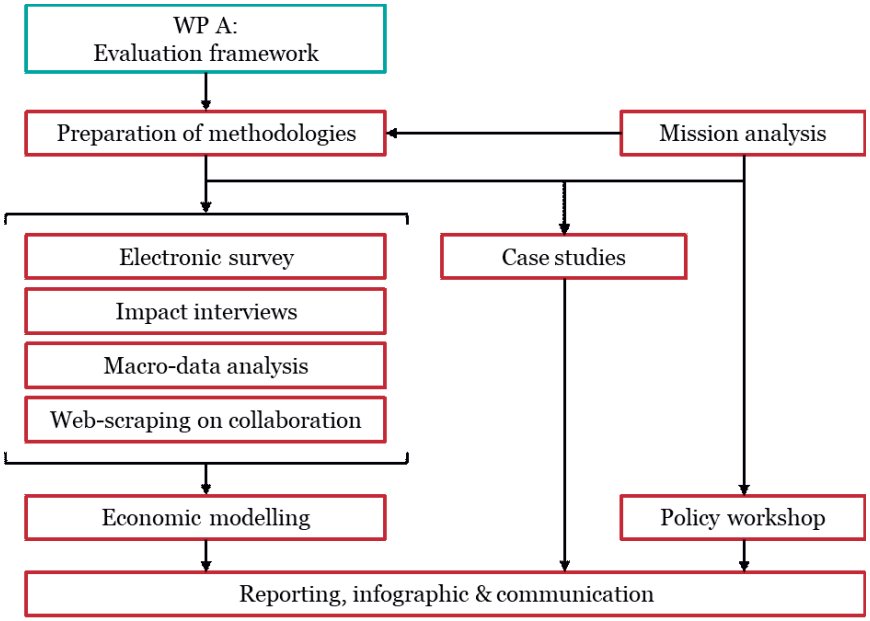
The way the inputs, like the efforts and financial investments of public and private actors, lead to the desired impacts, are called *impact pathways*. These pathways are for many interventions not linear, and this is especially the case for ecosystem policies, as activities will often lead to more than just one benefit. For instance, a collaborative international innovation project can strengthen relations, introduce players to new markets, innovative findings, additional private investments, follow-up initiatives, recognition, etc. For this impact measurement it is therefore important to measure three steps: 1) the effects of ecosystems on companies, 2) the results along the impact pathways and 3) the economic impact. This is shown in Figure 4.

In the next paragraph we outline the main research methods used in this study. When measuring the effects of ecosystems on companies and the effects of policy on ecosystems we have to isolate the effects from "normal" growth figures. In impact studies often a control group is used to see if growth figures of companies that are part of an ecosystem are higher than those not participating in the ecosystems. In this study, however, no data was available on companies that are not participating in the ecosystems. Therefore three other methods were used to measure additionality:

1. Self reflection of companies, based on guided estimations;
2. Differences between members within ecosystems, based on level of engagement of ecosystem members; and
3. Differences between ecosystems, based on the level of maturity of ecosystems.

FIGURE 4. Overview of impact measurement. Technopolis Group 2020

FIGURE 5. Overview of study methodologies. Technopolis Group 2020



2.3 APPROACH OF IMPACT STUDY

The approach used in this impact study consisted of a balanced mix of qualitative and quantitative methodologies. We started by using the insights from the WPA report and an analysis of the policy landscape to prepare our methodologies. This included developing questionnaires for the electronic survey and impact interviews in line with the methodological framework as presented in the previous chapter. Next to that we analysed the available statistics of the companies and used webscraping to gather insights on the collaboration between ecosystem members. Economic modelling was then used to outline the main economic results of the ecosystems. To gather more contextual insights four detailed case studies were outlined on a selection of the ecosystems. Finally, a policy workshop was held to discuss the findings with representatives of Business Finland and Ministry of Economic Affairs and Employment (TEM). In Figure 5 a schematic overview of the research methodologies is shown. Fully outlined results per method can be found in the annexes of this report, in these annexes some further context on the methods used is provided as well.

2.4 PROCESS & LIMITATIONS

Throughout the project there was a strong collaboration between the evaluation team and Business Finland to realise the results of this study. While the analysis was performed solely by the researchers to ensure objectivity, Business Finland played a key role in the data collection. Collectively the evaluation team and Business Finland put a substantial amount of effort in reaching out to the ecosystems and companies. Data collection was especially challenging for this study regarding the survey and interviews. We thank everybody involved for realising the results, and the participating companies for their valuable input.

The main limitations of the methodology and process of the study process are:

- Contact details of company ecosystem members were not readily available, as a result a lot of effort had to be put if retrieving responses. In general, this situation increased the likelihood of response bias: respondents with a positive attitude will be more likely to participate in surveys, interviews, etc;
- The available data had no overlap with the public intervention. Many interventions took place around 2018 and statistical data often lags behind a few years;
- In many cases the ecosystems were still in development, therefore company level results have not taken place for all companies;
- No control group was available, therefore isolating effect was more challenging;
- Future modelling is bound by many uncertainties, the unknown long-term effects of the COVID19-crisis will increase these uncertainties of future results. Specific limitations are outlined in the chapter regarding future modelling (chapter 6);
- No data was available on real collaborations, therefore webscraping was used to gather data on collaboration based on referrals between companies on their website; and
- The ecosystems have shown to be very heterogeneous. While we performed four case studies amongst the 13 ecosystems we analysed, case study results will still be anecdotical.

2.5 KEY ELEMENTS OF THIS REPORT

In this report we will broadly follow the flow of the impact pathways:

- We will start in chapter 3 by outlining the findings on the policy framework & design, to show insights into the key objectives of the ecosystem policy (where should impact pathways lead to?). In this chapter we also touch upon the relevance of the ecosystem intervention and the coherence of the ecosystem policy with other policies.
- Then, in chapter 4, we will outline the findings regarding the implementation of the ecosystem policy. Showing the inputs and activities, from the perspective of the policy.
- We follow this up by chapter 5, the largest findings chapter, where we start by outlining the development of the ecosystems. This shows the inputs and activities from the perspective of the ecosystems. Then, in the second section of chapter 5, we will show the results of the ecosystems along the impact pathways.
- Finally in chapter 6, we will look into the future to outline potential long-term impacts of the ecosystem policy.

Throughout this report we present the triangulated findings of all methodologies combined. We will support our findings with evidence by either presenting specific findings from the various methodologies directly in the text or by presenting results in coloured (blue, green, purple) text boxes to support statements of the main text. Full results per work package are available in the annexes.

The full findings, and triangulation between findings, were used to outline the conclusions in chapter 7. In addition, a red text box is placed at the start of each paragraph in chapters 3 to 6 to show which paragraphs are most important for each type of additionality analysed.

3 STUDY FINDINGS: POLICY FRAMEWORK & DESIGN

In this chapter we describe the overall policy framework and the design of the ecosystem policy of Business Finland. We will start by outlining the policy objective, key performance indicators, policy rationale and we will reflect on ecosystems as a policy intervention with regards to the identified challenges of the Finnish economy and society. Finally, we will briefly outline how the ecosystem policy relates to the broader policy landscape in Finland.

3.1 POLICY OBJECTIVE

This paragraph is important for **all types of additionality**, as the objective of the ecosystem policy are important for understanding the results of each type of additionality. It outlines the role of Business Finland and what the ecosystem policy aims to achieve.

Business Finland is, as the public agency for innovation funding and trade, travel and investment promotion, an organisation that focusses on generating prosperity for Finland, mainly through supporting companies to achieve sustainable growth at global level.[3] Stimulating the emergence of new and innovative activities is a key aim for Business Finland, as this is where public intervention is most appropriate. Business Finland sees it as their role to push forward new initiatives and share risks to initiate activities which would not be realised without public intervention. While the portfolio of activities of Business Finland is large, ecosystems are at the core of its work, mainly as innovation flourishes when different stakeholders and industries meet and collaborate. This is also shown in the Business Finland strategy of 2018, where the following key objectives are listed:

- ***Change makers in global business ecosystems:*** *Finnish companies form strong and attractive ecosystem nodes to gain critical positions in global business ecosystems, driven by global challenges;*
- ***Best knowledge to drive renewal:*** *Renewing ecosystems have access to knowledge, competences and talent, which drive the change; and*

[3] https://www.businessfinland.fi/en/for-finnish-customers/strategy

- ***World class trial environment:*** *Finland establishes significant large scale real life experimental platforms and environments, attracting leading global companies.*

Ecosystems are seen as a way to ensure Finland is better equipped for driving economic growth, increasing productivity, renewing activities, transforming industries and tackling today's societal challenges. The objective of the ecosystem policy in short is as follows:

"Create new billion-euro ecosystems and to strengthen existing ecosystems in Finland to drive economic growth."

Ecosystems were gradually introduced into the government programme. The Sipilä government original programme from 2015[4] makes no references to ecosystems. The government programme action plan from 2018 for the years 2018-19[5] specifically mentions the Business Finland Growth Engine initiative, allocating €60m for it for the two years. But it is only in the 2019 Marin government programme[6], where the objective of creating new billion-euro ecosystems is specifically defined.

In order to set up these new ecosystems Business Finland aimed to fund five new business ecosystems on a yearly basis with the potential to become billion-euro ecosystems in Finland. However, in recent years a higher number of ecosystems were supported to create a portfolio of ecosystems, taking into account that likely not all will reach the billion-euro target. Interviewees indicate that likely no more than 40 serious ecosystems (in different life-cycle phases) can be active at the same time within Finland, given the size of the economy. The design of the policy further developed over the past years. Recently, a funnel approach[7] was developed to set up a balanced portfolio of ecosystems with different development stages and risk levels, reviewing annually whether the ecosystems show sufficient potential to continue.

While the overall policy objective is clear, the evaluation findings show that the concept of the ecosystem – and relevant key performance indicators – has remained relatively general, and there have been different interpretations of the concept among stakeholders and within Business Finland. This leads to several questions, like:

- Is the billion-euro target referring to turnover, export, foreign direct investment or a combination of all of these?

4 https://valtioneuvosto.fi/documents/10184/1427398/Ratkaisujen+Suomi_FI_YHDISTETTY_netti.pdf
5 https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/160963/27_Hallituksen%20toimintasuunnitelma%202018-2019.pdf?sequence=1&isAllowed=y
6 https://valtioneuvosto.fi/marinin-hallitus/hallitusohjelma/elinvoimainen-suomi
7 Business Finland – VTT (2020), Ekosysteemikartoitus

- What exactly counts as "new" and when do we start counting?
- What part of the company growth counts towards the target of the ecosystems, especially when it concerns (large) companies active in multiple markets?
- Taking into account the previous point, is this target set up for each ecosystem separately, is it a collective target for all ecosystems or an average target across the ecosystems (allowing some to have lower results if others higher results)?
- How many years do ecosystems have to reach this target, what are the intermediate milestones and can the same results be expected from all ecosystems?
- What are the targets for more societal objectives for instance in terms of improving sustainability or wellbeing?
- What kind of initiatives are counted as "ecosystems" (and which are not)?

While many of these points outline the difficulties of operationalising the overall objective into measurable and manageable actions and results this does not mean that an overall shortly outlined objective does not have a function. On the contrary, these types of objectives make the overall policy easy to communicate and enthuse other players to rally behind the same goals.

Internally in Business Finland the objective was translated to a more tangible target of EUR 20 billion by 2025 for all ecosystems. This EUR 20 billion target seems to relate to the insights from earlier studies and evaluations performed for Business Finland (and formerly Tekes) in which a 20x multiplier was identified for public investment in innovation projects. The Business Finland strategy for 2020-2025 foresees a total allocation of €1b to programmatic activities, leading to the EUR 20 billion target. A key concern for this target is that not all programmatic activities are aimed at ecosystems and that ecosystems do not function identical to innovation projects.

Many ecosystems themselves seem to have formulated some form of strategy. Business Finland also has specific ecosystem level KPIs, often linked to the funding provided to the ecosystems. These objectives can include the number of companies in the ecosystem, specific innovation outputs (like #pilots, #technology developers, demonstration of solution in real world circumstances, etc.) or turnover/employment targets for the ecosystem or lead company. While these KPIs support accountability of the public investments they do not seem fit for the purpose of monitoring ecosystem development and overall policy level objectives.

Two main concerns are:

- In terms of development of the ecosystems, the KPIs do not show a clear development path from one stage to the next with regards to establishing all the key processes in the ecosystem, increasing the dynamics and trust levels in the ecosystem, increasing the visibility of the ecosystem, etc. Indicators could show more clearly the added value of the ecosystems (e.g. number of collaborations, network density, co-patenting, spin-offs, etc.). Similarly, some indicators that work well for accountability can potentially have reverse effects on development. An example is an indicator like the number of (paying) ecosystem members, this can drive ecosystems to focus a lot of effort on finding new members rather than increasing the quality of dynamics between and level of engagement of existing members – potentially resulting in many passive members.
- Regarding policy level objectives, ideally the monitoring of ecosystem level objectives provide insights into the state of play at policy level (across all ecosystems). There should be a good hierarchy in the objectives, where the objectives and ambitions of the country, ecosystem and company level are all well aligned. Using the current ecosystem level KPIs, it is unclear how the ecosystems will collectively support the overall objective.

3.2 POLICY RATIONALE

This paragraph is important for **all types of additionality**, as the rationale of the policy intervention outlines why the intervention is taking place. It therefore shows why the ecosystem policy is the correct policy intervention to apply in relation to the challenges of Finland.

The rationale of public policy is often related to certain "failures" to justify public intervention. These failures can broadly be classified as market and/or system failures and in recent times also transition failures have been added to the spectrum. Classical innovation policy is typically justified through market and system failures. Market failures concern issues like a lack of beneficial knowledge spillovers and external effects that would otherwise not come about, which is often addressed by instruments like innovation subsidies. System failures on the other hand concern issues that require higher levels of coordination to solve, like outdated regulation and social norms, lacking knowledge infrastructures or a lack of available competences in the labour market. Transformation failure is related to large scale and often long-term changes that require effort to increase the urgency and sense of direction, clear examples are the road towards renewable energy and sustainability but also industrial transformation.[8]

[8] Weber, M., Rohracher, H. (2012). Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework. Research Policy 41(6): 1037–1047.

The key challenges that are identified for Finland concern all three types of failures, but the majority is linked to system failures. As outlined by the OECD[9] in 2017 Finland should focus on the diversification and value creation of the economy by both creating new sources for growth and revitalising traditional industries. When looking at the strategy of Business Finland[10] we can see this featuring clearly through its focus on economic growth and competitiveness, often linked to internationalisation and renewal. Furthermore, it is clear that change should not only come from large but also from small companies, emphasising the role of existing and new SMEs. Furthermore, a strong focus on sustainability and link with the Sustainable Development Goals is visible, which is also visible in the 2019 Marin government programme[11] through key elements like biodiversity, wellbeing, equality and inclusiveness. For addressing societal challenges additional dynamics are also required, by increasing public-private collaboration, involving end-users and using co-creation methods.

Overall the key challenges to address by Business Finland can be summed up by:

- Lack of new (radical) innovations & entrepreneurship (market & system failures);
- Limited capacity building & skills development (system failures);
- Lack of (radical) innovation & industrial transformation (transformation failures);
- Lack of internationalisation (system failures);
- Lack of collaboration, networks and dynamics (system failures); and
- Lack of urgency & vision regarding societal challenges (transformation failures).

So, why the focus on ecosystem policy? The short answer is that ecosystems can clearly act on system failures as they add value regarding collaboration, networks and dynamics. However, ecosystems also provide a great platform to reach companies with other policy instruments that can address market failures or to increase the urgency and set out a vision for addressing transformational failures. It should, however, be clear that ecosystem policy does not directly address aspects like stimulating innovation, but by addressing collaboration, networks and dynamics it can induce, accelerate and improve the effectiveness of innovation activities. In that sense ecosystem policy is a prime example of being complementary to existing policies.

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9 OECD (2017). OECD Reviews of Innovation Policy: Finland 2017.

10 https://www.businessfinland.fi/en/for-finnish-customers/strategy#:~:text=Our%20new%20strategy%20aims%20to,tourism%20and%20investments%20in%20Finland

11 https://valtioneuvosto.fi/en/marin/government-programme

The long answer is that ecosystems can be a key mechanism to coordinate a variety of actions between companies themselves and between companies, public bodies and other stakeholders. Within ecosystems companies have the opportunity to outline the shared challenges they face and outline a strategy that supports (global) growth by addressing these. In some cases, these challenges will overlap with the key challenges identified by Business Finland, allowing other policy instruments to interact with the ecosystem intervention, clear examples being support for innovation and internationalisation. For Business Finland the ecosystems can furthermore be an entry point for a constructive dialogue with industry, in which Business Finland can advocate for industrial transformation and addressing societal challenges where relevant. Similarly, this constructive dialogue can also provide industrial intelligence that can be used to start a dialogue with various government departments to address obstacles faced by the companies, for instance regarding new innovations that clash with existing regulations.

3.3 POLICY COHERENCE

This paragraph is important for **all types of additionality**, as the analysis of coherence shows how the ecosystem policy relates to other policy interventions. Key aspects are synergies and overlaps that show how the ecosystem policy is strengthened (or not) by other policies and vice versa.

In this impact study we briefly touched upon the broader policy landscape in which the ecosystem policy of Business Finland is positioned. In this section we will cover the coherence with other Business Finland policy instruments, with the innovation policy context and with other public domains.

3.3.1 COHERENCE: BUSINESS FINLAND POLICIES

As described in section 3.2, key policies from Business Finland addressing innovation and internationalisation, funding and services, fit very well with the ecosystem policy. The objectives of these instruments are very much in line with the growth ambitions of the ecosystem policy and use of these instruments can strengthen each other. Next to that there are, however, other activities of Business Finland that could also lead to synergies in the future, examples mentioned during the policy workshop of this study were the work done by Business Finland on EU collaboration and on gathering market intelligence.

Another important set of instruments of Business Finland are the Business Finland Programmes. The Programmes represent key thematic areas in which Business Finland aims to fulfil its strategy of driving and supporting required market developments and renewal. Many of these Programmes cover broad thematic fields like *"Smart Energy Finland"* or *"Food from Finland"*. Through the Programmes awareness is raised and stakeholders

are brought together. Programme objectives may also include the creation of ecosystems. The Programmes can therefore play a role in the emergence of ecosystems, or in the phase before emergence by bringing stakeholder together and laying the groundwork of collaboration. This connection is also shown in the similarities between the instruments. For example, the Programmes also focus on *"enabling participants to resolve common challenges"* and knowledge exchange and collaboration in general are key aspects as well.

After the ecosystems have been set up the synergies between the Programmes and the ecosystems become less well defined. For outsiders, the intended synergies in practise between the Programmes and the ecosystem are not very clear and while many ecosystems operate in the thematic areas of the Programmes this does not seem to be of high relevance for the ecosystem members. For example, in our detailed case studies no specific alignments to the Programmes were mentioned in the interviews with ecosystem stakeholders.

As outlined in the methodological framework (chapter 2), ecosystem activities can reach further than just innovation and internationalisation as they need to focus on addressing the key challenges of the companies. For some of these areas, such as development of skills, no specific instruments are available in Business Finland.

While there are many opportunities to do more, it is even more important to remain strategic and clear. Offering too many policies is a risk in and of itself. During our study some companies indicated to struggle with the amount of initiatives and policies available, making it difficult for them to see what is most relevant to them. This also links strongly to the other policies deployed by others in the policy landscape which is covered in the next section. Either way it remains important that each piece of policy has a clear rationale and objective as well as a clear role in relation to the ecosystem policy.

3.3.2 COHERENCE: INNOVATION POLICY CONTEXT

The Vision and Roadmap of the Research and Innovation Council (TIN) outlined research and innovation policy towards 2030[12]. The outline refers to competence platforms and growth ecosystems. The former is an approach for strengthening research and the latter for strengthening innovation and growth. The government's R&D&I roadmap from 2020[13] – prepared in collaboration between Ministry of Education and Culture and the Ministry of Economic Affairs and Employment and approved

[12] https://valtioneuvosto.fi/documents/10184/4102579/Vision_and_roadmap_RIC.pdf/195ec1c2-6ff8-4027-9d16-d561dba33450/Vision_and_roadmap_RIC.pdf.pdf

[13] https://minedu.fi/documents/1410845/4449678/Tutkimus-%2C+kehitt%C3%A4mis-+ja+innovaatiotoiminnan+tiekartta/259864dc-a31c-cbcf-30ad-e2222724ccfa/Tutkimus-%2C+kehitt%C3%A4mis-+ja+innovaatiotoiminnan+tiekartta.pdf/Tutkimus-%2C+kehitt%C3%A4mis-+ja+innovaatiotoiminnan+tiekartta.pdf

by the Ministerial Working Group on Competence, Education, Culture and Innovation – assumes that there is a strong link between business ecosystems and centres of research-based knowledge[14]. Hence, the national Flagship funding from the Academy of Finland[15] is seen as an important tool to support the ecosystem policy objective. Similarly, the same policy outline from 2020 emphasises the role of cities as knowledge-based centres as well as innovation platforms, introducing ecosystem pacts[16] as a tool to foster and presumably align their support to ecosystem objectives.

This is also visible in the broader policy umbrella of the Ministry of Economic Affairs and Employment (TEM), which consists of the following initiatives:[17]

- **The Growth Portfolio**[18]
  Identifying future growth potential and building a knowledge base in support of strategic choices. The main purpose is to identify new areas for cross-sectoral strategic growth programmes.
- **Cross-sectoral strategic growth programmes**
  Cross-ministry programmes in the area's of health, transport, artificial intelligence, and circular economy.
- **Promotion of innovation partnerships and**
- **ecosystems**
  Tools for promoting innovation partnerships and ecosystems, including Growth Engines (Business Finland), flagship initiatives (Academy of Finland), and UN Technology Innovation Lab UNTIL.
- **Sustainable, innovative public procurement**
  Procurement via KEINO Competence Centre for Sustainable and Innovative Public Procurement and development of innovation-friendly regulations.
- **Development and testing environments**
  Building of development and testing environments for innovations and new solutions (Business Finland).
- **Innovation arenas**
  Innovation arenas as cooperation forums for public administration and business and industry: network of innovation policymakers (mainly events organised by TEM).
- **Urban Ecosystems Pacts**
  Ecosystem pacts with 16 urban areas (with university level presence) funded partially from the EU structural funds during 2021-2027 (TEM with cities).

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[14] Earlier, the Research and Innovation Council (RIC) prepared similar policy outlines on regular intervals. Although RIC was consulted, it did not lead nor had it any significant role in the preparation of the R&D&I roadmap.

[15] https://www.aka.fi/fi/akatemia/media/Tiedotteet1/2020/lippulaivojen-tutkimusinfrastruktuurien-ja-kumppanuusverkostojen-rahoitus-haettavaksi/

[16] https://tem.fi/ekosysteemisopimukset

[17] https://tem.fi/en/ecosystems

[18] https://tem.fi/kasvuportfolio

As outlined above, the Growth Portfolio mainly feeds into the cross-sectoral strategic growth programmes, yet experts from Business Finland do participate in this ministry process and new ecosystems are checked with TEM before selection to maintain alignment.

Outside the alignment with the Growth Portfolio there is little coherence with other 'ecosystem policies'. The R&D&I roadmap identifies the link between the business ecosystem objectives and other policy measures, but the link is not described or defined in great detail. While some actions refer to coordination between public actors like Business Finland, TEM, other ministries and regional actors, the overarching framework seems to be on a too general level. For instance, there does not seem to be an underlying analysis regarding the coherence between the ecosystem policy of Business Finland and other *'ecosystem-like'* directions, like the flagships/competence platforms (Academy of Finland) and urban ecosystems as innovation platforms (TEM with cities). There also is limited evidence that shows systematic coordination or governance across these policy directions. So far, attempts by Business Finland to address the alignment and coordination of these policies with other operators of the Finnish innovation system have not yet resulted in visible improvements.

3.3.3 COHERENCE: PUBLIC DOMAINS

Quite a few ecosystems are active in domains where the public sector has a prominent role as a market actor or regulator (e.g. healthcare, transportation, etc). These domains are known for requiring a high amount of coordination in order to achieve change, the main reasons being that many actors are involved and the current way of working has many intricacies that support and protect key values and rights. There is limited evidence of facilitated interaction between the ecosystems and the government departments of these particular domains. This can prove to be both a large opportunity for Business Finland to add value by solving coordination challenges – or a large threat for the success of these ecosystems in case these coordination challenges are not addressed.

4 STUDY FINDINGS: POLICY IMPLEMENTATION

This chapter describes the development of the ecosystem policy by looking back at the origins and the implementation of the policy. Afterwards an overview is provided of the policy instruments and services that Business Finland applies. In the last paragraph we show some key characteristics of the ecosystem portfolio that was included in this impact study.

4.1 ECOSYSTEM POLICY DEVELOPMENTS

This paragraph is important for **input additionality**, as it describes how the public input was applied and shaped over the past years.

4.1.1 THE ORIGINS OF ECOSYSTEM THINKING IN FINNISH R&D AND INNOVATION POLICY

The ecosystem thinking (in its current form) in Finnish innovation policy started to emerge in discussions between Business Finland, Sitra, Academy of Finland, VTT and the Ministry of Economic Affairs and Employment (TEM) during 2015/2016. These discussions were articulated in a number of papers[19] and blogs[20] by Sitra and eventually documented in a key 2017 TEM publication, where ecosystem thinking in innovation policy was outlined.[21] As a result, ecosystems were recognised as having an important role in the revised TEM sustainable growth policy of 2018[22], complemented by the identification and

[19] Hämäläinen, Timo (Sitra). Structural adjustment, emerging business ecosystems and new industrial policy; Hämäläinen, Timo (Sitra). Governance solutions for wicked problems: collective learning and systemic coordination in the Danish wind turbine industry.

[20] https://www.sitra.fi/blogit/suomi-tarvitsee-strategista-kasvupolitiikkaa/ and later https://www.sitra.fi/blogit/ekosysteemit-innovaatiopolitiikan-uusi-haaste/

[21] https://tem.fi/documents/1410877/4429776/Ekosysteemit+uuden+elinkeino-+ja+innovaatiopolitiikan+kohteena/f46d3709-fdcf-4a73-83df-e84ae24b4196

[22] https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161027/TEM_14_2018_oppaat_Kestavan_kasvun_agenda_10092018_WEB.pdf

brief descriptions of a large number of potential growth areas that could be explored[23].

The significance was in highlighting what was new in the ecosystem approach compared to the existing innovation policy at that time, as the title of the publication stated, *"Ecosystems as targets for new industrial and innovation policy"*. It for instance states that *"ecosystem policy challenges the traditional view that the public sector should not interfere with the development of individual business sectors but should only act as a remedy for market failures"* and that *"ecosystem policy looks at business conditions from a more holistic systemic perspective and focusing on the unique development needs and stage of development of a given ecosystem"*. As the innovation driven economic growth was furthermore emphasised, it is not surprising that the ecosystem thinking was closely linked to growth policy and that it started to influence growth policy initiatives. The publication outlined the new approach needed in facilitating ecosystems and introduced many different types of ecosystems, like innovation, entrepreneurial/start-up, growth and business ecosystems. However, it did not seek to provide a detailed definition of the ecosystem concept and clear framework for implementing the policy in practice.

At the same time, Business Finland together with TEM prepared a roadmap for digital platform economy[24]. This roadmap highlights the importance and potential of digital platforms in facilitating and enabling systemic and radical innovation, reform of value-chains, and eventually industrial and economic structures. Both the influence of ecosystem thinking and the stressed importance of platform companies on growth policy are now visible in the Business Finland Growth Engines initiative.

4.1.2 STARTING WITH THE ECOSYSTEM POLICY

The ecosystem thinking was introduced during rather turbulent times, as Tekes and Finpro merged into Business Finland at the end of the same year (2018) when ecosystem thinking was launched. Besides the impact of such large changes on the people and processes within the new organisation Business Finland, the policies were also affected by the change. To give an example, Tekes used to fund applied and strategic research as well as the SHOK-initiative focused on encouraging and facilitating longer-term strategic research collaboration between academics and industry. The disappearance of both created a gap and subsequently uncertainty about how this gap would be filled in the future. In the R&D&I roadmap it

[23] https://tem.fi/kestavan-kasvun-agenda
[24] https://www.businessfinland.fi/globalassets/julkaisut/alustatalouden_tiekartasto_web_x.pdf

was later proposed to address the gap through new public-private partnerships, however, it is still unclear how these will be set up exactly. Such uncertainties coupled with the regular turbulence that comes with reorganisation, made it challenging to implement a new policy initiative such as the ecosystems.

As outlined in the previous paragraph, section 4.1.1, many different types of ecosystems were introduced, which probably resulted in the dilution of the core ecosystem concept. While Business Finland indicates that there was a definition of ecosystems since 2018, evidence from interviews, other interactions and documentation[25] indicates that the concept used during 2018 and 2019 was still broad and not well internalised by both Business Finland staff and market stakeholders. Without a clear shared definition within the administration multiple ecosystem concepts were being used (sometimes interchangeably) at the same time. This also led to situations where existing activities within Business Finland have been continued as before by relabelling them as ecosystems, according to interviewees. While such difficulties are to some extent normal and understandable, especially given the turbulent times, it also shows that not all ecosystems have been set up from the same origins nor with the same intent and policy support.

At the end of 2020 a new document was integrated in the customer handbook that outlines more clearly what are considered ecosystems and what not. The definition outlines key aspects like the need for a "shared vision and clear common target" and that "working together to create bigger value together than the value each player gains individually of the cooperation". It, however, lacks to cover aspects like structure, organisation and governance of ecosystems, which are covered in our theoretical concept (see paragraph 2.1). The current definition of Business Finland makes it impossible to distinct ecosystems from for instance innovation projects, as innovation projects also have a network of players working together, have a common target and create more value together than companies could individually.

The policy landscape and developments have also had a clear impact on the ecosystem policy of Business Finland. For instance, it is clear that quite a few ecosystems focus in particular on radical innovations (not incremental changes of existing products/services). Similarly, quite a few ecosystems revolve strongly around a platform company that is aiming to open up the digital platform economy in a particular sector. While this in line with the

[25] Customer handbooks of former Tekes, from 2017, mentions ecosystems once. The documentation does not include a clear ecosystem concept, nor is a vision presented on how ecosystem can perform a function in the R&D&I landscape. Improvements to the customer handbook regarding ecosystems date from end of 2020.

policy framework and ecosystem thinking described in chapter 3 and paragraph 4.1.1, it also shows that some of the ecosystems have a strong high-risk-high-reward profile as they do not strongly depart from existing business activities (stable cash flow). A key aspect about renewal is that it intents to achieve industrial transformation, reforming the business model of an existing industry to a new more fruitful business model. The high-risk-high-reward ecosystems, however, tend to depart from this new business model rather than transforming current business models. A good example are ecosystems where the main organisation is a start-up platform company. The success of such ecosystems will depend on the success of the platform, of the start-up company and the development of the ecosystem itself – all three can be considered relatively risky endeavours.

Case study results (Smart Mobility): The Smart Mobility Ecosystem represents the type of radical and disruptive innovation associated with Business Finland's objective of supporting potential world-class ecosystems. At the same time, the ecosystem is a good example of the "winner takes it all" nature of the platform economy. This represents both high risks and high rewards, also from the policy perspective. As in all Growth Engines (with capital loan funding), the structure of the ecosystem is very light and highly focused around the one anchor company.

However, it seems that in some cases it might be very difficult for the platform companies to take a facilitator role while focusing on developing their own platform and business model. In this respect, the Smart Mobility ecosystem differs significantly from the "orchestrated" ecosystems as there is no neutral orchestrator or joint strategy facilitation (with all ecosystem members).

4.1.3 THE NEXT STEP IN ECOSYSTEM DEVELOPMENT & POLICY LEARNING

As can be observed from the previous paragraph, the space for extensive policy design was quite limited for Business Finland. At the same time ecosystem policy is a typical policy that requires long-term commitment, long-term development and continuous learning both within the ecosystems and by policy makers and implementers. Some participants to the policy workshop of this study recognised these challenges during the start of the ecosystem policy and stressed that they *"just needed to start"*. While a clear objective and key concept should have been outlined, *'just starting'* is actually a healthy attitude for ecosystem policy because of these long-term processes. It, however, also means that continuous reflection is needed to keep improving, making decisions and strengthening both ecosystem performance and support (capacity building).

Furthermore, the long-term nature of ecosystem policy also requires a relatively high degree of policy structure and stability. The decision making surrounding the ecosystem policy has so far, however, not been stable. A good example is the decision to set up the capital loans as part of the Growth Engine instrument based on a discussion of key innovation system stakeholders like TEM, VTT, Sitra and Business Finland. The prepared concept of the Growth Engines had to be adapted to fit the capital loan concept. Currently no new budget is allocated to the capital loans while a new instrument was introduced at the end of 2020 (see the leading company initiative in paragraph 4.2.2). Continuous changes in the policy instruments, whether for budget allocation or other reasons, do not support a stable policy portfolio on which the ecosystems can rely in their long-term strategy.

Regarding the selection of ecosystems to support, it is important to make sure these ecosystems will contribute to the overall goals of the ecosystem policy. Given the understanding of the ecosystem concept was still in development during 2018 and 2019 it is very likely that not all ecosystems will lead to similar results. As shown in the work package A report of this study (separate report), ecosystems have multiple development stages and many of the ecosystems in Finland have currently not yet reached (full) maturity. The understanding of these development stages and the public support required in these stages is an important step for further shaping the policy and helping ecosystems in taking their next steps. Similarly, these development stages also provide a starting point for gaining insight into the portfolio of ecosystems and outlining what can be expected from these ecosystems at what stage. Outlining milestones for the development on the road towards maturity can help further monitoring the portfolio of ecosystems. While outlining milestones for development it is important to also define objectives at ecosystem level which collectively add up to the objectives at portfolio level. As described in paragraph 3.1 Business Finland already works with ecosystem level objectives, these, however, are not directly tied to the portfolio and thus policy level objectives.

4.1.4 THE COVID19-CRISIS

The current COVID19-crisis that started early 2020 has an enormous impact on the economy and society of Finland and the world as a whole. While no specific analyses were done regarding the specific impact of the COVID19-crisis it is clear that also the ecosystems will be affected by this in the coming years. While all ecosystems will be affected, some sectors will be hit more strongly and differently than others. Some sectors have seen very little business this past year, while others have been able to meet new market demands generated by the functioning of society during the crisis (for example, more at home and online work, etc.). Either way, at portfolio level it is almost cer-

tain that growth figures will be very limited in at least the period 2020-2021, possibly longer. It is important to distinct the effects of ecosystems from these troubling times.

Case study results (Smart Mobility): Overall, the Smart Mobility Ecosystem (unlike some other ecosystems analysed as part of the study) can be considered as a good example of 'traditional business ecosystem' as it is strongly focused around developing a shared business concept, in this case build around a common platform. The ecosystem is currently in the 'startup-phase', aiming to find the optimal business model and niche for Finnish players in the global markets. The ecosystem is also a good example of how external shocks (such as COVID-19) can affect the trajectories of the ecosystems. This calls for flexibility and ability to adapt to changing circumstances.

4.2 BUSINESS FINLAND POLICY INSTRUMENTS

This paragraph is important for **input additionality**, as it describes the instruments used in the ecosystem policy. This overview also makes tangible through which inputs Business Finland added value to the other forms of additionality – but the results of this are described chapter 5.

4.2.1 TWO TYPES OF SUPPORT

In term of instruments relevant for ecosystem policy we can distinct two types:

1) instruments & services aimed at supporting ecosystem **development & functioning**; and
2) instruments & services aimed at **supporting specific functions** of ecosystems.

It is important to understand that the first type of instrument operates at the ecosystem level and can be really perceived as ecosystem interventions. The second type is often aimed directly at companies (or collaborations of companies and for instance academia) and therefore does not support the development or functioning of the ecosystem itself. It can support its objectives if the activities of supported companies are relevant to achieving the strategy of the ecosystem as a whole.

The instruments & services that **support the development and functioning** of the ecosystem revolve around key aspects within ecosystems:

- Organisation & governance;
- Coordination & orchestration;
- Analysis of challenges & formulation of a vision and strategy;
- Networking & collaboration; and

- Learning & implementation of best-practises (within and between ecosystems).

The instruments & services that support specific functions of ecosystems most commonly focus on aspects like innovation, internationalisation, human capital, etc. This can include a wide rage of policies like subsidies, advice, training, etc. These supported functions of ecosystems are outlined in chapter 2.

Both types of support, for development & functioning and the specific functions, depend more strongly on financial instruments than on services performed by Business Finland. This can be considered a political preference, as it is preferred that public means are provided directly to companies rather than spent on public personnel costs.

4.2.2 BUSINESS FINLAND: SUPPORTING ECOSYSTEM DEVELOPMENT & FUNCTIONING

During the past two years Business Finland had two dedicated financial **instruments aimed at supporting ecosystem development & functioning**. Both of these instruments are labelled as Growth Engines, one focuses on support for orchestration and the other concerns a capital loan for platform companies. Table 1 shows an overview of both Growth Engine instruments. Next to the Growth Engine instrument many other instruments are used to support the functions of the ecosystems (like innovation and internationalisation), but these instruments are not focused on supporting the development & functioning of the ecosystem (see 4.2.1 and 4.2.3), but rather on the performance of companies.

At the end of 2020 a new instrument was introduced, *the leading company initiative* (in Finnish "Veturi").[26] Given the recent introduction this instrument was not in scope of this impact study. It is, however, important to note that this instrument focuses very strongly on a leading organisation.

Next to these instruments Business Finland provides a few limited services at ecosystem level, as indicated before the focus of the ecosystem policy is on financial instruments. For each ecosystem there is a main responsible person within Business Finland. They maintain a dialogue with the ecosystems, some visit ecosystem meetings and they can set up a service plan used within Business Finland that outlines what the ecosystems need in order to progress. These responsible persons are called *"ecosystem leads"* as they are the main contact point for the ecosystems. In this report we will put the acronym of Business Finland (BF) in front of the term to avoid potential confusion with leading representatives of the companies within the ecosystems.

[26] https://www.businessfinland.fi/en/for-finnish-customers/services/funding/funding-for-leading-companies-and-ecosystems

TABLE 1. Overview of the Growth Engine instruments. Technopolis Group 2021, based on the website & documentation of Business Finland[27]

GROWTH ENGINE	SUPPORT	TARGET GROUP	USE OF THE FUNDING
Orchestration funding	Grant funding that stimulates innovation cooperation and facilitates joint activities of ecosystem members. The grant can account for a maximum of 50% of the overall costs.	Private company, association, foundation. In exceptional cases, research organisation or a public body.	To achieve common goals of the business ecosystem. To develop innovation cooperation within the ecosystem through research, development and innovation activities. To activate the business network for joint research, pilot and demo projects and activities on an international scale.
Capital loan	The maximum amount of loan is €2.000.000 to 10.000.000. The loan has a repayment schedule and interest to be paid.	Platform companies.	To promote the development of the competitiveness and new innovations of the companies involved in the Growth Engine ecosystem.

Case study results (Advanced Industrial Loops): The ecosystem has been able to benefit from ecosystem orchestration funding as well as co-innovation funding for joint activities. MEX Finland ry was initiated by Synocus (consultancy company), which still manages the day-to-day operations of MEX Finland ry. However, participating companies are now organized into the board of MEX Finland which has the legal and strategic responsibility of MEX Finland ry. While the funds have been successfully used for their respective purposes, the ecosystem has identified further needs to which they have not been able to find support, e.g., education and training.

4.2.3 BUSINESS FINLAND: SUPPORTING SPECIFIC FUNCTIONS OF ECOSYSTEMS

The arsenal of instruments that support the functions of the ecosystems is a lot larger, although they mainly focus on innovation and internationalisation. In essence there are two types of instruments, those that support companies directly and those that support collaborations between companies and other parties.

Collaboration level instruments of Business Finland include:

- Innovation/R&D cooperation funding (industry-academia); and
- Co-creation funding.

Direct (company) level instruments of Business Finland include:

- Internationalisation and innovation-funding;
- Internationalisation services; and
- R&D funding for large companies.

Next to these instruments there are the Business Finland Programmes. The Programmes are in essence also focused on common innovation and internationalisation challenges identified by the participants, but operate at a higher level. As described in paragraph 3.3.1, the Pro-

[27] https://www.businessfinland.fi/en/for-finnish-customers/services/funding/growth-engines

grammes play a role in the emergence of the ecosystems, but after ecosystems have been set up the practical synergies are insufficiently clearly outlined for external stakeholders.

Finally, Business Finland has an instrument that enhances the domestic and international visibility & attractiveness of testbeds developed by companies, and other organisations, in Finland. This is seen as having great potential in acting as major attractor for bringing international innovation actors and investments to Finland.

4.3 THE ECOSYSTEM PORTFOLIO OF BUSINESS FINLAND

This paragraph is important for **all types of additionality**, as it shows an overview of the sample of ecosystems that this impact study focused on. It is especially important for **input additionality** as it shows which interventions were applied to which (number of) ecosystems.

In this section we provide an overview of the portfolio of ecosystems that we will focus on in this impact study. At the time of this study, there were 34 ecosystems supported by Business Finland. For this study we specifically focused on a selection of 13 of these ecosystems. This report covers only work package B of the larger study regarding the ecosystems, work package A (separate report) provides more details into the portfolio of ecosystems. The selection of these 13 ecosystem for this impact study was made during work package A. Note that the selection of 13 ecosystems was made to represent the wide variety of ecosystems, including the variety of maturity levels to be found in the portfolio of ecosystems.

For the purpose of this report, we will mainly introduce the ecosystems we will focus on, showing some key characteristics like the development phase of the ecosystem (as classified during work package A) and the public support each ecosystem received. This overview is presented in Table 2. The blue and green coloured lines in the table highlight the ecosystems that received ecosystem level public support, while other ecosystems in the selection did not receive such support (only the ecosystem members received collaboration/direct support for innovation or other activities).

TABLE 2. Overview of the selection of 13 ecosystems included in this impact study. Technopolis Group 2021, based on direct input from Business Finland

ECOSYSTEM	DEVELOPMENT PHASE	PUBLIC SUPPORT	YEARS OF PUBLIC SUPPORT
BatCircle	1: Exploration / emergence	Collaboration/Direct	2019-2021
FinnGen	1: Exploration / emergence	Collaboration/Direct	2017-2021
Telaketju 2	1: Exploration / emergence	Collaboration/Direct	2016-2019 2019-2021
CleverHealth	2: Birth / startup (experiment)	Growth Engine: Orchestration	2017, onwards
ForBest	2: Birth / startup (experiment)	Collaboration/Direct	2013-2016 2018-2020
LuxTurrim 5G Plus	2: Birth / startup (experiment)	Collaboration/Direct	2017-2019 2019
Smart Mobility	2: Birth / startup (experiment)	Growth Engine: Capital loan	2018, onwards
Smart Otaniemi	2: Birth / startup (experiment)	Collaboration/Direct	2018-2020 2019-2021
Adaptive Industrial Loops	3: Growth / expansion	Growth Engine: Orchestration	2019, onwards
Elastronics	3: Growth / expansion	Collaboration/Direct	2018
Internet of Locations	3: Growth / expansion	Growth Engine: Capital loan	2018, onwards
One Sea	3: Growth / expansion	Growth Engine: Orchestration	2016-2021
Plastic Waste Refining	3: Growth / expansion	Growth Engine: Capital loan	2018, onwards

5 STUDY FINDINGS: ECOSYSTEM PERFORMANCE

In this chapter we outline the ecosystem performance up to this point by first describing the development of the ecosystems and then the results of ecosystems.

5.1 ECOSYSTEM DEVELOPMENT

5.1.1 PROFILE & ACTIVITY OF THE ECOSYSTEMS

This paragraph is important for **input & behavioural additionality**. It shows results regarding the input from the private sector in the form of the activity at ecosystem level. This is also important for the behavioural additionality as it shows to what extent ecosystems show the activities as described in the theoretical model (see paragraph 2.1).

The overall profile of the ecosystems is very heterogeneous, which reflects the study focus on different types of ecosystems. In general, many ecosystems are clearly still in development and this is one reason for the differences between the ecosystems. Differences are found in terms of having a detailed shared strategy including an analysis of challenges, the structure of the governance and orchestration and the overall dynamics in the ecosystems. On a more fundamental level we found that the overall setup and the objectives of the ecosystem can be quite different as well.

The four performed case studies show this very clearly, see Appendix C for the full case studies and some examples in the textbox below. The cases show the heterogeneous nature of the ecosystems which also translates into the results that can be expected.

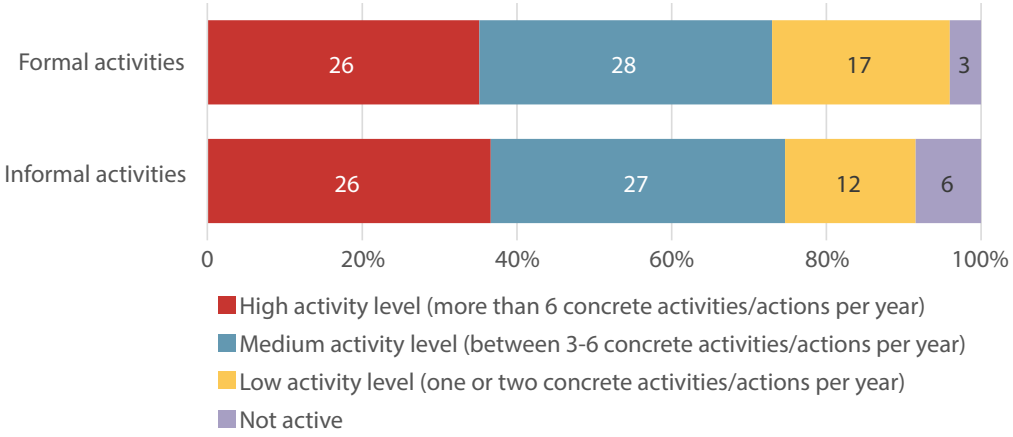
The CleverHealth ecosystem revolves around access to healthcare data and knowledge to develop innovations. HUS is a key player in the ecosystem that provides this access to companies, in turn HUS gets access to the innovations without the companies selling their innovations to HUS.

The SmartMobility ecosystem revolves around a platform company. The success of the ecosystem will depend on the success of the platform and the MaaS concept, therefore little effort is being put on classic business ecosystem activities you see in mature markets.

The BatCircle ecosystem revolves around current activities related to battery materials and component development while future developments will rely on the recycling of batteries. As there are no battery manufacturing companies in Finland, the location factor of the recycling will play a large role.

The Advanced Industrial Loops ecosystem revolves around improving manufacturing. The ecosystem is not geared towards developing but rather adopting new solutions. As companies come from a variety of product markets they do not seem bound together through strong commercial interests.

FIGURE 6. Overview of survey responses regarding the activity of the ecosystems. Technopolis Group 2021



While the ecosystems are in many regards heterogeneous, some common elements can be found as well. Across the ecosystems a strong focus on R&D and innovation can be identified. Survey and interview results also confirm that for many companies this is an important factor to be active in the ecosystem. At the same time, it is clear that many ecosystems analysed are not business ecosystems in the classical sense, at least at their current stage of development. Rather some are platforms in the broad sense and some are collaborative initiatives/projects for innovation, some of which may develop into business ecosystems if the value chain connections fall into place. This is in line with the findings of chapter 4 where we outlined that some activities were relabelled as ecosystems.

Survey results show that a majority of the ecosystems have a healthy amount of activity, yet about a third of the survey respondents indicated that their ecosystem only has one/two activities per year or even no activity at all. This picture seems to be very similar when distinguishing between formal activities, organised by a central body within the ecosystem, and informal activities, organised through the initiative of the members themselves.

5.1.2 ACTIVITY & PERCEPTIONS OF ECOSYSTEM MEMBERS

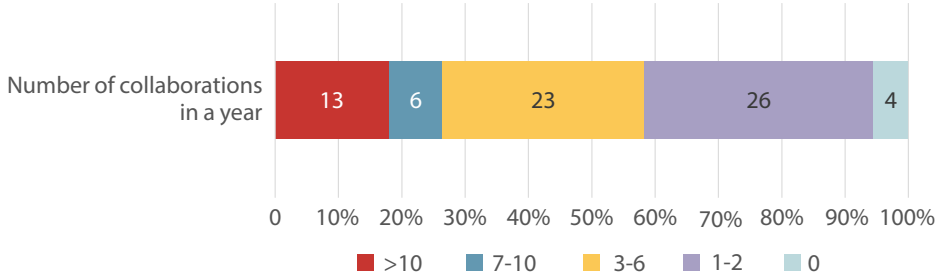
This paragraph is important for **input & behavioural additionality**, as it shows the activity and commitment at the level of the members of the ecosystems.

When looking at the members themselves, we found that about one of every six companies we contacted for either the survey or the interviews indicated to not recognise the ecosystem at all. For the other companies that did recognise the ecosystem we found that just more than half of the members are actively collaborating, of which a smaller group shows an impressive amount of collaborations. At the same time this means that the rest, nearly half, of the companies only collaborates a few times per year. See Figure 7 for an overview concerning the companies that recognised the ecosystems.

We found that nearly all interviewees indicated that the ecosystem helps them to connect with other actors. However, this did not always concerned new connections and also the level of collaborations resulting from these connections varied. Notably quite a few companies did mention that collaborations with companies from a difference size and/or with academia and end users are important to them, which can be a core benefit of ecosystem participation.

The activity of ecosystem members also correlated with their perception of the ecosystem. Companies that are more engaged in the ecosystems also tend to have a more positive view of the ecosystems. Overall a decent amount of companies are positive about the ecosystems, but many also still have mixed feelings. From the interviews and the open answers in the survey it shows that many companies are not yet convinced of the added value of the ecosystems, stating that *"the future will tell"* – which is consistent with the findings of section 5.1.1, ecosystems are still in development. This means that many companies take an individualistic and opportunistic approach in which the success of the ecosystem does not equal to success for the company.

FIGURE 7. Overview of survey responses regarding the company activity within the ecosystems. Technopolis Group 2021



Interview results: The general stance towards the ecosystems was mainly positive (15/36). Out of these fifteen, a third brought up a very positive stance towards the ecosystem. There were no interviews in which the view would have been predominantly critical, however nine interviewees had a mixed stance. The activity in the ecosystem seems to correlate with the stance towards the ecosystem, with active members being more positive about it. These active members see ecosystems as more useful and hence also value the ecosystem more than others. An analysis of the interview data by company size, suggest that in general large companies had a more positive stance towards the ecosystems. However, large companies were also in general more actively involved in the ecosystem (11/14 of the large companies were active).

As a result it seems like many companies are not yet really committed to the ecosystems and many ecosystems have not yet reached the maturity for companies to recognise their value. While in many cases this just takes time to growth together, it is important to recognise the bond between value recognition and ecosystem strength through the activity of its members. While both can strengthen each other in a virtuous cycle, they can also negatively reinforce each other when progress takes too long. It also shows not all ecosystems have been able to really involve all their members. This was also confirmed by survey findings as a few companies even indicated in the open answers that they felt a bit excluded from the ecosystem by the core members.

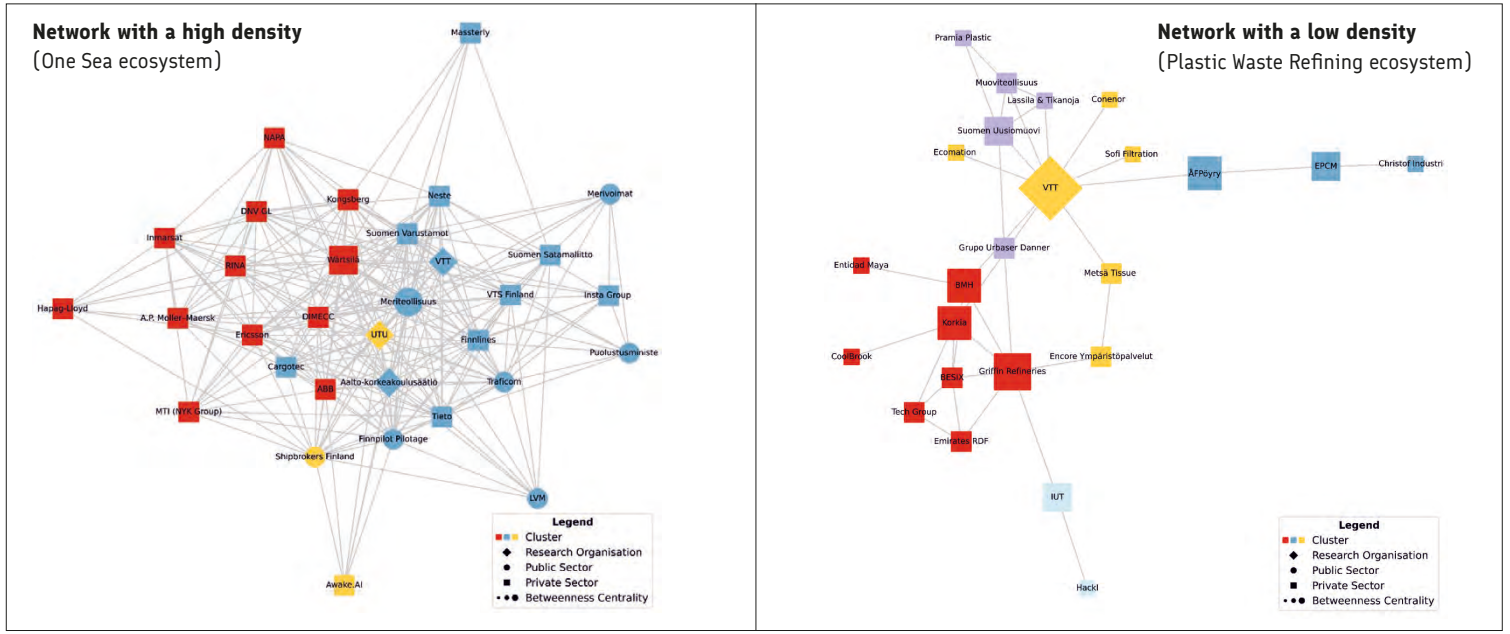
5.1.3 ECOSYSTEM NETWORKS & STRUCTURES

This paragraph is important for **behavioural additionality**, as it shows the structures of the networks in the ecosystems, outlining as well the role of central players in the ecosystems.

Based on webscraping we were able to construct a network analysis of the ecosystems. While this is not based on collaboration data, it does provide insights into the structures of the networks. Please see Appendix D for a full outline of the network analysis of the ecosystems.

We found that a handful of ecosystems show a dense network in which many of the ecosystem members are connected to each other. Especially LuxTurrim 5G and One Sea show very dense networks keeping in mind the number of actors in each of these ecosystems. However, we also found a few ecosystems that do not show a lot of connections. The network of the Plastic Waste Refining ecosystem seems rather scattered and a few of the larger ecosystems (like Telaketju2, Smart Mobility and Smart Otaniemi) show high numbers of organisations with only

FIGURE 8. Impression of the differences in network density of the ecosystems. Technopolis Group 2021

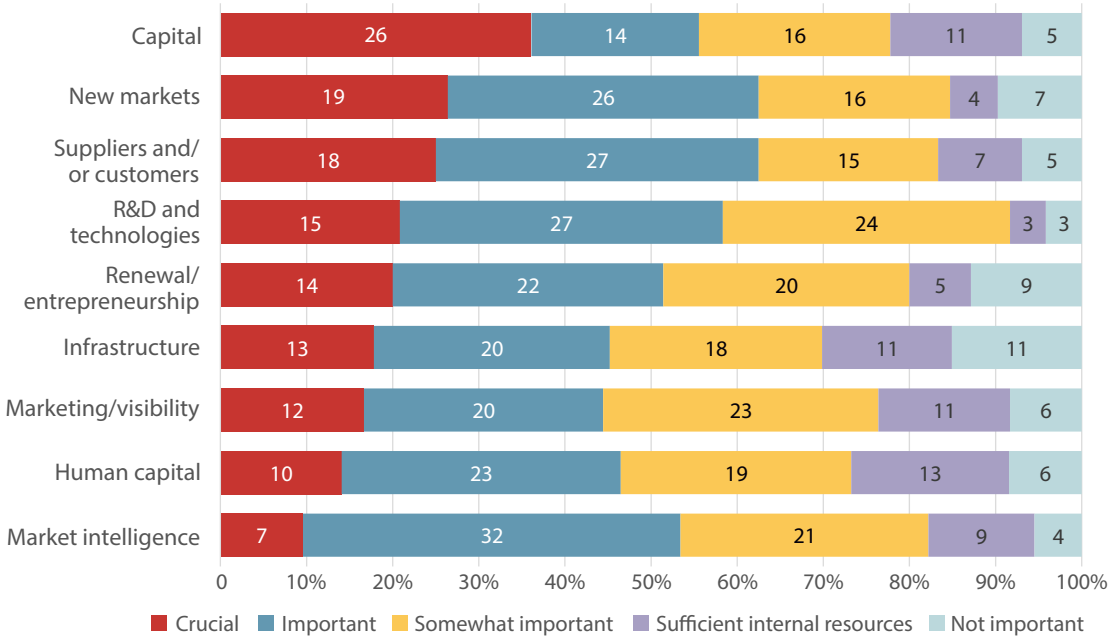


a few connections within the ecosystem. Below, Figure 8 shows two small-sized networks of two ecosystems to give an impression of the differences – note that for each ecosystem a full-sized network graph and analysis is available in Appendix D.

Across the board research organisations tend to have a very central position in the ecosystems, as do large companies. Smaller companies seem to be mainly well connected in the few ecosystems that have dense networks. In other ecosystems they are often found on the edge of the networks often linked to less than a handful of other organisations. One ecosystem, Adaptive Industrial Loops, clearly shows a single central orchestrating organisation that is a lot stronger connected than other organisations in the ecosystem. A few others rather show a more connected core with a few research organisations and large companies.

Given that relatively many ecosystems revolve strongly around the connections of research organisations and large companies their incentives for participating in the ecosystem become important, especially when they have a leading role in the orchestration of the ecosystem.

FIGURE 9. Overview of survey responses regarding the importance of external resources. Technopolis Group 2021



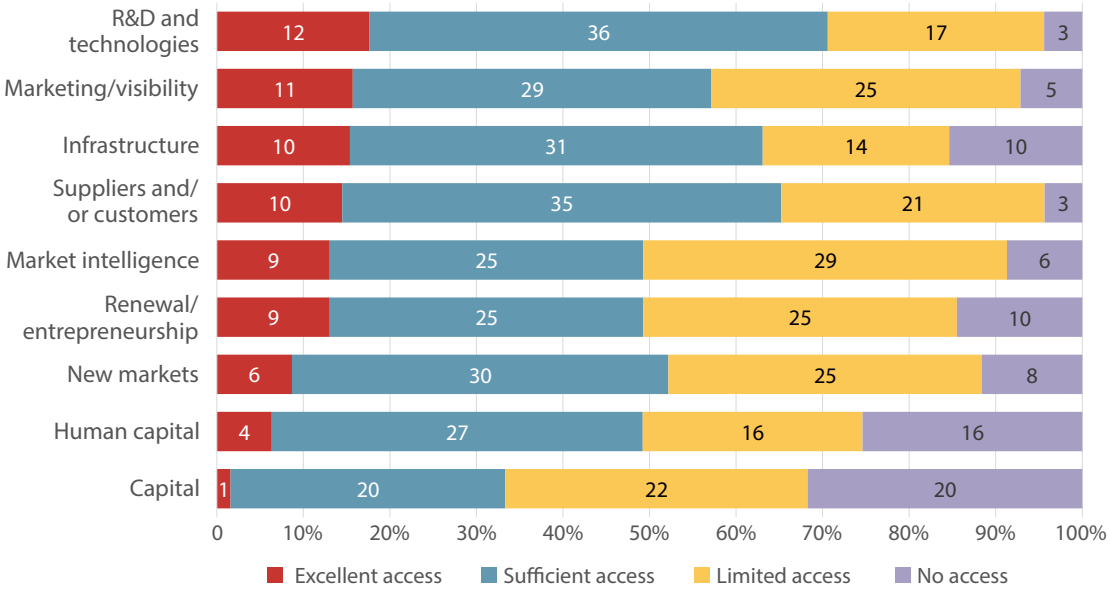
5.1.4 ECOSYSTEM FUNCTIONS

This paragraph is important for **input & output additionality**. The ecosystems functions describe how ecosystems provide access to external resources for their members which is the main added value of the ecosystems for their members (see paragraph 2.1).

Overall a strong focus on R&D and innovation was found for the ecosystems. However, survey results show that, while R&D and innovation are important, companies also need many other external resources. As described in section 2.2, the methodological framework, ecosystems can provide many different functions for their members by providing access to resources through network contacts and formal activities. Examples are access to capital through networking events with investors or access to human capital through an internship programme with high education institutions. When looking at crucial resources we see access to capital, new markets and suppliers/customers at the top of the needs of companies. However, if we look at crucial and important resources combined all functions from the methodological framework are values by around half of the companies that answered the survey. This shows the wide variety of needs amongst the companies. Figure 9 shows a full overview of the importance of external resources for the companies.

Now when looking at the survey results regarding the extent to which the ecosystems provide access to these external resources we see quite balanced results. Overall not many companies have indicated the ecosystems provide excellent access to any of the resources, but many companies have scored the access at sufficient. See Figure 10 for an overview of the access to external resources provided by the ecosystems.

FIGURE 10. Overview of survey responses regarding the access provided to external resources. Technopolis Group 2021



More importantly, however, is that if we cross-analyse the needs of and access provided to individual companies we find that in many cases the assessment of importance and access is in balance. Meaning for example that companies that find access to market intelligence important also have sufficient access, and that companies that find for instance infrastructure only somewhat important only have limited access, etc. Clearly, many small mis-matches are found as well, but overall the balance is quite impressive.

When interpreting the open answers of the survey responses and the interviews we find that overall the expectations of many companies regarding the added value of the ecosystems are not very high. This correlates to the findings of section 5.1.2 where we indicated that many companies are not yet fully committed. As a result, we feel that many companies do not yet fully recognise the potential that the ecosystems have, and therefore often scoring the access provided to the functions in relation to their (low) expectations, i.e. sufficient for what can be expected.

As presented in Figure 10, the score of access provided to capital is significantly lower than the other functions. The main explanation is that many companies linked the access to capital to the access to public funds provided by Business Finland. Some even mentioned to have joined the ecosystem to get access to public

funding and others mention to question the allocation of resources within the ecosystem. These findings can a bit worrying as there should be an intrinsic motivation to join the ecosystems. The value of the ecosystems should be strengthened by public funding rather than be replaced by it. For now, we conclude that this could be resolved when the commitment of members and value recognition are improved through further development of the ecosystems.

Interview results: When queried about the main added value and the companies' motivation for joining the ecosystem, several different themes were brought up by the interviewees. On an aggregate level the most common references were to R&D collaboration, insights and knowledge on future trends and opportunities, as well as exploring new business opportunities. Additionally, networking among different actors was considered important by many of the interviewees: this included both the formal and informal aspect. When considering external factors, access to Business Finland funding was often seen as an important attractor for companies.

5.1.5 STRENGTHS/DRIVERS & WEAKNESSES/BARRIERS OF THE ECOSYSTEMS

This paragraph is important for **input & output additionality**, as strengths/drivers & weaknesses/barriers show how well the ecosystems are able to get their ecosystem working as intended as well as how this impacts the output of the ecosystems for their members.

The view of the companies on the value of the ecosystems differs strongly. When analysing the various strengths and weaknesses as well as drivers and barriers, we found many conflicting results. For example, where some companies praised the value of the ecosystems in building connections between members others indicated to have difficulties in finding partners. Table 3 provides an overview of these conflicting findings. In general this is again a sign of some ecosystems being active and successful in involving their members where others are not, and some companies being active and invested where others are not.

A few of these results should be emphasised. This first being the focus on R&D and innovation which is valued by some, while other indicate that the ecosystem is *"too academic"*. As we have seen, in many ecosystems research organisation and/or knowledge institutions have a very central position in the ecosystems, which means

TABLE 3. Overview of conflicting strengths/drivers & weaknesses/barriers. Technopolis Group 2021

STRENGTHS/DRIVERS	WEAKNESSES/BARRIERS
Connecting with others & partnerships	Difficult to find partners & lack of collaboration
Good management of the ecosystem	The functioning of the ecosystem
R&D projects/collaboration	Too academic – lack of business case
Expertise & knowledge sharing	Competition within/between ecosystem(s)
Market specific business opportunities	Small Finnish market
	Commercialisation step of innovation (regulation, public debate, launching customers, pilots/demonstrators, ...)

they will likely also have a big say in the direction of the ecosystem. Note that in the ecosystem concept presented in the methodological framework we emphasised that the core the ecosystem should consist of private actors to secure the business minded focus ecosystems require.

A common questions is: "What is the difference between business ecosystems and innovation ecosystems". While many authors and experts will provide different answers to this questions, our answer would be that both should depart from the same principles. Ecosystems should always perform an analysis of common challenges and set up a shared strategy to act upon these challenges. In some cases a focus on R&D and innovation is required to overcome challenges. This means business ecosystems can effectively be 'innovation-focused' and thus be labelled as 'innovation ecosystems', however a clear distinction should be made with innovation systems. Innovation systems are distinctly different from ecosystems as they are organic and have no governance – meaning they commonly do not work based on an analysis of common challenges and a shared strategy.

The second finding to emphasis is the barrier regarding the commercialisation step of innovation. In many of our methodologies we found companies struggling with framework conditions of their innovative activities. In some cases companies were confronted with regulation frameworks that blocked them from taking a next step with their innovations, the same we encountered with regards to for instance the availability of pilots/demonstrators. With some ecosystems revolving around a particular (radical) innovation it is important to focus on actively removing barriers for such an innovation – unless the innovation is not deemed fruitful for further development. Otherwise also the development of these ecosystems can be hampered.

5.1.6 ROLE OF THE ECOSYSTEM FOR COMMERCIAL OUTCOMES & THE SECTOR

This paragraph is important for **output additionality**, as it shows in general level how important the ecosystems are considered to be with regards the company level results as well as sector level results.

Many companies indicated that the role of the ecosystems is relatively limited with regards to specific commercial outcomes. This further confirms that for many companies the ecosystems are currently something that plays a minor role for their company. A small selection of companies however sees the ecosystems as having a critical role or even as the main driver for these commercial outcomes. See Figure 11 for a full overview of the survey results. The strong focus on R&D and innovation also shows up here, as the role of the ecosystems is rated higher for improving innovative activities. Given the policy focus on export it important to recognise that almost 40% of respondents currently see no role for the ecosystems for increasing export. Similarly, 50% of respondents see no role regarding enhancing resilience, which is important given the current COVID19-crisis and other kinds of future crises.

When asked about the role of the ecosystems regarding sector-level outcomes the role of the ecosystems is rated higher. Many companies see an important support role for the ecosystems with regards to these outcomes, see Figure 12 for the survey results. In contrast to the results regarding export discussed above, it is encouraging to see the role of the ecosystems regarding international recognition showing up strongly. On the other hand renewal is rated lower while this a focus area for Business Finland as well, half of the responding companies indicated that ecosystems play an important (support) role for renewal.

FIGURE 11. Overview of survey responses regarding the role of the ecosystems for commercial outcomes. Technopolis Group 2021

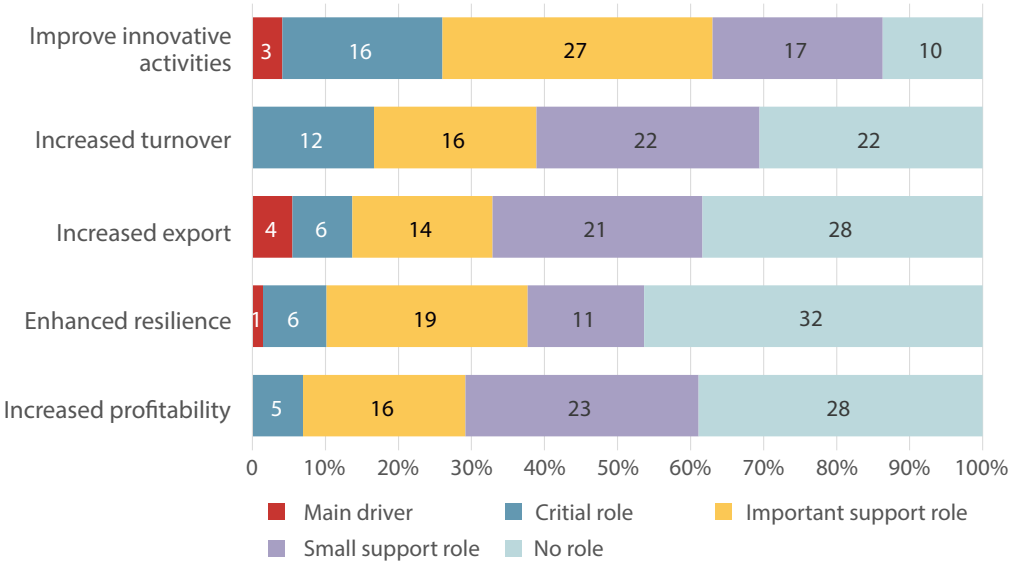
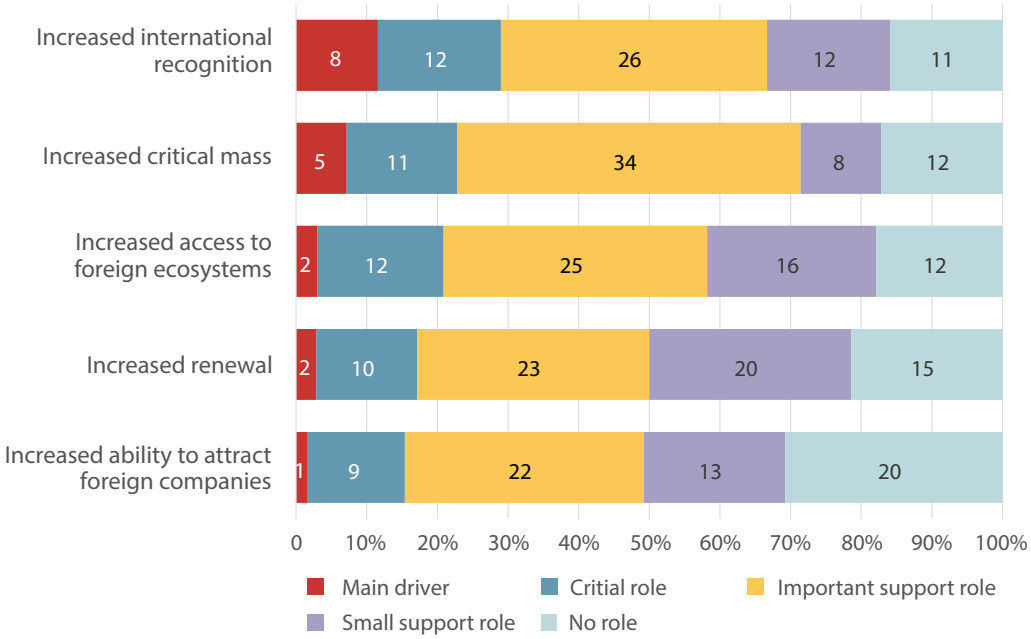


FIGURE 12. Overview of survey responses regarding the role of the ecosystems for the sector. Technopolis Group 2021



5.1.7 POLICY FOR ECOSYSTEM DEVELOPMENT & FUNCTIONING

This paragraph is important for **input & behavioural additionality**. It provides a reflection of the ecosystem members on the policy interventions, specifically regarding the development and functioning of the ecosystems.

When discussing the role of the public policy it was clear that most companies recognise the support provided by Business Finland. Many companies link this to direct funding at company level like for example innovation projects. Both the interview as survey results confirm that quite a large portion of the companies are unaware of the support Business Finland provides at ecosystem level. To some extent this is to be expected, as we have seen that only about half of the ecosystems have received support through the Growth Engines which is the main ecosystem level instrument aimed at the development and functioning of the ecosystems (see paragraphs 4.2 and 4.3). Other instruments are mainly aimed at results in terms of innovation or internationalisation rather than the development and functioning of the ecosystems.

Interview results: Most of the interviewees recognised at least some role of Business Finland in supporting the ecosystem, but there were also many interviewees who had no clear view on Business Finland role. In these cases with no clear view, the interviewees commented not to have that much concrete interaction with Business Finland in the context of the ecosystem. Often in these cases the most visible actor for them was the ecosystem orchestrator or coordinator.

Based on feedback from Business Finland it becomes clear that the ecosystem policy has also not been communicated externally very clearly up to this point – although it is listed prominently on the website of Business Finland and various articles[28] are being published with prominent business leaders and Business Finland representatives.

The non-financial services provided at ecosystem level that support the development and functioning of the ecosystems mainly revolve around the BF ecosystem leads of Business Finland (see paragraph 4.2.2). Other services are mainly aimed at results in terms of innovation or internationalisation rather than the development and functioning of the ecosystems. In the survey some companies mentioned that these BF ecosystem leads are present during ecosystem meetings. These companies expressed mixed feelings about the role of Business Finland during these meetings as they found the input provided by the BF ecosystem leads limited. More importantly it seems that it is not clear to these companies why Business Finland is present during the meetings (for support, for monitoring, etc.).

Overall, most companies classify the role of Business Finland as either "enabling" or "supportive", and many companies indicate that this is a fitting role for a public institution. The leading role of business in ecosystems is indeed in line with ecosystem literature and principles, although at policy/portfolio-level a more active role of public policy is required.

The needs expressed by companies regarding public policy at ecosystem level mainly revolve around coordination *within and between* ecosystems. This is in line with the weaknesses/barriers presented in paragraph 5.1.5. Next to that quite a few companies mention they would appreciate a *"lobby"* from Business Finland across government departments to put key ecosystem interests on the agenda. While lobbying in some contexts can have a negative connotation, a constructive dialogue is quite common in ecosystem policy. Such a dialogue can provide very valuable industrial intelligence for policy making, which is something Business Finland already is known to do through its other channels.

[28] An example of an article: https://temkirjeet.sst.fi/messages/view/1016/0/69713679a1f2acbc921ddf3660554a96

Case study results (BatCircle): The ecosystem governance is coordinative rather than shared, as there are no joint action plans or roadmaps for the ecosystem apart from the jointly defined public research agenda. The interaction and collaboration take place mainly in joint projects. The ecosystem has used Business Finland co-creation and co-innovation funding, but no orchestration funding. In addition to funding, Business Finland has supported the ecosystem participation in national and European strategic activities, as well as promoted investments into local battery material and component production, battery recycling facilities, and cell and battery manufacturing facilities.

5.2 ECOSYSTEM RESULTS

In this section we present the key figures regarding the ecosystems. We focus here on presenting the main findings, but full tables of all available figures can be found in Appendix E. In terms of timeline, this paragraph details the findings for the situation in 2018 as well as the years leading up to 2018. The analysis is focused on the sample of 13 ecosystems. Further modelling towards the future is presented in chapter 6. As many ecosystems have either developed from past projects and/or originated directly from industry, no strict starting dates of the ecosystems are available. Nevertheless, the perception is that many of the ecosystem activities have been starting in recent years.

Figures only reflect the ecosystems themselves, no effects from public intervention were present in the data as interventions often took place in 2018 and the most recent statistical data is from 2018.[29] No findings for specific ecosystems will be presented as the sample per ecosystem is too small (many ecosystems have around 15 companies, the smallest only 9 and the largest 58).

Besides key figures we also provide qualitative context based on the impact interviews performed. Note that in these interviews it also showed that many ecosystems are still fully in development – about a third of the companies interviewed indicated that tangible results (like innovation or accessing new markets) have not yet been realised, but are expected in the future.

[29] Tax data was available for 2019/2020 but discrepancies with regards to the 2018 turnover figures and inconsistent across companies were too large that this data could not be used to scale data to recent years.

5.2.1 GROWTH

This paragraph is important for **output additionality**, as it shows the key economic results related to growth. It also reflects on the results for different company size classes and development stages of ecosystems which is relevant to **behavioural additionality**.

The growth of companies is best explained through key figures regarding turnover and employment. The full activities of the companies show very high figures, exceeding even the 20 Billion Euro figure mentioned in paragraph 3.1 as an internal target for Business Finland. However, this figure does not provide insight into turnover that is linked to the activities of the ecosystem.

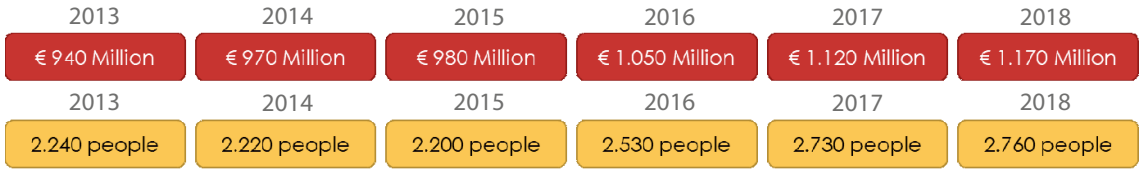
In our survey we asked companies to specify how much of their activities would be considered *"ecosystem relevant"*[30]. With this we measured what part the current business activities will be affected by the ecosystems. As can be observed in Figure 13 in 2018 the value of ecosystem relevant turnover was just over one billion Euro, realised by just under three thousand employees. For very large multinationals the relevance percentage is low as they have a very broad portfolio of business activities, while for smaller companies a lot more variety is observed.

Over the past years the relevant turnover and employment of the companies in the ecosystems has steadily grown, with the biggest growth visible in the years 2016, 2017 and 2018. See Figure 14 for an overview of the figures. To get an indication of the growth experienced by

FIGURE 13. Overview of ecosystem relevant business activity (turnover and employment). Technopolis Group 2021

[30] Note that for non-respondent companies (x%), we inferred the share of activity related to the ecosystem based on the average value of those companies that did respond, controlled for firm size.

FIGURE 14. Overview of the growth of ecosystem relevant business activity over the past years. Technopolis Group 2021



most companies we calculated the median[31] of 9% growth in turnover and 3% growth in employment over the years 2016-2018.

Case study results (CleverHealth Network): Through the results of the projects societal value is likely to be created for the clients of HUS (in terms of better care, new healthcare solutions, etc.). It is, however, very difficult to determine, which share of the ecosystem's economic added value will eventually remain in Finland given that many of the core companies are large global businesses with subsidiaries and/or a headquarters in other countries. The key issue therefore is that the (high-quality) R&D operations of these companies will remain in Finland, and hopefully be expanded.

A very substantial part of the turnover in 2018 is related to large companies, not only due to their individual size, but also due to the relatively high number of large companies active in the ecosystems. On the contrary, the number medium-sized companies is low and therefore their share in the total relevant turnover is also limited. See Figure 15 for a full overview.

When looking at the lifecycles, we see that most of the relevant turnover is taking place in ecosystems that are still in early development, see Figure 16.

[31] The median is the middle value of growth of the companies sorted on growth percentage. Using this figure is more reliable than the true average as start-ups can have growth values of 0% (when there is no previous turnover) or very high percentages (when previous years turnover was very low but higher than zero), similarly, very large companies often experience very minor percentage shifts – which can still make a large difference in actual turnover.

FIGURE 15. Split of ecosystem relevant turnover across company size classes. Technopolis Group 2021

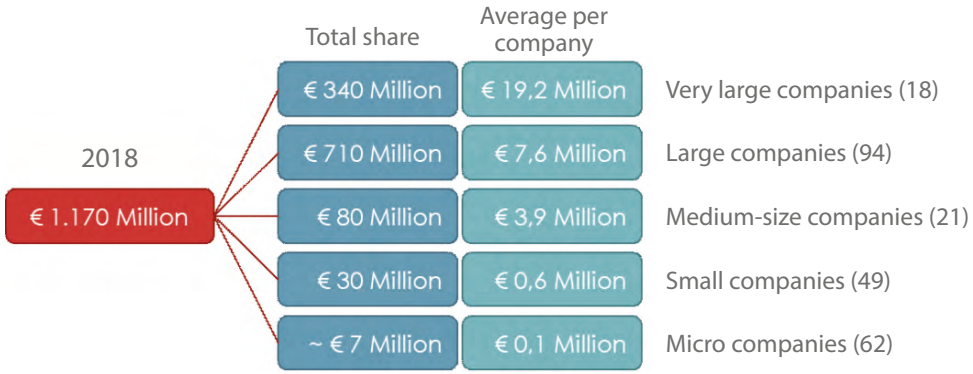
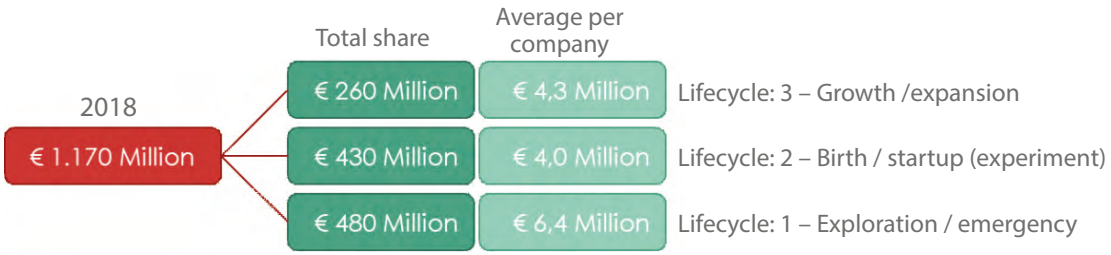


FIGURE 16. Split of ecosystem relevant turnover across ecosystem lifecycles. Technopolis Group 2021



5.2.2 INNOVATION & RENEWAL

This paragraph is important for **output additionality & impacts to the Finnish economy and society**, as it shows the key results regarding innovation and renewal as well as productivity levels.

Renewal and (radical) innovation are key objectives for Business Finland. For Business Finland renewal includes both new business activities and adapting current business activities. Note that renewal can take place at company level and at the level of the economy (or in this case at ecosystem level), see the text box below. The key aspect of renewal is continuous development and transformation to make sure the business activities remain relevant in the long term. Renewal at ecosystem level should be visible through systematic innovation of the majority of companies in the ecosystem, wide uptake of new technologies and business models and upcoming new firms (entrepreneurship) that challenge existing firms and business models. Incremental changes on existing business activities are not considered renewal.

Renewal at company level includes both growth of companies by introducing new innovations next to existing products/services/processes as well as transforming existing business activities. An example of company level renewal would be a change towards a more sustainable way of working.

Renewal at the level of the economy (or the ecosystems) would include both widespread company level renewal as described above as well as entrepreneurship (new companies that create new business activities). A key element is that new companies can also replace existing companies if these do not renew their activities to stay relevant. An example of ecosystem level renewal would be the One Sea ecosystem where the ecosystem focuses on a transition towards autonomous maritime activities.

Renewal is a priority in the ecosystem policy as is shown in the focus of many ecosystems. A handful of ecosystems focuses on absorbing technologies or entrepreneurship (new firms), but innovation by ecosystem members is the dominant method applied for renewal. Innovation is a key focus of many of the ecosystems as well as the companies within the ecosystems. More than 40% of the companies in our sample indicated that more than 25% of their expenditures are related to R&D. Similarly, more than 40% of the companies indicated that more than 50% of their turnover is derived from innovations they introduced in the past 5 years. See Appendix A for full survey results. During the impact interviews most companies that mentioned tangible results of participating in the ecosystem, indicated to have realised new innovations. While some feel the ecosystem was crucial in achieving these results, others indicated limited or even no importance. Nearly all these companies mention that the (expected) turnover, related to their new innovation, is not displacing current business. This shows that the innovations are likely aimed at growth (new business activities) rather than transformation existing business activities.

Innovation is also related to labour productivity. Our analyses show that across the sample companies have a labour productivity of about €120.000 per employee, and this has been quite stable over the past years. Figure 17 shows an overview of the labour productivity for different company size classes. Higher productivity numbers are visible for larger companies, but the biggest different is visible at the top, the very large companies (multinationals).

Over the period 2013 to 2018 a total of 40 new companies were created that are now part of the ecosystems.

FIGURE 17. Labour productivity across company size classes (2018). Technopolis Group 2021

This is the equivalent of 17% of all companies. These companies started to generate turnover in 2016, and in 2018 they accounted for 70 million Euro of the relevant turnover. Notably, more than half of these new companies are part of the Smart Otaniemi and Telaketju 2 ecosystems which are also the largest ecosystems in terms of number of members. The concentration of new companies in these ecosystems may align with their ecosystem strategy, it is a form of renewal, but this was not analysed at ecosystem level.

5.2.3 INTERNATIONALISATION

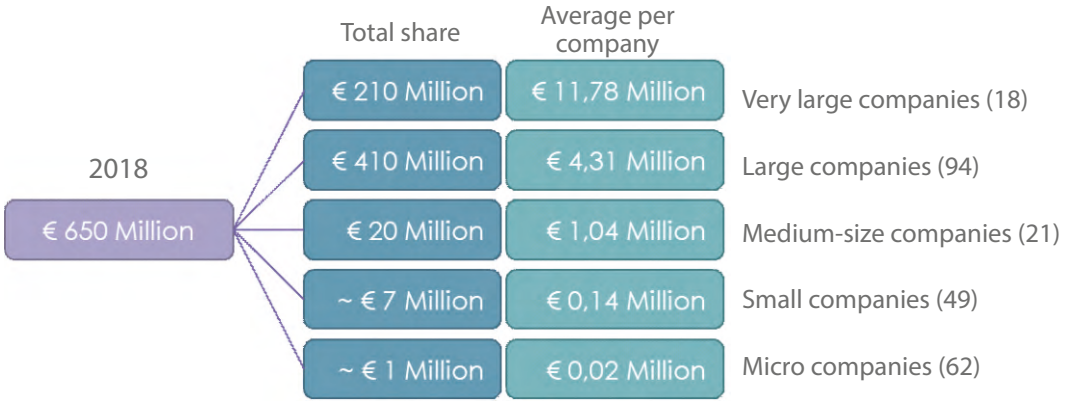
This paragraph is important for **output additionality & impacts to the Finnish economy and society**, as it shows the key results regarding internationalisation, and reflects on the role of ecosystems in attracting these companies to Finland (FDI). The export results for different company size classes is relevant to **behavioural additionality**.

The ecosystem relevant export of the companies also shows a strong growth over the past years, see Figure 18. Looking at the distribution of the relevant export across the different company size classes, see Figure 19, it shows that mainly medium-sized, large and very large companies perform export. For smaller companies this still is quite limited. During the impact interviews a handful of companies mentioned than they were able to access new markets through participation in the ecosystems, three companies mention the domestic market and two export markets. The perceived added value of the ecosystem in accessing these markets however varied.

Export seems to be a key area for further development and growth for the smaller companies. Investigating this further shows that the median share of export for the companies is about 9% of the turnover. For very large companies the median is about 60%, just above the average of the full ecosystem sample of 55%. Ecosystems have the potential to play a big role in getting smaller companies to benefit from export markets, as often these smaller companies find it difficult to undertake internationalisation activities on their own. There are however multiple options in doing so. The most obvious option is to directly support smaller companies in exporting products/services to foreign markets. The second option is to aim for a supplier relation to larger Finnish companies,

FIGURE 18. Relevant export across company size classes (2018). Technopolis Group 2021

FIGURE 19. Relevant export across company size classes (2018). Technopolis Group 2021



letting smaller companies benefit from export markets in an indirect way. The third option is to work on internationalisation of the ecosystem itself, allowing smaller companies to access foreign markets through the ecosystem activities, for instance by building strategic collaboration with foreign ecosystems or clusters.

Including foreign companies, without a Finnish subsidiary, in the Finnish ecosystems is a strategy to increase the internationalisation strength of the ecosystems. It is, however, not clear how these foreign companies will add value to the ecosystems besides an exchange of knowledge as they are likely to remain focused on individual objectives and the strategy does not seem to be aimed at FDI (attracting these companies to Finland).

5.2.4 THE POTENTIAL OF THE ECOSYSTEMS

This paragraph is important for **output additionality**, by showing the potential of ecosystems on the performance of their members.

No effects from public intervention were present in the data shown in previous paragraphs, as interventions often took place in 2018 and the most recent statistical data is from 2018. While the presented figures do not yet show the impact of policy, they do show that the companies included in the ecosystems show strong growth, emphasising the potential of the ecosystems. Furthermore, our analysis did find some evidence that companies that were more active in the ecosystems also shows stronger economic results[32].

- *Significant correlation found between added value growth and the number of years a company has been a member of the ecosystem. ($p<0.10$)*
- *Significant correlation found between turnover growth and the use of access to external resources by the ecosystem, the ecosystem functions. ($p<0.10$)*

[32] The direction of causality cannot be determined with our dataset.

6 LOOKING TO THE FUTURE

In this chapter we aim to provide perspective on the future of the ecosystem, by presenting growth models as well as discussing challenges & opportunities for the future.

This paragraph is important for **impacts to the Finnish economy and society**, as it outlines finding regarding the growth potential of the ecosystems, and to what extent overall objectives can be obtained in the long term.

As outlines in paragraph 4.1, the key performance indicators for the ecosystem policy are not clearly defined. To allow us to provide perspective on the future developments of the ecosystems, we outlined a few assumptions in line with our methodological framework to have a clear target for modelling:

- The main KPI is expressed in turnover;
- Only ecosystem-relevant turnover is used in calculations;
- A 10-year period is taken from the start of public interventions (reference year 2018); and
- A collective target of 1 billion Euro relevant turnover will be set for all ecosystems together.

A few key caveats for interpreting modelling results:

- *Economic modelling includes high uncertainty (future prediction)*
- *Economic potential estimated are set up using midpoint estimates*
- *The extrapolation is based on growth numbers from a strong economic period (2016-2018)*
- *The expected economic decline of the COVID19-crisis is not included in the model for the coming years, we however did classify multiple scenarios of which the 2016-2018 growth is used as the highest growth scenario*
- *The available (micro-economic) data does not allow for extensive macro-economic modelling. The figures presented here are therefore based on relatively exploratory estimations based on company-level data.*

Using these guidelines, we outlined a model for the future growth of the turnover of the ecosystems. We will present one model without and one model with an estimation of the effects of public intervention. In each model a high scenario based on the growth of the period

2016-2018 is presented (median: ~9% growth), as well as a medium scenario (median: ~6% growth) and a low scenario (median: ~3% growth).[33] We account for an average of 2% of inflation, figures are presented in 2018 EUR, so all growth is real growth. In the scenarios with public intervention included, the effect of public intervention is modelled at 3%.[34]

FIGURE 20. Model of future relevant turnover growth with three scenarios. Technopolis Group 2021

FIGURE 21. Model of future relevant turnover growth, including estimated effects of public intervention, with three scenarios. Technopolis Group 2021

The model without the estimation of the effects of public intervention is presented in Figure 20. The model shows that if the strong economic growth of the past years (2016-2018) continues the target we outlined of 1 billion Euro relevant turnover is likely to be met without any public support. If growth declines, a growth of about a third of the target is projected. With a further decline in the growth rate the turnover of companies will no longer grow but shrink.

The model in which we estimated the effects of public intervention is presented in Figure 21. In these scenarios it shows that growth can be further accelerated. The medium scenario now nearly reaches the 1 billion Euro relevant turnover we set, similarly, the low scenario is now no longer negative but nearly stagnant.

While this modelling at portfolio level helps to get a grasp on future developments, monitoring and impact measurement can be further improved in the future. We provide some insights into challenges and opportunities regarding monitoring in the next paragraph and have outlined a more detailed recommendation regarding impact measurement in paragraph 8.3.

33 In the model in company specific growth rates were calculated and used. The median growth rates are simply an indication of the growth rate. The specific growth rates coupled with the size of the companies determine the results.

34 Current estimates on the net effect of public support to R&D on economic indicators vary wildly from study to study and from context to context. This estimate was chosen based on the comparison with a number of interventions that have similarities to the ecosystem approach in terms of interventions and context.

7 CONCLUSIONS

This chapter starts with the overall conclusions of this impact study, afterwards paragraphs 7.2 to 7.5 present more detailed findings per type of additionality, addressing the main research questions of this impact study. For each type of additionality general findings are presented first, then the sub-questions are answered.

7.1 OVERALL CONCLUSION: STABILITY AND CLARITY NEEDED TO REALISE GREAT POTENTIAL

The ecosystem policy is a relatively new policy initiative that shows strong potential for the future of Finland. Ecosystem development is known to be a long-term process in which the operations and governance of ecosystems as well as the trust levels and dynamics between ecosystem members emerge and mature. This impact study was performed after the first two years of the ecosystem policy, which is relatively early given the long-term nature of ecosystem development. At the same time, the conditions under which the ecosystem policy were implemented were quite turbulent given the Tekes and Finpro merger in 2018 and the COVID19-crisis from Spring 2020 onwards.

The findings of this impact study show mixed results. On the one hand we found that ecosystems are quite heterogenous, development levels of the ecosystems differ strongly, and different degrees of engagement and commitment are visible among ecosystems members. It is still too early to make strong statements about the economic and social impact of the ecosystem policy. On the other hand, we also found that ecosystem members show a very strong innovation and growth profile, some ecosystems already show to be well organised with decent governance models and strong network ties. We also found statistical signs that the length and depth of ecosystem participation of companies is associated with stronger company growth.

Overall the emphasis on ecosystems could provide strong impacts for Finland given how well the policy intervention fits the faced challenges, requiring systemic solutions through higher levels of coordination and collaboration. The ecosystem concept also fits well with the role of Business Finland as ecosystems allow for strong

interaction between Business Finland and collaborations of growth-minded businesses that can be challenged to focus on renewal and internationalisation. From this perspective, the ecosystem policy shows great potential, provided that Business Finland further develops its policy design and implementation of the ecosystem approach. While we think there is work to be done, we also recognise that ecosystem policy requires time, stable commitment and continuous learning at policy level on how to reach the best results. To some extent the same holds true for other stakeholders in the innovation landscape, including the Ministry of Economic Affairs and Employment, as more can be gained through policy stability and commitment, better coherence between initiatives and clearly defined strategic and operational objectives.

7.2 CONCLUSIONS REGARDING INPUT ADDITIONALITY

Input additionality describes the effects of resources put into the ecosystem policy. This concerns both the available financial and non-financial resources and capabilities of Business Finland as well as those available within the ecosystems (human resources, orchestration, etc.).

The overall policy framework of the ecosystem policy fits well with the observed system failures and challenges. System failures concern issues that require higher levels of coordination to solve, which is why ecosystems are a relevant intervention. The implementation, however, does not completely match the framework. Not all ecosystems have the set up and characteristics to develop into the ecosystems Finland needs to meet its long-term objective. The companies in the ecosystems show, however, a strong economic and innovative profile. Currently, the policy instruments at ecosystem level that support development and operations mainly revolve around the financial Growth Engine instruments by which only some of the ecosystems are supported. Since many of the ecosystems are still in development, they could benefit strongly from non-financial ecosystem services as well to help them taking steps towards maturity.

Key chapters/paragraphs to read more regarding input additionality are:
3 / 4.1 / 4.2 / 5.1.1 / 5.1.2 / 5.1.4 / 5.1.5 / 5.1.7

DOES BUSINESS FINLAND HAVE THE APPROPRIATE RESOURCES AND CAPABILITIES IN PLAY TO IMPLEMENT THE ECOSYSTEM POLICY?

The ecosystem policy of Business Finland has been maturing during the past years. Business Finland took a next step in defining the ecosystems they want to focus on at the end of 2020 and is tailoring their services more towards the development phases of the ecosystems. It is clear that Business Finland still has some catching up

to do in terms of capabilities in managing a portfolio of ecosystems, but its focus on improvement is reassuring. Further strengthening of the policy and implementation framework will, however, be necessary. Working from a common understanding of ecosystems that can be differentiated from other initiatives like innovation projects, ecosystem policy and coherence with other Business Finland policies can be further developed.

The policy instruments that Business Finland currently employs at ecosystem level to support development and operations are limited to the financial Growth Engine instruments and the modest non-financial support through the BF ecosystem leads. The other Business Finland instruments support specific functions of the ecosystems (like innovation and internationalisation), but these are not aimed at the development and operations of the ecosystems. Overall the financial means for the Growth Engines, about €30 million in 2018 and 2019[35], seem sufficient to support the development and operations. However, funds could be linked more strongly to development objectives and the overall portfolio objective. The non-financial service portfolio is currently too lacklustre to secure return on investment of financial instruments. Many services that other countries provide, like training, peer-to-peer learning, providing templates and platforms, etc. seem to be missing.

The overall policy framework in Finland, in which the ecosystem policy of Business Finland operates, can be improved to better support coherence between initiatives. A first step would be to continue the discussions regarding the link between the Business Finland ecosystems and other *'ecosystem-like'* directions, like the flagships/competence platforms (Academy of Finland) and urban ecosystems as innovation platforms (TEM with cities).

DO THE (MEMBERS OF THE) ECOSYSTEMS HAVE THE APPROPRIATE RESOURCES AND CAPABILITIES TO DEVELOP AND OPERATE SUCCESSFUL BUSINESS ECOSYSTEMS?

At early stage, when the value and organisational structure of the ecosystem is still unclear and new to many members, the ecosystems have trouble marshalling sufficient resources to cover the early development steps. The findings show that there are quite strong differences between the ecosystems. There are both ecosystems that have very dense networks and strong operational structures as well as ecosystems that have neither. Many ecosystems seem to have a strong core of committed members and a shell of companies around their core is often not strongly committed.

Capacity building in the ecosystems is an area that requires more attention. In some ecosystems the neutral

[35] https://www.businessfinland.fi/en/for-finnish-customers/services/funding/growth-engines

orchestrator role is performed by a private consultancy that is hired for this role. While this can have benefits due to their expertise, it also creates a large dependency as no operational expertise is build up in the ecosystem itself (where that would be the case if the ecosystem would hire their own people for this role). In other ecosystems where this role is being performed by a single company/organisation a similar dependency is created – while the ecosystem should allow for continuous development with or without that specific company/organisation. When this company is a start-up, we question whether there is sufficient capacity to take on a serious leading role in developing the ecosystem.

DO THE (MEMBERS OF THE) ECOSYSTEMS HAVE THE ABILITY TO TAKE STEPS IN INNOVATION AND INTERNATIONALISATION TO SUPPORT OVERALL POLICY OBJECTS?

Many of the members of the ecosystems have strong innovation profiles and the presence of research organisations strengthens R&D capabilities. We, however, found quite a few barriers in later stages of the innovation process. These barriers were linked to the framework conditions of innovation (like regulation) as well as to resources like available pilot/demonstration sites. In terms of internationalisation the capabilities seem to be mainly present in larger companies, whereas smaller companies still struggle to tap into international markets. Internationalisation at ecosystem level, building up relationships with other ecosystems/clusters/hubs elsewhere in Europe is something that seems to be missing.

ARE THE RIGHT INITIATIVES CURRENTLY SELECTED TO THE ECOSYSTEM PORTFOLIO?

The policy of Business Finland has been implemented in turbulent times when the merger of Tekes and Finpro took place and the ecosystem concept was relatively new and too broadly defined. During the start Business Finland aimed at selecting ecosystems so they could start their development. As a result some existing activities were relabelled as ecosystems. Not all ecosystems have the characteristics of business ecosystems and could rather be characterised as a collaborative initiative/project. As such not all ecosystems in the current portfolio seem well positioned to contribute to the overall objectives and to build towards ecosystems that will grow strong over the coming years. That does, however, not mean that these are not strong initiatives that could benefit Finland, just not as an ecosystem.

Currently the overall state of play of the ecosystems is not very mature and the ecosystems are very heterogeneous. While there are a few mature ecosystems, many ecosystems are still in development and not all seem to have key ecosystem elements in play like an analysis of

common challenges, a shared strategy and a neutral orchestrator. In case of relatively new ecosystems, attention should be paid to development of these key ecosystem elements.

WHEN AND HOW SHOULD BUSINESS FINLAND, AS A FUNDER AND SUPPORTER, START AND STOP BEING INVOLVED IN THE ECOSYSTEMS TO BEST SUPPORT THE POLICY OBJECTIVES?

While in many cases ecosystems will require public funds to get started, it should be clear at what point the ecosystems should be self sufficient – if at all. In some countries, like Austria and the Netherlands, governments decide to always funds their main ecosystems/clusters with a baseline amount of funding as they argue that it is legitimate to cover the costs for ecosystems/clusters to support public objectives, maintain a dialogue with the government, etc. In other countries governments and ecosystems/clusters aim to work towards a clear exit strategy that describes how the ecosystem will stay active after public funds are no longer available. Note that this often does not include funds for projects – but mainly the funds for ecosystem development and operations. If this is not well arranged in time, there is a risk that public investments get lost when ecosystems cease to exist.

7.3 CONCLUSIONS REGARDING BEHAVIOURAL ADDITIONALITY

Behavioural additionality describes the change in the processes of companies and ecosystems as a whole. To some extent this can be called the human factor of policy as it is about a change in the way people (and in this case companies and other ecosystem members) act as a results of policy stimulus.

While some ecosystems show very dense networks and strong operations, this is clearly not the case for all ecosystems. The analysis shows that not all ecosystems work from an analysis of common challenges and a shared strategy. As a result, about half of the members36 are not very committed to the ecosystems. Many ecosystems show a structure of a core of central members consisting of research organisations and large companies. The role and the incentives of these central players are very important when a board of representatives of all members and a neutral orchestrating body are missing in the ecosystem.

Key chapters/paragraphs to read more regarding behavioural additionality are:
3 / 5.1.1 / 5.1.2 / 5.1.3 / 5.1.7 / 5.2.1 / 5.2.3

WHAT ROLES AND INCENTIVES DO DIFFERENT TYPES OF ECOSYSTEM MEMBERS HAVE AND HOW DOES THIS INFLUENCE THE DEVELOPMENT AND OPERATIONS OF THE ECOSYSTEMS?

The analysis shows that the incentives and capabilities of central players play a large role in the ecosystems. As companies outside the core of central players are not well engaged, the question arises whether their needs are well addressed. In many ecosystems the focus on R&D is strong due to the central position of research organisations and large companies, while for smaller companies R&D alone is not sufficient to spend considerable time on an ecosystem. The concentration of funds in central organisations also increases the importance of well balanced incentives that are in line with shared objectives of the ecosystem that are relevant for all members – not just for central players in the core.

Overall, about half of the of the companies[36] were found to be not really committed to the ecosystems. Companies that are not engaged and committed to the ecosystem also tend not to invest a large amount of time and attention into the ecosystem. In theory these companies are often labelled as *"deadweight"*, as they add little value to the ecosystem and can dilute the dynamics of ecosystems. During the development of the ecosystem this is to some extent normal, as the ecosystem is starting up and its value to companies still needs to grow – however if this takes too long it is very difficult to gain commitment from these companies.

WHAT WAS THE ROLE OF BUSINESS FINLAND WITH REGARDS TO THE DEVELOPMENT AND OPERATIONS OF THE ECOSYSTEMS?

For many ecosystems Business Finland was involved in bringing stakeholders together, often (far) before the ecosystem policy was implemented. During the development of the ecosystems the role of Business Finland is mainly limited to the Growth Engines since other instruments focus on stimulating innovation or internationalisation instead of ecosystem development. Overall the instruments of Business Finland focus on financial instruments, which is political preference. The BF ecosystem leads, therefore, seem to have a minor role in the development and operations of the ecosystems. Other instruments that support innovation or internationalisation are not aimed at ecosystem development or operations. As outlined before, the Growth Engines are not always directly linked to development and operational objectives, including the establishment of key process-

[36] In the survey 42% answered to only collaborate 0-2 times per year with another member. On top of that one in six respondents indicated no to recognise the ecosystems. In the interviews about 35% of the interviewees was either not active or did not recognise the ecosystems, and many other companies did not respond to interview requests.

es in the ecosystem, increasing the dynamics and trust levels in the ecosystem, increasing the visibility of the ecosystem, etc.

The role of Business Finland is perceived by many companies as "supportive" or "enabling". While this is a suitable role at ecosystem level, at portfolio level a more active role is required, for instance through organising trainings; providing methods, templates and platforms for common activities (networking, setting up strategy, matchmaking, etc.); peer-to-peer learning between the ecosystems, etc. Not providing such non-financial services seems like a missed opportunity.

7.4 CONCLUSIONS REGARDING OUTPUT ADDITIONALITY

Output additionality describes the results that are realised due to the ecosystem policy.

Overall, the economic performance of the companies has been strong in the past years. Both the turnover as well as employment grew significantly. The overall turnover of all companies combined is very large, but only a portion of this can be deemed relevant to the ecosystems as the rest is linked to activities that have little to do with the ecosystems the companies are involved in. Furthermore, signs were found that ecosystem participation has a positive correlation with the economic performance, which could mean that companies that have been participating longer in ecosystems and use more of its functions show stronger growth figures in terms of turnover and added value (or vice versa).

Key chapters/paragraphs to read more regarding output additionality are:
3 / 5.1.4 / 5.1.5 / 5.1.6 / 5.2.1 / 5.2.2 / 5.2.3

WHAT ARE THE KEY ECONOMIC RESULTS OF THE ECOSYSTEMS?

The total value of ecosystem relevant turnover was roughly estimated at €1.170 million, realised by 2.760 employees. Large companies have a very prominent role in the results as they are the size class with the highest number of companies in the ecosystems and they also have high turnover figures. In terms of labour productivity steady results across the years were found around €120.000 added value per employee. In general, large companies have a bit higher productivity than smaller companies – but very large companies operate at far higher productivity rates than the rest. In terms of export, we found this mainly takes place for medium-sized and larger companies, the figures for smaller companies are very limited. The median share of export for the companies is about 9% of the turnover. For very large companies the median is about 60%, just above the average of the full ecosystem sample of 55%.

HOW DO MULTINATIONALS AND FOREIGN (OWNED) COMPANIES PLAY A ROLE IN THESE RESULTS?

Multinational companies were included in these analyses as long as they have a Finnish subsidiary. Turnover and employment figures are thus included, and specific remarks about very large companies are made above. When it comes to the effects of the ecosystems on these companies it will really depend on what the activities of the subsidiary entail within Finland. For example, if a R&D-lab resides in Finland but production takes place outside of Finland, then innovation results will likely relate to knowledge intensive employment in Finland while turnover growth will likely take place outside of Finland.

7.5 CONCLUSIONS REGARDING IMPACTS TO THE FINNISH ECONOMY AND SOCIETY

This last additionality section describes the wider impact of the ecosystems on both the economy as well as the society.

The ecosystems have been set up to stimulate growth, the focus is therefore often on increasing the economic activity of the companies in the ecosystems. The overall objective of €20 billion plays a strong role in promotion of the ecosystems, setting ambitious targets is important to activate players on all levels. However, the objectives are not well defined, making it difficult to make any statements regarding reaching this target. Definitions aside, with the companies of the ecosystems ambitious targets are attainable.

Renewal is a priority in the ecosystem policy as is shown in the focus of many ecosystems. A handful of ecosystems also focuses on absorbing technologies or entrepreneurship (new firms), but innovation by ecosystem members is the dominant method applied for renewal. Innovation is a key activity within many of the ecosystems, and many members have a strong innovation profile. Results show innovation seems mainly aimed at growth (new business activities), rather than industrial transformation (change of current business activities).

Contributions towards other goals like FDI and sustainability will most likely be indirect and in synergy with other policies.

Key chapters/paragraphs to read more regarding impacts to the Finnish economy and society are:
3 / 5.2.2 / 5.2.3 / 6

DO ECOSYSTEMS SUPPORT RENEWAL OF INDUSTRY?

Renewal is a priority in the ecosystem policy as is shown in the focus of many ecosystems, innovation by ecosystem members is the dominant method applied for renew-

al. The majority of companies in the ecosystems show a very strong innovative profile. More than 40% of the companies indicated that more than 25% of their expenditures are related to R&D. Similarly, more than 40% of the companies indicated that more than 50% of their turnover is derived from innovations they introduced in the past 5 years. While there is a strong focus on innovation and R&D the aim of these activities seems to focus on growth (new business activities), rather than industrial transformation (change of current business activities). This was shown as innovations mainly relate to new turnover and not to replacing existing turnover. One ecosystem analysed in the case studies revolved more strongly around absorbing new technologies (from abroad) rather than innovating themselves. Renewal can furthermore be realised through entrepreneurship. Over the period 2013 to 2018 a total of 40 new companies were created that are now part of the ecosystems, in our sample this is the equivalent of 17% of all companies. The majority of these companies are set up within two out of the 13 ecosystems. This may align with the strategy of these ecosystems, but this was not analysed at ecosystem level.

Business Finland has a portfolio of ecosystems with a high and lower risk profile. While this is a good strategy to support a balanced portfolio, we did notice that the high risk ecosystems often revolve strongly around a start-up and/or a platform company. While these new companies can definitely be relevant for renewal and many of these initiatives seem promising, we question whether building an ecosystem so strongly around these type of companies will be very fruitful. These companies tend to have to focus very strongly on building their own business, and have no strong economic activity to build upon. It seems like the success of these ecosystems will revolve too strongly around the success of the start-up and/or a platform company and that these companies will likely have very minimal resources to be a driver of ecosystem development without strong support from Business Finland. If the ecosystem development would revolve more around (the strategy of) a broader set of companies the development of the start-up and/or a platform company could be one avenue rather than the only avenue for success. In the end, start-up and/or a platform companies often have very limited means (cash flow and man power) to spend outside their own activities, which is far from ideal when needing to activate and develop an ecosystem.

ARE ECOSYSTEMS ABLE TO PLAY A ROLE IN ATTRACTING GLOBAL ACTORS TO FINLAND (FDI)?

While some ecosystems have foreign players active in their ecosystem, no specific strategies were found regarding attracting global actors to Finland through the

ecosystems. On the long term strong ecosystems can definitely play a role in the attractiveness of Finland, especially as synergies with other policies like testbeds are well exploited. Overall, the activity of foreign players in the ecosystems, without a subsidiary in the country, is something that is rare in other countries. These members are likely not very committed to the ecosystem development in Finland. A stronger model would be to seek for international collaboration at ecosystem level as this can facilitate a similar (if not stronger) exchange of knowledge and collaboration.

HOW LIKELY IS IT THAT THE LEADING OBJECTIVE OF "NEW WORLD-CLASS BUSINESS ECOSYSTEMS OF €20 BILLION" WILL BE REACHED BY 2025?

In terms of economic potential, the growth of the ecosystem members of the past years has been quite impressive and the strong focus on innovations shows the potential for scalability. The 20 billion Euro target is, however, not well enough defined to determine whether this portfolio could reach this figure. When looking at turnover that is directly relevant to the ecosystems is seems like 1 Billion Euro growth should be attainable by the 13 ecosystems analysed in this study by 2028. Given the large differences between the ecosystems it is unreliable to simply extrapolate this figure up to the full sample of 34 ecosystems without performing micro level data analysis, however growth between the 2 and 3 Billion Euro would be in line of expectations and our explorative model.

While the level of individual ecosystems was not analysed in detail in this study, it is quite clear that not all ecosystems will be able to contribute to an overall turnover target in the same way. Some ecosystems seem not well positioned to generate turnover in Finland and other ecosystems are just a lot smaller than others in terms of current turnover. Setting up ecosystem level objectives that collectively allow for reaching the overall target can improve the policy implementation framework.

Regarding the future developments the COVID19-crisis needs to be addressed. While the challenges in the economy and society can already be felt, the COVID19-crisis will also have long-term (negative) effects that will impact the ecosystems, its members as well as the policy. As the ecosystems are still in development, the crisis can make this even more challenging. Some ecosystems we looked into already indicated very strong impacts on their operations and members. Furthermore, when at a later stage effects of the ecosystem policy need to be analysed, the crisis will likely distort the analysis. It is key to make sure negative effects of the crisis are not identified as failures of the policy intervention.

WHAT KIND OF IMPACTS WITH REGARDS TO ENVIRONMENT AND WELL-BEING CAN BE EXPECTED FROM THE ECOSYSTEMS?

The main objectives of the ecosystem policy are to support economic growth, by facilitating the development and operations of ecosystems. This in itself is not directly contributing to societal impacts like environment and well-being. However, all ecosystems provide a platform for a constructive dialogue as well as for other policies to seek synergies. Next to that some ecosystems are active in relevant sectors performing for instance R&D-activities that can improve the services provided in hospitals (see the CleverHealth case study, Appendix C) or focus on the developments in the field of recycling of batteries (see the BatCircle case study, Appendix C).

8 RECOMMENDATIONS

In this chapter we provide our recommendations to Business Finland based on findings of the impact study. We start by outlining the main recommendations, followed by two paragraphs that provide more details regarding ecosystem policy and monitoring & evaluation.

8.1 MAIN RECOMMENDATIONS

1. **Develop a clear vision, including a clearly defined ecosystem concept**

   Many of the challenges outlined in the conclusions relate to the lack of a clear shared or mutually owned vision and SMART[37] objectives through different levels of government and agencies regarding the ultimate goals, expected impacts and intermediary outcomes of the ecosystem policy/policies. Additionally, the demarcation criteria between a business ecosystem and other RDI activities and networks should be clear between the stakeholders. Business Finland should be able to unanimously answer questions such as: what are considered ecosystems, how exactly they are different from other (groups of) beneficiaries, and what are not considered ecosystems? What type of potential does Business Finland want to see? What should be the key challenges that Business Finland considers relevant to ensure coherence with other policy objectives? By setting up a more specific definition everybody will depart from the same idea. This will also help in outlining why and how Business Finland would like to support these defined ecosystems in order to reach the overall policy objectives.

2. **Set up a portfolio of ecosystems that fit the definition of the ecosystem concept**

   When a clear vision for and definition of ecosystems is outlined and implemented throughout, it would be recommended to review the current ecosystem portfolio. Some of the current ecosystems will likely not match the definition and should no longer be classified nor be supported as an ecosystem. This does

[37] SMART: Specific, Measurable, Attainable, Relevant, and Timely

not mean that these initiatives are not valuable, good initiatives deserve support, but they will not benefit from ecosystem instruments if they are not on track to develop into an ecosystem. The ecosystems Business Support should be well positioned to become the *world class* ecosystems Finland deserves. This also means that new ecosystems should be reviewed in the same way.

3. **Review the policy level objectives, KPIs and the timeframe**

   Based on the state of play of the ecosystem portfolio the policy level objectives and associated KPIs should be reviewed, for which this evaluation can be a point of departure. What can reasonably be expected from the portfolio of ecosystems and the potential future ecosystems Business Finland will support? Business Finland currently follows KPIs for the ecosystems oriented at accountability of funding decisions. It would be advisable to have KPIs that focus on the development of ecosystems, for instance regarding organisation and governance, intensity and quality dynamics/ collaboration, etc. These KPIs should also be available on portfolio level (not only for individual ecosystems). Ideally there is a balanced hierarchy between the indicators at the level of Finland, ecosystems and companies. It would also be recommended to review the timeframe of the policy, and to keep in mind that not all ecosystems started at the same time and not all start from the same level of development. Finally, both the objectives and the timeframe will be impacted by the COVID19-crisis.

4. **Set up a balanced and stable policy mix of financial and non-financial instruments**

   Ecosystem development requires both financial and non-financial support (services) that remain relatively stable over time. We recommend to add a portfolio of non-financial services to the existing financial instruments. If not through Business Finland personnel, as this is not the political preference, Business Finland could earmark funds to direct them at professional service providers. Furthermore, in line with the previous recommendation, the support can be more strongly linked to the development steps that are expected to be taken. These support instruments should be available to all ecosystems and should remain fairly stable over time so ecosystem players know what kind of support they can expect to receive (as long as they keep meeting their KPIs).

5. **Clear agreements, guidance, monitoring & capacity building**

   At ecosystem level clear agreements should be made about the expectations from both sides. We would recommend to set clear milestones for all ecosys-

tems and to link these milestones to the support you provide to the ecosystems to create a healthy dialogue. Current KPIs serve very well for accountability, but do not support ecosystem development very well. During development Business Finland can decide with the ecosystems to adjust milestones, development is always uncertain. With the provision of support comes also the obligation to support monitoring. Development and capacity building go hand in hand, therefore it should also be discussed how knowledge and experience regarding development will be secured within the ecosystem. The people in the ecosystems that drive development will be very important to keep around – or their knowledge should be effectively shared with others.

6. **Aim for balanced representation of all ecosystem members (including SMEs)**

   In ecosystems it is important that all members are engaged. In the current set up the role of large companies and research organisations seems too prominent. By making sure decisions in the ecosystems are made by representatives of all members, SMEs will have a better position in bringing their challenges and needs to the table. Support instruments that focus on central players, can be effective in activating the ecosystems but may put too much emphasis on the needs of these central players (rather than the needs of all members combined).

7. **Set up a constructive dialogue and make use of industrial intelligence**

   Ecosystems provide a very valuable platform for a constructive dialogue with industry. In some cases ecosystems revolve strongly around radical innovations or platform companies that are running into various framework conditions. Through a constructive dialogue Business Finland can make sure framework conditions remain favourable for funded ecosystems. This will likely also require a coordinating role of Business Finland across governmental departments.

8.2 DETAILED RECOMMENDATIONS REGARDING ECOSYSTEM POLICIES & SUSTAINABILITY OF PUBLIC INVESTMENTS

Ecosystem development is an activity that requires long-term commitment from both the ecosystem members as well as from Business Finland. It is important to create a relationship of trust and patience as learning is a big part of success. Business Finland could develop a partnership model where the stakeholders clearly commit to certain SMART[38] milestones and deliveries should be examined

[38] SMART: Specific, Measurable, Attainable, Relevant, and Timely

to formalise the mutual commitment to an extent. This roadmap could optimally outline the ecosystem activities, deliveries and investments for the coming years, although periodical reviews are advised. Formalising the mutual commitment in the form of a contract may be useful to support the transition from verbal agreement to action.

We further recommend to create a balanced combination of financial instruments and non-financial support services to support the development. This can be largely based on the current Growth Engine instrument, but should be available to all ecosystems depending on their development. The overall policy needs to start with supporting the development of the ecosystems, then shift towards professionalisation of the ecosystems and eventually work towards a graduation model, possibly with exit of public funding. It is a political decision whether this means a full exit without any funding for operating the ecosystems, or a soft exit where the funding is reduced to a minimum but not fully phased out. Either way it is advised to always keep some of the services active, as mature ecosystems can also share their knowledge with new ecosystems and the industrial intelligence gained from mature ecosystems will remain valuable. Table 4 shows an overview of a possible policy mix. We have included an indicative timing in the table, but this will strongly depend on the development stage of each individual ecosystem.

Services that do not address ecosystem development, functioning or transformation this includes policies that aim to support the functions of the ecosystems. These have been listed as supporting instruments/services and can include the current policy instruments aimed at innovation and internationalisation. While these policies are important to provide specific support to the members of the ecosystems, it is important to emphasise that these policies do not support the ecosystems themselves in terms of development or operations.

TABLE 4. Overview of a possible mix of financial and non-financial instrument for ecosystem policy. Technopolis Group 2021

POLICY	TYPE OF POLICY	FOCUS OF POLICY	INDICATIVE TIMING
Early development funding	Financial	Setting up key ecosystem aspects: attracting members, analysis of common challenges, shared strategy, governance structure supporting representation of all members and neutral orchestration	First 5 years
Operational funding	Financial	Follow-up funding, to increase the maturity aspects: dynamics, collaboration, formal activities linked to the strategy, internationalisation of the ecosystem, etc.	Second 5 years
Top-up funding for transformation	Financial	Additional funding for platform companies and/or renewal projects performed by the ecosystem members. Activities need to be relevant to the ecosystem strategy and accessible to all ecosystem members.	When relevant
Learning	Service	Capacity building through trainings, peer-to-peer learning between ecosystems, sharing and supporting implementation for best practices from abroad, etc.	From the start
Professionalisation	Service	Improving the functioning of the ecosystems by providing methods, templates and platforms for common activities (networking, setting up strategy, matchmaking, etc.), by inviting international ecosystem experts for a review at ecosystem level, etc.	From the start
Industrial intelligence	Service	Using a constructive dialogue (by the BF ecosystem leads) to identify and discuss key challenges and opportunities. Acting as a single point of access between the ecosystems and government departments to act upon key challenges and opportunities.	From the start (first build a trust relationship, after 5 years this will become very useful)
Coherence	Passive service (not offered to ecosystems)	Actively seek within Business Finland and with other parts of government for synergies between other policy initiatives and the ecosystems. Like for instance getting ecosystems involved in EU level networks, using ecosystems strategically for FDI, etc.	From the start
Supporting instruments/ services	Financial/ services	Focused on specific functions of the ecosystems, like innovation, internationalisation, human resources, infrastructure, capital, etc.	When relevant

8.3 DETAILED RECOMMENDATIONS REGARDING MONITORING, EVALUATION & IMPACT MEASUREMENT

Monitoring, evaluation & impact measurement always departs from objectives (theory of change / intervention logic) and the key performance indicators (KPIs) that make objectives tangible. For ecosystem policy it is key to outline what the expectations are at ecosystem level, to operationalise these in milestones and describe how these individual ecosystem milestones contribute to the overall policy objectives. For ecosystems it is important to outline operational milestones as well as strategic milestones. Operational milestones describe key steps in their development as well as key steps in their formal activities (input). The strategic milestones describe the results of their ecosystem (output). At portfolio level a clearly defined objective should be outlined that supports monitoring, evaluation & impact measurement – but that does not mean a key KPI cannot be used in a similar fashion as the current million euro ecosystems target.

In the current impact study, we have outlined a methodology in which key methodological challenges have been covered. We have for instance focused on relevant business activities only and introduced the structure of the functions of the ecosystems that relate the needs for external resources to what the ecosystems provide access to. Furthermore, we distinct the effects of ecosystems on member companies from the effects of public policy on companies through ecosystem level interventions.

For future impact measurement it will be important to further improve the data and information available, a set of key suggestions would be to:

- (Ask ecosystems to) maintain an overview of ecosystems members and their contact details, including company ID numbers in this overview is a benefit for data matching
- (Ask ecosystems to) monitor the operational and strategic milestones
- Set up a repository for strategic documents from the ecosystems (these might change over the years)
- Monitor the policy interventions (when and what), and include a GDPR-proof requirement on participation in monitoring, evaluation & impact measurement activities (like survey, interviews, case studies, etc.)
- Provide a wider data set of companies, including data from companies not active in the ecosystem to allow for setting up control groups and including sector trends
- (Ask ecosystems to) label formal activities and identify informal activities that have a contribution to societal objectives

APPENDIX A. STUDY RESULTS: SURVEY

On 6st October 2020, the survey has been launched to collect views of ecosystem members on how business ecosystems affect performance of participating companies. The survey has been completed by 75 respondents, 11 of which only partially answered the questions. In the current sample, a greater number of respondents are members of Smart Otaniemi and BatCircle ecosystems, while the ecosystems that have been represented the least are Internet of Locations and FinnGen (Table 5). Due to insufficient number of respondents from each business ecosystem, the survey analysis discusses responses across all ecosystems.

TABLE 5. Overview of the survey respondents per business ecosystem (N=75). Technopolis Group 2021, survey data

ECOSYSTEM	NUMBER OF RESPONDENTS
Smart Otaniemi	15
BatCircle	10
Telaketju2	9
LuxTurrim 5G	8
Plastic Waste Refining Ecosystem	7
Adaptive Industrial Loops	6
One Sea	5
Elastronics Connected Health	4
Smart Mobility	4
ForBest	3
CleverHealth	2
FinnGen	1
Internet Of Locations	1

FIGURE 22. Overview of responses on the share of total expenditure spent on Research & Development efforts in the last financial year (N=65). Technopolis Group 2021, survey data

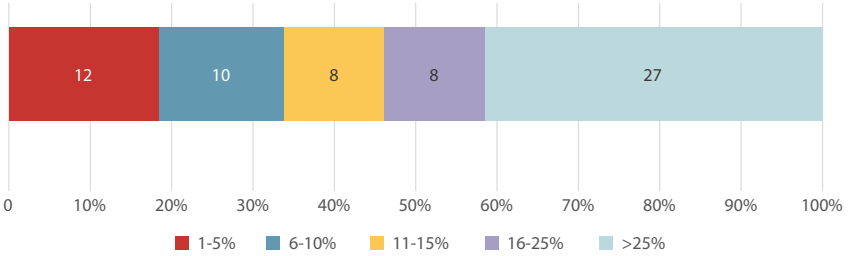


FIGURE 23. Overview of responses on the share of turnover derived from new/improved products or services that an organisation introduced as innovations during the past 5 years (N=55). Technopolis Group 2021, survey data

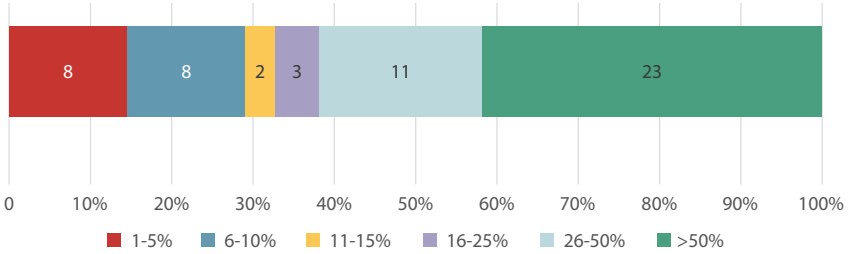
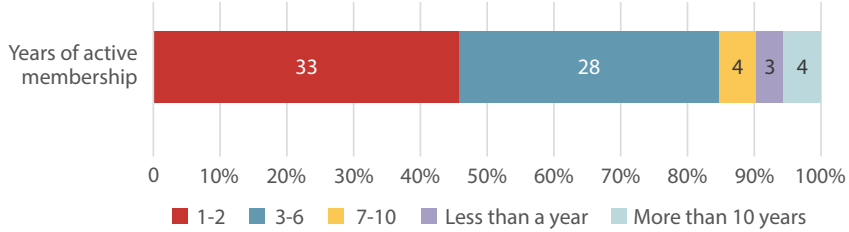


FIGURE 24. Overview of survey responses regarding the years of active membership in a network (N=72). Technopolis Group 2021, survey data



SURVEY QUESTIONS REGARDING THE PROFILE OF RESPONDENTS' ORGANISATIONS AND THEIR ENGAGEMENT IN THE ECOSYSTEMS

Survey respondents were asked to indicate the share of employees in their organisation that is focused on a particular business ecosystem. On average, 28.6% of employees are participating in activities related to an ecosystem. Based on responses, the shares of employees vary significantly, ranging from 0,004 to 100%. The median value is 10%.

Respondents were asked about the share of total expenditure spent on Research & Development (R&D) by their organisation in the last financial year. Figure 22 illustrates a significant investment of respondents' organisations in R&D. Next to that, participants were asked to estimate a share of turnover in the last financial year derived from new/improved products or services that they introduced as innovations during the past 5 years. For majority of respondents, the share of turnover from innovations is higher than 25%, pointing to great importance of innovations for business activity of ecosystem members.

To analyse engagement of respondents' organisations with their ecosystem, they were asked about the period of membership in an ecosystem and the number of actors with which they collaborated in the last year. Figure 24 shows that a majority of members do not have a long

FIGURE 25. Overview of survey responses regarding the company activity within the ecosystems (N=72). Technopolis Group 2021, survey data

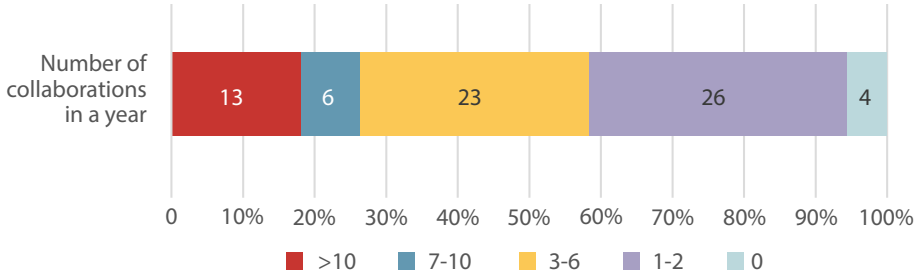
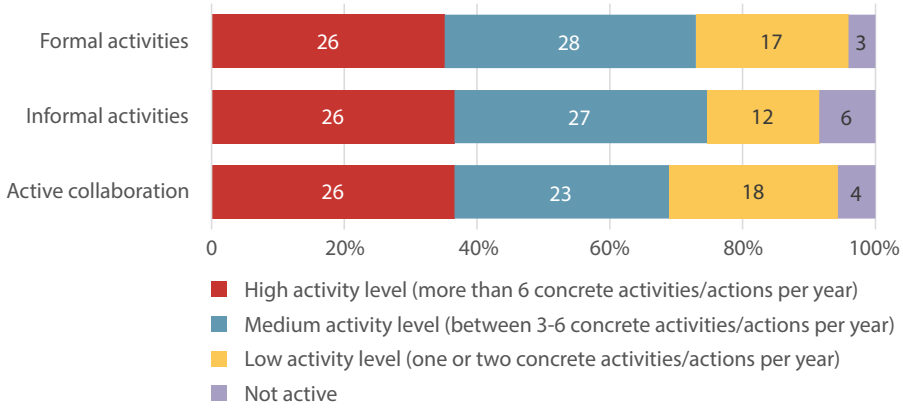


FIGURE 26. Number of respondents answering a question: "In your view, how active is your ecosystem overall (regardless of your own participation in these activities)?" (N=71). Technopolis Group 2021, survey data



history of participation in an ecosystem, while Figure 25 highlights that almost 30% of respondents have a decent number of activities in the ecosystem. Nevertheless, majority of respondents indicate low activity that you would normally expect from ecosystems.

To assess the perception of the overall activity of the ecosystem (regardless of respondents' participation), survey respondents were asked to assess the activity in terms of formal activities (e.g. organised networking events, setting up a shared strategy), informal activities (i.e. between ecosystem members themselves), and in terms of active collaboration between members of the ecosystem (e.g. collaborative projects). Figure 26 shows that the perception of activity across the three categories is very similar, as around 70% of respondents assume that the engagement can be characterised as high or medium activity.

SURVEY QUESTIONS REGARDING THE BUSINESS ECOSYSTEM VALUE FOR THEIR MEMBERS

Respondents were asked to assess the importance of particular external resources for their organisation (Figure 27). The follow-up question focused on the extent to which respondents could access these resources through the ecosystem. Results illustrated in Figure 28 reveal that the ecosystems to a great degree satisfy the needs of ecosystem members in most aspects, although a clear mismatch is visible in access to capital.

Survey participants were asked about the extent to which they have used the functions of the ecosystem to access needed resources. The comparison of Figure 29 with Figure 28 shows that the overall level of use of resources is slightly lower than their accessibility through the ecosystem. Nevertheless, most accessible resources, such as R&D and technologies, are also most utilised. This highlights a relatively high utilisation of provided resources by ecosystem members.

FIGURE 27. Responses to a question: "To what extent are the following external resources important for your organisation at the moment (meaning you need access to these resources as your own organization is not self-sufficient in these)?" (N=73). Technopolis Group 2021, survey data

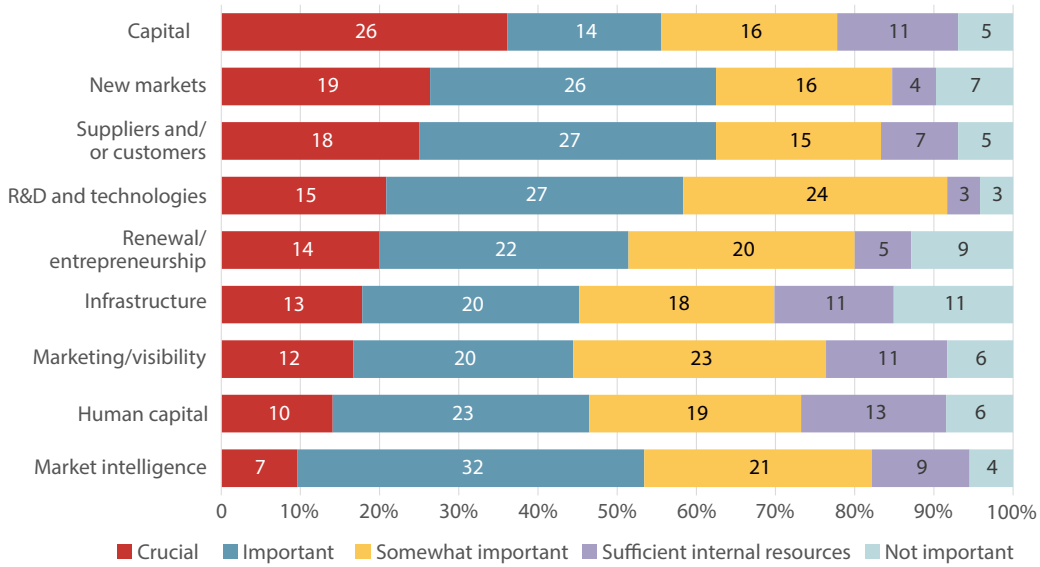


FIGURE 28. Responses to a question: "To what extent does your ecosystem provide access to the following functions (i.e. access through collaboration and exchange with your partners)? This is regardless whether you actually use the ecosystem for this?" (N=68). Technopolis Group 2021, survey data

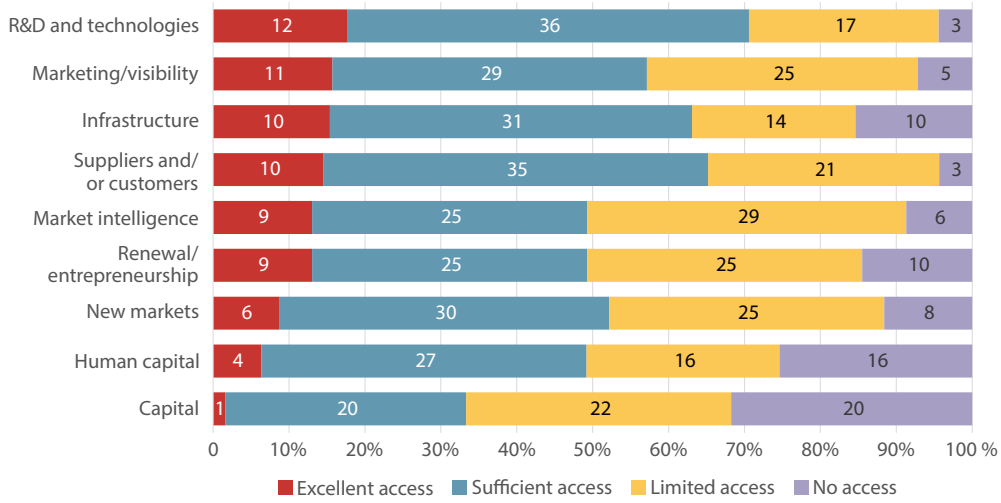
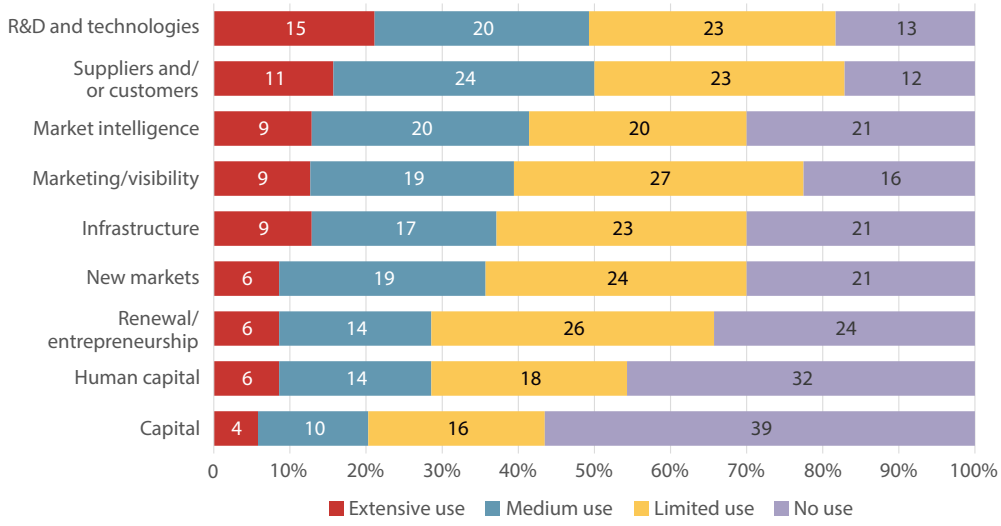


FIGURE 29. Responses to a question: "To what extent have you used the following functions of the ecosystem? I.e. have you worked with partners in the ecosystem to gain access to the following resources?" (N=70). Technopolis Group 2021, survey data



SURVEY QUESTIONS REGARDING IMPACT OF THE ECOSYSTEM ON THEIR MEMBERS

Survey respondents were asked about the importance of the ecosystem for commercial outcomes of their companies and for the sector. Figure 30 reflects that the ecosystems have been offering important support for companies, impacting all commercial outcomes. The ecosystems make a large contribution in improving innovation activities in companies of respondents. However, it also shows that many companies so no role for the ecosystem regarding important aspects, like increasing export. The comparison with the sector outcomes shows that ecosystems play a more important role for sectors than for individual companies (Figure 31). In terms of the sector outcomes, the ecosystem has been more helpful in increasing international recognition of the sector outside Finland and critical mass of their sector in Finland.

FIGURE 30. Responses to a question: "How important has the ecosystem (i.e. the collaboration with your partners) been for the following company commercial outcomes" (N=72). Technopolis Group 2021, survey data

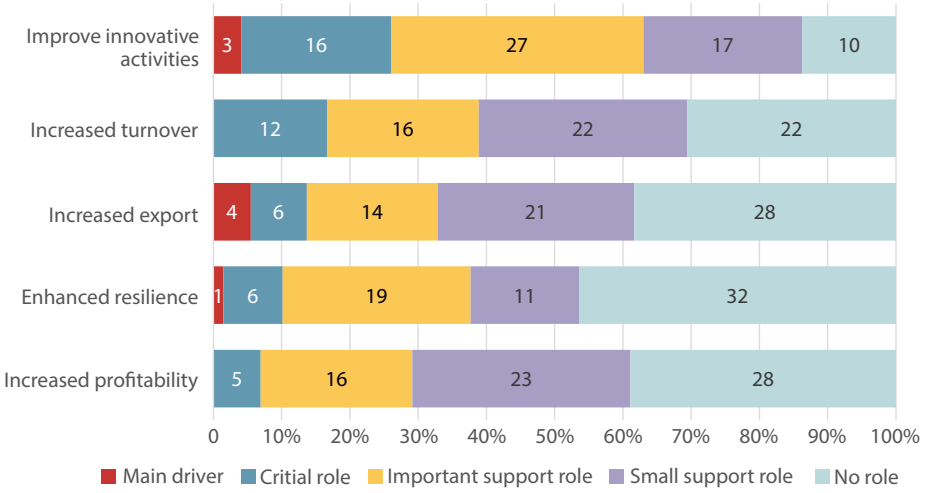
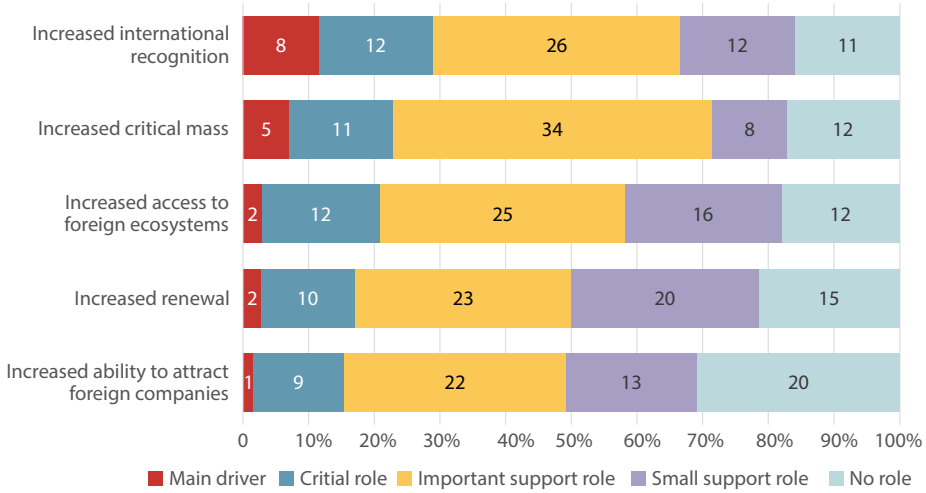


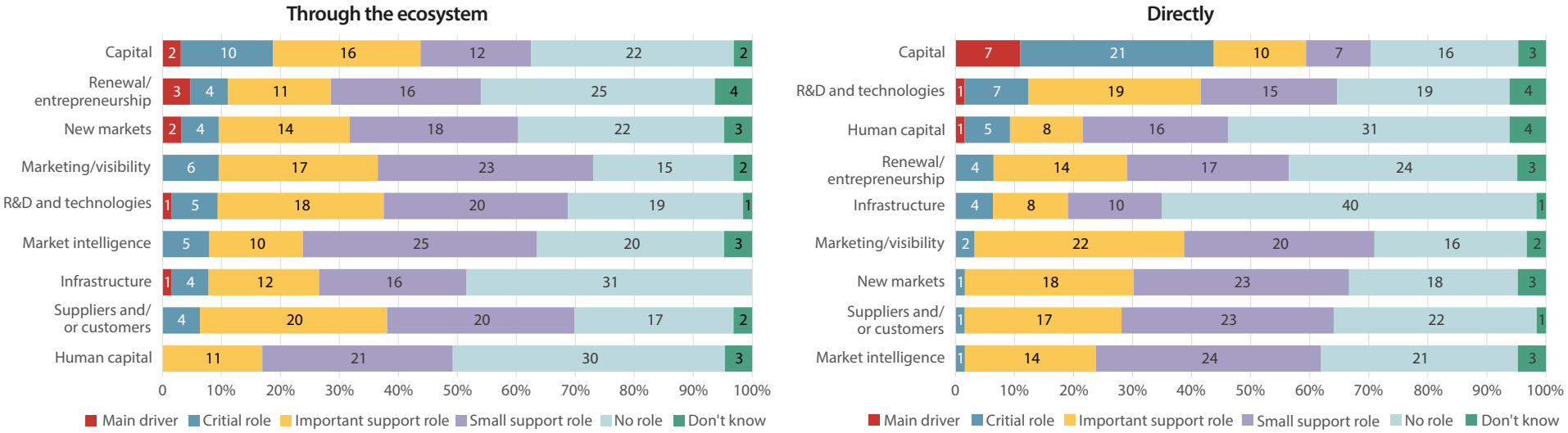
FIGURE 31. Responses to a question: "How important has the ecosystem (i.e. the collaboration with your partners) been for the following sector outcomes" (N=70). Technopolis Group 2021, survey data



SURVEY QUESTIONS REGARDING THE ROLE OF BUSINESS FINLAND POLICY

Survey respondents were asked about the role of Business Finland in supporting access to specific resources through the ecosystem (e.g. by supporting collaboration, networking, ecosystem services, etc.) and directly (e.g. through innovation projects, export services, etc.). Figure 32 shows that respondents recognise an important role of Business Finland in accessing all types of resources through the ecosystems, while the direct support is more limited in some areas, such as access to infrastructure, human capital. Despite that respondents indicated that they have a relatively low level of access to capital through the ecosystem (Figure 28), Business Finland has been playing an important role to facilitate that access both through the ecosystems, but even more so directly.

FIGURE 32. Responses to a question: "For your organisation, how important has been the role of Business Finland in supporting access to the following through the ecosystem or directly?" (N=70). Technopolis Group 2021, survey data



STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS OF ECOSYSTEMS

At the end of the survey, respondents were asked a few open questions where they provided statements and comments. Participants indicated key strengths, weaknesses, opportunities and threats for their ecosystem. Despite the focus of the question on characteristics and factors that impact the business ecosystem as a whole, many respondents seemed to reply from an individual rather than a collective perspective.

Out of 51 respondents that commented on strengths of their ecosystem, 22 pointed to the extensiveness of the network and diversity of its members. Around a quarter of respondents stressed that important actors are part of their network and 10 respondents claim that the ecosystem has great expertise and enables knowledge sharing. Almost a third of respondents, namely 14, indicated that good collaboration, characterised by trust, openness and commitment is a key strength of their ecosystem. In addition, 5 respondents mentioned good management of the ecosystem that supports and ensures effective collaboration of members.

Among major weaknesses of business ecosystems was listed a difficulty to find a suitable partner. Several respondents clarified that some partners in the ecosystem are too academically oriented, theoretical and lack a business case. In view of 9 respondents, the ecosystem lacks active collaboration, realisation of ideas. Some respondents pointed to the lack of funding that prevents development of ideas.

Among other weakness were mentioned bureaucratic barriers that weaken collaboration (government regulations, slow process of finalising project agreements, unclear governance and conflicting programmes at Business Finland), limited business opportunities in the Finnish market, and exclusion of some members in the ecosystem due to clustering or allocation of resources among specific members.

Almost all respondents pointed to business opportunities available – favourable situation in the market, business opportunities in new markets, growing sector in which they are working. Fruitful collaboration with current or new partners is considered a viable opportunity for about a third of respondents. Innovation and learning are the third most popular area where respondents see opportunities.

The list of perceived threats to the business ecosystems is diverse. However, a larger number of respondents, namely 9, think that the competition within the ecosystem is growing and leads to a conflict of interest. In view of 6 respondents, competition in the market, including with foreign companies, represents the main threat. 4 respondents consider that their ecosystem is losing focus or lacks effective and efficient organisation. Among regulatory barriers, 4 mentioned the GDPR, while

2 survey participants are worried about (over)regulation, especially in the area of IP. The limited business opportunities in the Finnish market, a relatively weak business climate and investment environment were mentioned by 5 respondents. In addition, 4 respondents are worried that they will run out of funding or will not be able to access funding.

SUPPORT NEEDS

Lastly, respondents were asked about the type of support that Business Finland could provide to support their organisation in grasping opportunities and in dealing with threats. In terms of opportunities, 17 out of 45 respondents stated that finance/investment support would be appreciated. Respondents offered numerous ideas on what should be financially supported (e.g. financial support to scale-up technologies, small companies, companies that grow internationally, overall support for the ecosystem). The most common request for financing was for innovation.

According to 15 respondents, Business Finland should play a more active role in coordination and communication within and between ecosystems. For example, in contacting or influencing specific actors within ecosystems, supporting collaboration between ecosystems in Finland and abroad. Among these respondents, 4 suggest that Business Finland should connect more actors to the ecosystems and stimulate private-public partnerships, and 3 respondents would like Business Finland to identify export opportunities for their members.

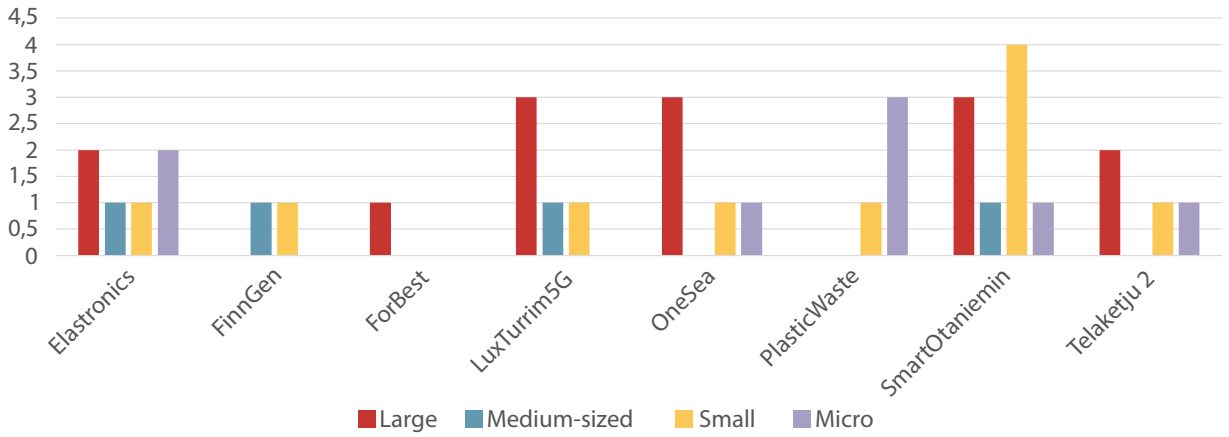
In terms of desirable methods of dealing with threats, the financial support has been most frequently mentioned by respondents (12 out of 41 respondents). Respondents suggest Business Finland to offer either direct financial support or to connect ecosystem members with funding/investment organisations. The second most popular category of support is the so-called lobbying of interests of ecosystems or their actors in discussions with the government and investors. In addition, 4 respondents advocate for a stronger coordination role of Business Finland. Lastly, 2 respondents indicated that they would appreciate more information on (foreign) markets from Business Finland.

APPENDIX B. STUDY RESULTS: IMPACT INTERVIEWS

BACKGROUND AND FIELDWORK NOTES

There were a total of 36 interviews conducted, covering eight ecosystems. The four case study ecosystems were analysed separately, see Appendix C. The composition of the interviewees was the following: 14 represented large companies, four medium sized companies, ten small companies and eight micro companies. Additionally, one interviewee represented an industry association that itself is an ecosystem member. The distribution is presented by ecosystem in Figure 33 below.

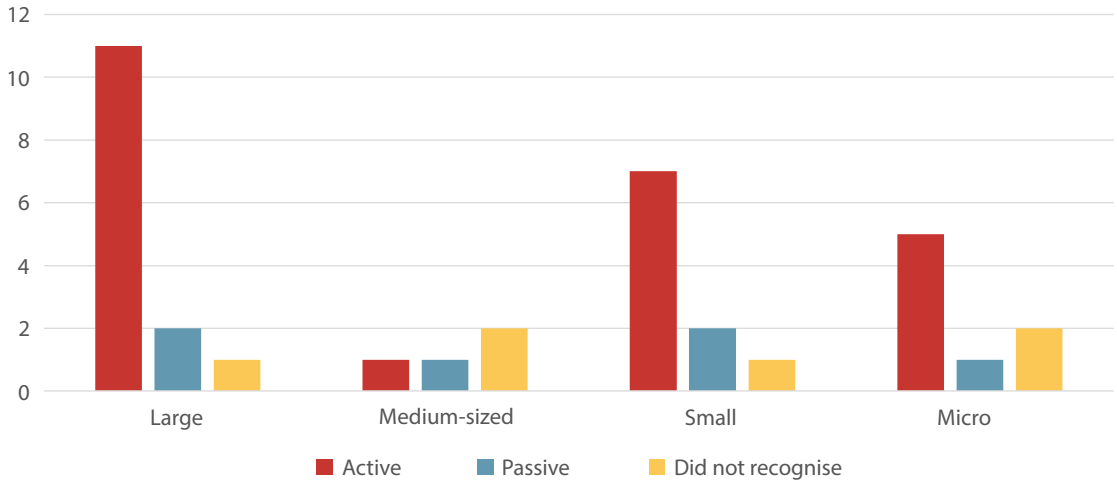
FIGURE 33. Interview distribution by ecosystem and company size. 4Front 2021



In total of 137 different companies were invited for the interview. Challenges in arranging the interviews were, as expected, twofold. Firstly, there were some challenges identifying the right people to interview as good contact details were missing. Secondly, several of the invited companies and/or persons were not fully aware of the ecosystem or their company's role in it. The reasons for this were various and often surfaced only after the interview had been underway for some time.

The level of activity in the ecosystem was different among the interviewed companies. While most of the interviewed companies were active members – in other words involved in joint projects, had found partners and/or customers – there were also less active members and some companies were not able to identify the ecosystem at all. The distribution by different size classes is presented in Figure 34.

FIGURE 34. Level of activity in the ecosystem by company size. 4Front 2021

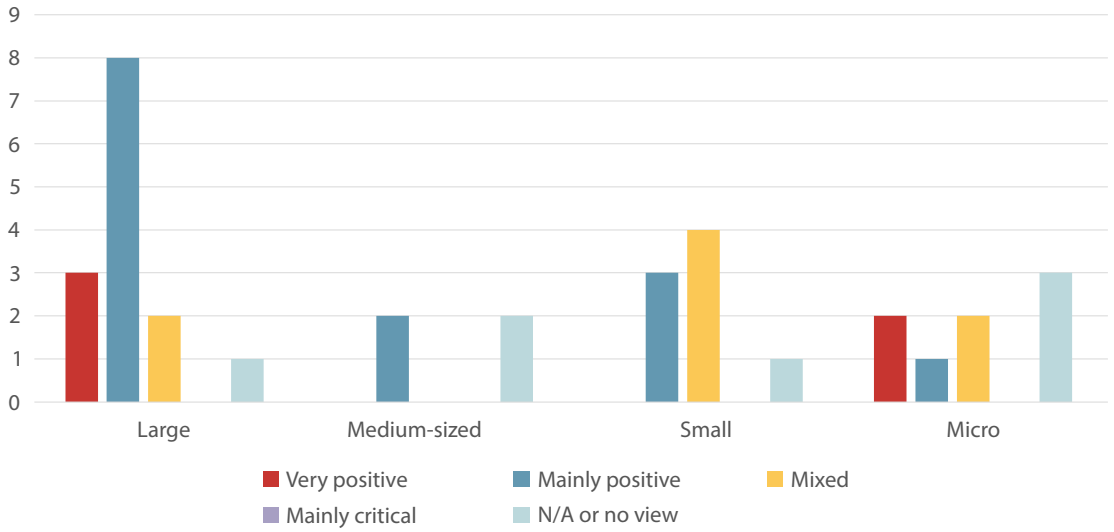


GENERAL STANCE TOWARDS THE ECOSYSTEM

Based on the interviews, the general stance towards the ecosystems was mainly positive (15/36). Out of these fifteen, a third of brought up a very positive stance towards the ecosystem. There were no interviews in which the view would have been predominantly critical, however nine interviewees had a mixed stance. The activity in the ecosystem seems to correlate with the stance towards the ecosystem, with active members being more positive about it. These active members see ecosystems as more useful and hence also value the ecosystem more than others.

An analysis of the interview data by company size, suggest that in general large companies had a more positive stance towards the ecosystems. However, large companies were also in general more actively involved in the ecosystem (11/14 of the large companies were active).

FIGURE 35. General stance towards the ecosystem by company size. 4Front 2021



MAIN ADDED VALUE AND MOTIVATION FOR JOINING THE ECOSYSTEM

When queried about the main added value and the companies' motivation for joining the ecosystem, several different themes were brought up by the interviewees. On an aggregate level the most common references were to R&D collaboration, insights and knowledge on future trends and opportunities, as well as exploring new business opportunities. Additionally, networking among different actors was considered important by many of the interviewees: this included both the formal and informal aspect. When considering external factors, access to Business Finland funding was often seen as an important attractor for companies. Anecdotal references included access to data and/or raw materials.

MOST VALUABLE ECOSYSTEM FUNCTIONS AND ROLE IN CONNECTING ACTORS

The most valuable ecosystem functions and their role in connecting actors reiterate some of the earlier findings. Several references were made to different kinds of networking events, which were seen to create and foster connections between different actors. This finding was further verified when nearly all interviewees agreed that the ecosystem helps to connect with other actors when queried about this specific aspect. However, the level of collaboration and new connections vary considerably – this was somewhat linked to the company size and especially their own level of activity and the resources available.

Many interviewees also highlighted the value of ecosystem functions in information sharing: the ecosystem framework provided a concrete and easy way to discuss about relevant matters and gain access to new information with low costs. The third aspect that was brought up were the concrete research and/or company projects that were completed or ongoing in the context of the ecosystem. Some interviewees also brought up the possibility to affect the regulation through the ecosystem: for single companies this is challenging, but an ecosystem can provide a joint platform.

VIEWS AND PERCEPTIONS ON BUSINESS FINLAND'S ROLE IN SUPPORTING THE ECOSYSTEM

Most of the interviewees recognised at least some role of Business Finland in supporting the ecosystem, but there were also many interviewees who had no clear view on Business Finland role. In these cases with no clear view, the interviewees commented not to have that much concrete interaction with Business Finland in the context of the ecosystem. Often in these cases the most visible actor for them was the ecosystem orchestrator or coordinator.

Business Finland's role was mostly associated with funding, especially direct or project funding to ecosystem members. Some references were made also to other non-financial roles, such as global networks, "sparring", or providing larger 'national support' for the ecosystem brand. Approximately 75 percent of the interviewees reported having received direct Business Finland funding regarding the topic or thematic focus of the ecosystem. This was mostly identified as funding for R&D projects.

CONCRETE RESULTS ASSOCIATED WITH THE ECOSYSTEM (STRUCTURED QUESTIONS)

In fifteen interviews a concrete result in which collaboration in the ecosystem "played a critical or highly important role" was identified. In addition to these, there were twelve cases in which expected results in the future were identified. The results were mostly related to new innovations (ten references), additional references were made to new domestic customers (three references) as well as new export markets (two references). For the remaining interviewees (nine companies) the question was not asked as they considered it to be not relevant. The most frequent reasons behind this were the respondent's limited role or limited understanding of the ecosystem.

These findings indicate that most of the ecosystems are still in their early stages and their results are not yet available. This is further corroborated by the fact that only eight companies reported associated turnover with the specific result. However, most of the interviewed companies expect at least some turnover growth linked to the results in five years of time but find it very challenging to identify quantitatively. Expected growth ranges from few percentages to more than 100 percent.

VIEWS ON THE IMPORTANCE OF BUSINESS FINLAND'S SUPPORT & THE ECOSYSTEM'S SUPPORT

In achieving the described results, Business Finland's support is generally seen as very important, with eleven interviewees considering it as "critical" and ten repondents seeing it as an "important support role". This support was mostly associated with the direct funding, thus enabling companies' R&D efforts. The ecosystem's perceived importance varied considerably among the interviewees: for some the ecosystem has been crucial, for others only of limited or no importance. In these results it is important to take into account the different levels of companies' activity and/or involvement in the ecosystem – if company had not 'found' their place or a concrete niche in the ecosystem the importance was seen lower than among the active members.

In general, Business Finland's direct support was seen as more crucial than the ecosystem's, often it was rather difficult for the interviewees to separate these two, as

Business Finland's funding typically linked very closely with the ecosystem and/or enabled the company's access to the ecosystem. Therefore these results should be interpreted with care.

VIEWS ON ECOSYSTEM GROWTH AND BUSINESS FINLAND'S FUTURE ROLE IN SUPPORTING THE ECOSYSTEMS

Views on the drivers and barriers for ecosystem growth expectedly differed depending on the ecosystem in question. The ecosystems were seen as good environment to do pilots and demonstrations and therefore being drivers of development. However, the same aspect came up as a barrier, especially in cases where the level of concreteness was low – in these cases the full potential of the ecosystem was considered not to be fully utilized or atleast more concrete pilots were desired.

In the interviews, there were also several references to regulation. Especially among ground-breaking technology or services, many regulatory issues were mentioned as potential barriers for growth. The additional responses about drivers and barriers were rather versatile, with several different kind of issues raised up which was likely related to the different levels of ecosystem maturity. These issues included lack of coordination (barrier), skills and/or talent (both as driver and barrier) and climate change (mainly as a driver).

Views on Business Finland's future role in supporting the ecosystems were rather mixed, likely stemming from different contexts and backgrounds. Generally speaking, Business Finland is expected to provide support – understood in a broad sense – for ambitious and large-scale pilots and demonstrations, as well as bringing together different actors and facilitating the ecosystems. Some interviewees saw that Business Finland could have some kind of a role in supporting the dialogue for a more innovation-friendly regulation. Interviews also included several references to challenge competition model ('veturiyritysmalli') as a promising instrument to support ecosystems and to clarify the roles of different companies in the ecosystem.

APPENDIX C. STUDY RESULTS: CASE STUDIES

CleverHealth Network

General information identifying the ecosystem

OFFICIAL ECOSYSTEM NAME

CleverHealth Network

SCOPE AND FOCUS OF THE ECOSYSTEM

CleverHealth Network aims to develop new health and wellbeing technologies and innovations for global markets. The technological solutions are based on HUS Helsinki University Hospital's health and welfare data. The ecosystem is orchestrated by Hospital District of Helsinki and Uusimaa (HUS).

The objective is to innovate. New innovations will help to provide better and more precise patient care and remodel the practices in health care, as well as generate new exports, help SMEs access global markets, and attract foreign investments to Finland.

The basic idea of the ecosystem is to bring together companies and researchers with HUS's health care experts (clinicians) and to use high-quality data to develop new solutions for specific clinical needs.

The vision of the ecosystem is "to be an internationally renowned ecosystem, which processes and cultivates health and welfare data, a forerunner in the health care revolution, and to create dozens of world-class solutions related to the cultivation of healthcare data".

LAUNCH DATE

The ecosystem was officially launched in the spring of 2017 when the first Business Finland funding for orchestration was received.

A SHORT HISTORY HOW THE ECOSYSTEM HAS DEVELOPED INTO WHAT IT IS NOW

The initiative for the CleverHealth Network came from HUS, bringing together a group of core companies for the funding application. Business Finland was, however,

actively involved from the beginning and contacted HUS about the possibility to coordinate the ecosystem. Supporting ecosystems was identified as an important objective at Business Finland and, having funded the OneSea ecosystem already, they saw the need for such an ecosystem within the health care sector.

Before the ecosystem was established there had already been different individual collaboration projects between HUS and companies to develop digital health innovations. However, this approach was deemed insufficient to develop new solutions for solving the complex health care needs.

Currently there are four ongoing research and development projects[39]. First concrete results (products or services) are expected within 2-3 years' time.

In 2019, CleverHealth Network was handed Growth Engine status by Business Finland and additional funding to orchestrate the ecosystem (Growth Engine orchestration funding, 50% of the costs).

BASIC QUANTITATIVE INFORMATION

Besides HUS, key members of the ecosystem are its 14 core companies: BCB Medical, BC Platforms, CGI, Elisa, Fujitsu, GE, Innofactor, Microsoft, Noona, Planmeca, Tieto, Takeda, Productivity Leap and Pfizer.[40]

In 2019, the total turnover of these core companies (in Finland) was €3.7 billion (of which €1.5 billion from Elisa). The companies generated in total of €515 million profits and employed in total of 12000 persons. However, it should be noted that many of the ecosystem members are large corporations and therefore the figures can be misleading. The figures do not take into account the companies' international activities, nor that only part of the companies' business is relevant to the ecosystem.

Besides these core companies, there are several subcontractors involved in the projects (approximately 40 in total, mainly research organisations and Finnish SMEs).

In line with the Growth Engine status, the ambition of the ecosystem is to generate billion Euros of new turnover.

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[39] Projects are: **eCare for Me**, aiming to produce AI-assisted solutions for early disease detection, automated diagnostics and treatment selection, and comprehensive home care. It consists of the following three sub-projects: 1) Diagnostics for rare diseases, 2) Treatment of acute leukaemia, 3) Development of Home dialysis. **Child with diabetes**, aiming to increase the type 1 diabetic patients' daily safety by creating an open-source API solution. The solution is using only permission-based data, given by the child or their family. The permission process is based on the IHAN concept, developed by Sitra. **Head area imaging analytics**, aiming to improve the treatment of brain disorders by developing a diagnostic tool to assist physicians. **Remote monitoring of gestational diabetes**, aiming to improve the treatment and monitoring of gestational diabetes by developing a mobile application for measuring the mother's glucose levels, physical activity, nutrition, pulse and daily weight and storing it in the cloud in real time. The fifth project, **Health Village®** – Creating a common development concept, is currently in the pipeline.

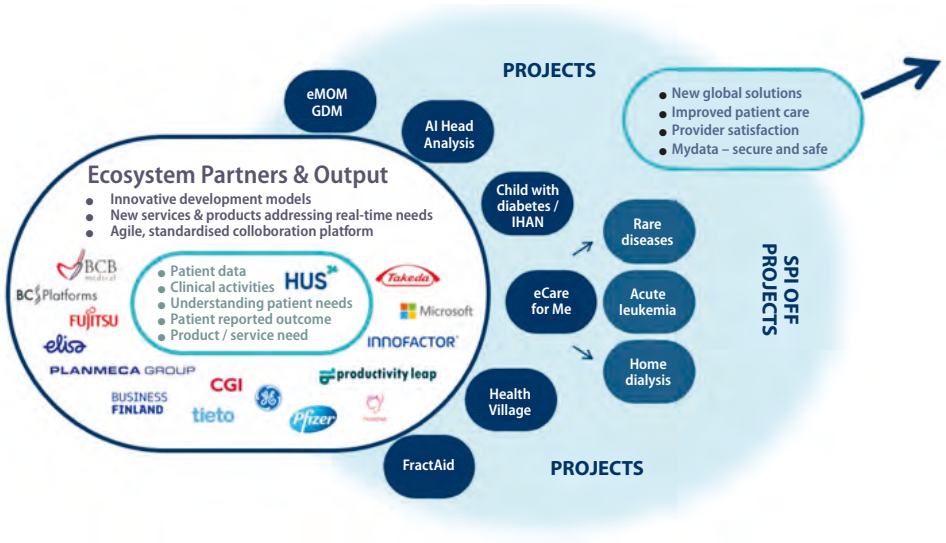
[40] According to the CHN website.

ANALYSIS OF THE GENERAL SITUATION OF THE ECOSYSTEM

The ecosystem is currently in the early stages of its life cycle. The first projects are still ongoing and concrete new products or services are not expected in the near future. Even after that, it is likely to take more time before the products and services are available in the market. Given this, the ecosystem is best described as an 'innovation or knowledge ecosystem' (instead of 'business ecosystem').

Notably, the ecosystem has managed to attract and maintain a diverse set of companies from relevant key industries. Many of them are large companies, including some of the leading global companies.

Structure of the ecosystem



ECOSYSTEM LEADING AND CORE ACTORS AND THEIR RESPECTIVE ROLES

The ecosystem is coordinated by HUS, formally the Hospital District of Helsinki and Uusimaa. HUS is the largest health care provider and the second-largest employer in Finland. HUS manages a total of 22 hospitals, the largest being the HUS Helsinki University Hospital. At the core of the ecosystem are HUS Helsinki University Hospital's DataLake, clinical activities and specific clinical needs. Importantly, HUS also gets royalties from the new products and services which are developed in the ecosystem projects.

Other leading actors in the ecosystem are the 14 core companies. The companies represent several different types of industries. In short, the ecosystem aims to bring together data science expertise (algorithms, software and IT services), health-tech and clinical experts (HUS). For each project, the role of the companies is to analyse, whether it is possible to build successful products or services. HUS, in turn, assesses if these products or services can actually solve any significant needs in the hospital or health care sector.

Six of the companies are large global corporations (CGI, Fujitsu, GE, Microsoft, Pfizer, Takeda), each being one of the globally leading companies in their field: While CGI, Fujitsu, GE and Microsoft are among the world's largest technology and IT service providers, Pfizer are

Takeda are pharma industry giants. Each of these companies have strong local presence in Finland.

Of the Finnish large companies, Elisa and Tieto are amongst the largest IT service providers in Finland. Planmeca Group is, at global level, one of the largest health care technology providers in certain niche markets.

The Finnish SMEs are focused on digital technology and IT services (Productivity Leap, BCB Medical, BC Platforms, Innofactor). The Finnish health-tech provider Noona was acquired by Varian in 2018.

Besides the core companies, there are several subcontractors involved in the projects. These are typically research organisations or SMEs with some specific competences or resources needed in the projects. These subcontractors are not official members of the ecosystem.

Importantly, the companies involved in the ecosystem cannot sell the developed products and services to HUS (who gets the access to the solutions). Instead, they need to find other (ideally foreign) clients. The rationale for this is to improve the incentives for HUS for participating in R&D collaboration projects but also to ensure that the developed solutions are scalable and targeted for global markets from the beginning. For some companies, this has been a very difficult requirement as HUS has traditionally been one of the key clients for Finnish companies in this field. According to HUS, several companies have decided not to join the ecosystem because of this requirement.

ECOSYSTEM OPERATIONAL ENVIRONMENT

When considering the operational environment of the ecosystem, regulation and public authorities have an important role. One of the key questions is the secondary use of health information. The new act (552/2019) addressed the issue by allowing the use of (micro-level) data for scientific research. Although this has enabled launching research projects, both interviewed companies and HUS saw that the new regulation is too restrictive by categorically limiting the use for scientific research only. The issue is, of course, difficult and finding the right balance for data privacy and innovation is very delicate. Also, the regulation regarding public procurement is seen to make it difficult for public actors such as HUS to collaborate with companies, despite some progress with the new Procurement Act in recent years.

On a more technical level, the fragmented nature of the data, lack of standards, as well as data security issues were also seen as important challenges to be solved in the future. For the development of new innovations based on health data, the high quality of the data is crucial. A large share of the data is still collected manually by the clinicians and other health care personnel. Thus, if the data is not collected and inserted into the IT systems with precision, there is a risk that the quality of available data is not sufficient for the purposes of the ecosystem. According to HUS, hospitals and other data producers

should have better incentives to collect the data to ensure its high quality.

The availability of funding is also an issue in the health care sector. The development cycles in the field are very long and therefore often less attractive for many private investors. The development is also very resource-intensive and required investments often outside the scope of many (domestic) private equity funds.

The traditional and often very hierarchical organisations and "old-fashioned" ways of working were also seen as bottlenecks. This was seen to apply to not only public sector organisations but also to private companies. The Finnish health care market – with several publicly-owned "in-house" companies and lack of competition – was also seen to discourage innovation activity in the sector. This is related to the broader health care reform currently ongoing in Finland.

THE SHARED PLATFORM OF THE ECOSYSTEM

In practice, the ecosystem is organised around co-creation projects, each involving some of the core companies as well as other, project-based, partners. The practical roles of the partner companies vary across projects. In the beginning of the projects, the roles of the partners are discussed. One key aspect here is to agree, who the 'owner' of the product is, and what are the roles of other actors. In most cases the owner is one of the larger companies in the ecosystem, but this is not necessarily always the case.

Some of the companies are also competitors in some business areas. The goals is to generate networks and a general collaborative atmosphere which leads to further collaboration projects between the partners (not necessarily officially part of the CleverHealth Network).

An essential part of the ecosystem is the HUS DataLake, an analysis and storage location for large masses of unique and high-quality data. The DataLake was developed in collaboration with Sitra. Although this is not a traditional technology 'platform', it is – combined with the clinical experts – the main 'attractor' for the companies to join the ecosystem. Also, the products and services are developed around this DataLake with the idea that they can be later scaled with other hospitals in Finland and globally.

MAIN MODELS OF INTERACTION, COLLABORATION, AND OTHER ACTIVITIES AIMED AT DEVELOPING THE ECOSYSTEM AND CREATING MUTUAL BENEFITS

Besides the project-specific activities, HUS organises common events for the ecosystem members and provides other coordination and facilitation support for the projects, e.g., for funding applications and project management.

The role of 'neutral facilitator' (HUS) was highlight-

ed also by the participating companies, who saw that it would not be possible to build trust and collaboration without such an actor.

All projects aim to produce both new products and/or services as well as scientifically ambitious findings. Each project involves partners from different sectors and industries. The aim is to include both large corporations and SMEs/startups in the projects to help facilitate collaboration between the different actors. In fact, one of the important aims of the ecosystem is to encourage broader cultural mindset changes and generate collaboration between the actors also outside the official ecosystem projects.

GOVERNANCE MODEL

The Steering Board of the CleverHealth Network (with representatives of the core members) steer the activities of the ecosystem and decide, which projects will be launched.

HUS is responsible for coordinating the ecosystem and its activities. Approximately 1,5 FTEs is allocated for the coordination. In addition, HUS has contracted external facilitators, such as Spinverse[41], to help facilitating the ecosystem (e.g., in setting up projects, funding applications, etc.). Business Finland has supported the coordination with 50 % Growth Engine orchestration grant. The other 50 % is covered by participation fees.

The participation fees vary according to the size of the companies. For large companies the fee is €30.000 annually, for SMEs much less. The fee for companies outside the core members to join the projects is €5.000 per project. With the participation fees, the companies get the access to the HUS data and experts (through projects) as well as for the joint events and other coordination services.

Each project has its own budget. Two of the projects have been supported by Business Finland co-innovation funding. One of the projects is funded by Sitra. One project is funded by the core partners only.

ANALYSIS OF THE STRUCTURE OF THE ECOSYSTEM

The structure of the ecosystem, focused around HUS and core company partners, is very clear and easily recognisable. In comparison to some other ecosystems included in this study, CleverHealth Network is very systematically coordinated and collaboration between the partners is very structured. The core of the collaboration is quite 'traditional', revolving around co-innovation projects,

[41] Spinverse is a Finnish private innovation consulting company specialised in facilitating innovation ecosystems and arranging funding and commercialising of emerging technologies. www.spinverse.com

supported by joint agenda setting, matchmaking and, importantly, a contractual framework. The role and added value of the "neutral orchestrator" was highlighted in interviews.

Value of the ecosystem

ADDED VALUE OF THE ECOSYSTEM

For the participating companies, the main added value in short- and medium is the access to the high-quality data as well as HUS's clinical experts. The latter was strongly emphasised as it is not possible to develop products around the data without such knowledge – and this knowledge would be very difficult to get without the ecosystem. The experts can also help to clarify the actual needs and future plans of the hospital(s). The ecosystem also provides the companies an opportunity to pilot their technologies in a real-life environment.

The companies are especially involved in their development projects, where they collaborate with other project partners in regular meetings. Besides the development projects, companies value the different types of networking events (organised by HUS), especially when they have the opportunity to network with the clinical experts and get valuable information on the hospital's specific needs and future plans. This helps the companies to develop and plan their own innovation activities. More general events were seen as less useful.

Although the direct contacts with the clinical experts were seen as especially valuable, the companies value also the opportunities to build and deepen networks with other companies in the ecosystem, especially through the collaboration projects. Especially the Finnish partners see the involvement of global companies as very valuable for potential future scaling opportunities. There is also some evidence of joint collaboration initiatives between the ecosystem members also beyond the official collaboration projects. Facilitating this kind type of collaboration is also one of the objectives for the ecosystem.

As for more 'tangible' business impacts (e.g., impact on turnover), the development projects are currently still ongoing and there are not yet any specific results (such as new products or services) available.

As for more long-term added value, the ecosystem is also seen to help to build common understanding between different actors about the future opportunities and challenges regarding digital health and welfare innovations. In addition, the ecosystem is seen to contribute to a more fundamental "cultural change" – both within the public sector and within the larger companies –and increase understanding that the development needs to be based on collaboration with many different actors.

STRATEGIC IMPORTANCE NOW AND IN THE FUTURE

From the business perspective, the broader strategic importance is related to the need to find new and more dynamic collaboration models as the traditional "subcontractor" model is largely seen outdated in the current complex context where many different skills and competences are needed. Operating within the context of global competition requires a collaborative approach and increased openness both from the companies and public actors.

Finding new collaboration models and developing a more dynamic model for development is also vital for HUS (and other public actors within the health care system). Traditionally is has been very difficult for publicly funded organisations to invest into research and development. Pressures to cut public expenditure further highlights the trend. In this respect, the royalty-based model of the CleverHealth Network is seen to have broader strategic importance.

ANALYSIS OF THE VALUE OF THE ECOSYSTEM

Although the impacts and results of the collaboration facilitated by the ecosystem remains to be seen, the added value of the CleverHealth Network is clear. Without the network, the companies would struggle to get the access to similar data and expert resources, while HUS would need to revert back to the more traditional "subcontractor model", which lacks the benefits of the more collaborative and open ecosystem approach. The case also highlights the importance of building trust between the ecosystem members.

Through the results of the projects *societal* value is likely to be created for the clients of HUS (in terms of better care, new healthcare solutions, etc.). It is, however, very difficult to determine, which share of the ecosystem's *economic* added value will eventually remain in Finland given that many of the core companies are large global businesses with subsidiaries and/or a headquarters in other countries. They key issue therefore is that the (high-quality) R&D operations of these companies will remain in Finland, and hopefully be expanded. Access to talent, data and piloting opportunities are important factors behind these decisions, and the case provided some evidence that the CleverHealth Network has managed to successfully contribute to these factors.

Role of Business Finland and public support

WHAT HAS BEEN THE ROLE AND ADDED VALUE OF BUSINESS FINLAND AND ITS INSTRUMENTS IN SUPPORTING THE ECOSYSTEM IN DIFFERENT PHASES?

As discussed above, Business Finland was actively involved in initiating the ecosystem. In addition, Business Finland has supported the orchestration of the ecosys-

tem. In 2019, CleverHealth Network was handed Growth Engine status by Business Finland and additional funding to orchestrate the ecosystem (Growth Engine orchestration funding, 50% of the costs).

Besides orchestration funding, two of the ongoing four development projects have received Business Finland's co-innovation funding. Many of the core members have also had other Business Finland -funded R&D projects (also before CleverHealth Network).

Besides funding, also the customer-centric approach and dialogue with Business Finland experts was highlighted by the interviewees.

WHAT COULD BUSINESS FINLAND DO (IN COLLABORATION WITH OTHER PUBLIC ACTORS) IN THE FUTURE TO BETTER SUPPORT THE DEVELOPMENT OF THE ECOSYSTEM?

The role of Business Finland funding for both orchestration as well as for the actual development projects remain important also in the future. The projects are still very early stage and even after the projects are complete, further efforts are needed for commercialising the findings. Business Finland funding remains also one of the only options for funding public organisations' RDI activities.

Further development of innovative procurement remains very important for the ecosystem as the main clients for the developed solutions are mostly publicly owned hospitals. Therefore, the ability of the hospitals and other health care organisations to flexibly pilot and acquire new solutions is important for building reference cases for ecosystem members. Business Finland, in collaboration with other actors, could continue to support the development of new innovative procurement practices and pilot environments. Business Finland could also be active in facilitating dialogue to build understanding of new health-care technologies and innovations, and the role of regulation is supporting the ecosystem.

Regarding Business Finland's approach to ecosystems, the interviewees called for more clarified goals and definitions of what is expected. On the other hand, the actors welcome the ambitious goal of reaching billion Euros of new turnover as it recognizes the great market opportunities in digital health innovations. However, on the other hand, it was seen that the goal can only be reached on a very long long-term and even then, the contribution of the ecosystem in achieving this goal would be very difficult to assess. Therefore, instead of setting broad long-term goals, the ecosystem would benefit from setting more concrete and hands-on "milestones".

Another example is Business Finland's emphasis on exports and internationalisation of SMEs, which is seen as a valid goal but the role of the ecosystem in achieving this is not clear. For example, in the case of CleverHealth Network, access to global markets is promoted by attracting global large companies in Finland (not 'exporting' Finnish SMEs abroad).

Regarding the Business Finland ecosystem instruments, the new challenge competition for leading companies ("veturiyritykset") was seen as a promising opening to support collaboration between (especially large) companies and research organisations – something that was seen to have been too bureaucratic and unattractive (from large companies' perspective) with the previous instruments.

Finally, Business Finland could also help to facilitate the collaboration of CleverHealth Network with other Finnish hospitals, for example by helping them to join the ecosystem projects, to ensure that the findings can be scaled on a national level.

ANALYSIS OF THE ROLE OF PUBLIC SUPPORT

The role of Business Finland funding – both for orchestration and for development project – has been very important for the ecosystem. Such funding would be difficult to attain from private sources, especially in the field where the projects can be very risky and resource intensive.

The case also highlighted the important role of public sector in supporting the ecosystem with other forms, for example by developing public procurement practices and the regulatory environment.

Sources

WRITTEN INFORMATION

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INTERVIEWS

Visa Honkanen & Mirka Tammi, HUS

+ interviews with four member companies' representatives (anonymous)

Smart Mobility Ecosystem

General information identifying the ecosystem

OFFICIAL ECOSYSTEM NAME

Smart Mobility Ecosystem (Growth Engine)

The focus of this case study is on the Smart Mobility Ecosystem, one of the first Growth Engines funded by Business Finland. The concept of 'smart mobility ecosystem' (or MaaS ecosystem) is, however, often used to describe the broader ecosystem in Finland.

SCOPE AND FOCUS OF THE ECOSYSTEM

The ecosystem, managed by a Finnish start-up company Kyyti Group Oy, aims to develop a Mobility-as-a-Service (MaaS) platform, bringing together transport operators, companies and public actors.

In short, MaaS refers to a concept which combines different public and private transport services (public transportation, car-sharing, taxi services, etc.) into a new type of customer-friendly service concept, enabling consumers to choose the services needed with a single payment and interface (e.g., via mobile App) instead of needing to pay for many different services/tickets. It represents a shift from 'service-provider-centric' model towards 'user/consumer-centric' model of transportation and mobility.

The development and scaling of such a platform by combining different services and offerings into a joint solution is the main goal of the Smart Mobility Ecosystem. Currently the focus of the ecosystem activities is on building international reference cases and finding the best possible business model and "niche" for the Finnish actors.

LAUNCH DATE

Smart Mobility Ecosystem Growth Engine was officially launched in November 2018. It was among the first five Growth Engines funded by Business Finland.

A SHORT HISTORY HOW THE ECOSYSTEM HAS DEVELOPED INTO WHAT IT IS NOW

The roots of the Growth Engine date back to previous co-creation projects between different partners. One important project was VAMOS (2016–2018)[42], which aimed to develop a MaaS concept in Lapland. The project was coordinated by VTT and supported by Business Finland

[42] VAMOS. Project website. https://vamosapi.com/vtt/

co-innovation funding. VAMOS was followed by ALPIO (2018–2019) -project[43], funded by Sitra. Some of the actors involved in these projects (such as VTT, PayIQ and Vinka) decided to join Kyyti Group in applying for the Growth Engine funding.

The plans and composition of the ecosystem have changed considerably since the launch of the ecosystem, and some of the original members have not been involved in the ecosystem as planned. According to the interviews, this is largely because the MaaS ecosystem has not developed globally as expected and there has not been enough demand and client cases for MaaS concepts. This has forced many MaaS companies to rethink their business models and strategies. In 2020, the COVID-19 crisis has drastically affected both the global MaaS market and the Smart Mobility Ecosystem. The crisis has a strong impact on the demand from clients like cities and public transport operators for MaaS solutions as many orders have been postponed or cancelled. This has forced the ecosystem, at least temporarily, to focus on Finland and 'survival', instead of global projects and scaling.

BASIC QUANTITATIVE INFORMATION

Originally, the Smart Mobility Ecosystem Growth Engine consisted of 20 members, of which 17 were companies.[44]

In January 2020, the ecosystem consisted of 50 partners, including both Finnish and international companies, research organisations, cities, networks and industry organisations and NGOs[45]. It should be noted, however, that the role of these partners as well as the nature and level of collaboration between them varies considerably. Also, it is likely that some of the partners do not consider them as part of the Smart Mobility Ecosystem (Growth Engine) despite having some collaboration with Kyyti Group.

ANALYSIS OF THE GENERAL SITUATION OF THE ECOSYSTEM

Overall, the Smart Mobility Ecosystem (unlike some other ecosystems analysed as part of the study) can be considered as a good example of 'traditional business ecosystem' as it is strongly focused around developing a shared business concept, in this case build around a com-

[43] Alueellisen Liikkumisen Palveluiden Integroitu Operointi (ALPIO). Project website. https://cris.vtt.fi/en/projects/alueellisen-liikkumisen-palveluiden-integroitu-operointi

[44] Smart Mobility Ecosystem, presentation at Growth Engine info event in 2018. https://www.businessfinland.fi/49f09f/globalassets/finnish-customers/news/cases/2018/kasvumoottori_info-14122018_pekka-motto_-kyyti_smart_mobility_ecosystem.pdf

[45] Kyyti Group's mid-term report for Business Finland (confidential), 15.5.2020

mon platform. The ecosystem is currently in the 'start-up-phase', aiming to find the optimal business model and niche for Finnish players in the global markets.

The ecosystem is also a good example of how external shocks (such as COVID-19) can affect the trajectories of the ecosystems. This calls for flexibility and ability to adapt to changing circumstances.

Structure of the ecosystem

ECOSYSTEM LEADING AND CORE ACTORS AND THEIR RESPECTIVE ROLES

The Smart Mobility Ecosystem Growth Engine is built around a Finnish start-up Kyyti Group and its MaaS-platform (see description of the platform below). Kyyti Group was founded in 2015 (under the name Tuup). Originally the company focused on the B2C markets, but in 2018 it made a strategic decision to become a B2B platform operator. The ambition is to become a global B2B platform operator in Europe, the United States and Japan within the next few years.[46]

Other important actors in the ecosystem include different types of digital technology and service providers (e.g., platform technologies, payment services, car sharing companies, route guide developers, etc.) as well as public transportation authorities (PTAs) and private service providers (e.g., taxi companies, car sharing, city bikes, etc.) in different cities and regions. The PTAs, cities and regions are both important clients for the ecosystem's companies but also important suppliers of transport and mobility data, essential for the development of MaaS solutions and services. Next to that the ecosystem includes research partners, service providers, consultants, industry organisations and NGOs.

ECOSYSTEM OPERATIONAL ENVIRONMENT

The global smart mobility market is estimated to be over 8.000 billion Euros in 2050, of which the market for MaaS is expected to reach 1.000 billion Dollars by 2030.[47] In general, the market is still very young and many of the MaaS companies are startups (Finnish companies like Kyyti Group and Maas Global among them). The value chains are not yet established, and the future development of the market and value chains are still undetermined, especially after the disruption created by the COVID-19 crisis.

The concept of MaaS is largely seen as a Finnish innovation and Finland is seen as one of the forerunner

[46] https://www.businessfinland.fi/en/whats-new/cases/2020/kyyti-group-accelerates-the-transformation-of-global-transport-services/

[47] Ministry for Employment and the Economy (2017). Liikennealan kansallinen kasvuohjelma. https://tem.fi/liikenteen-kasvuohjelma

countries.[48] Yet, the scaling of the concept to the global context has not yet succeeded. Some of the interviewees have the view that the 'window of opportunity' is closing now that the global competition is increasing as global technology giants such as Google and Amazon have become more active in the field. Therefore, it is important for the Finnish companies to find the right 'niche'. A good example of global competition is the recent acquisition of Moovit (an Israeli mobility startup) by Intel for USD900 million[49].

As discussed, the COVID-19 pandemic has severely affected the market demand and transport operators. As a result, many MaaS companies (typically startups developing mobility solutions & services) are struggling and the short-term future of the ecosystem is largely dependent on how Finland recovers from the crisis. On the other hand, on the long-term, the disruption caused by the pandemic can help to boost the transition in the transportation and mobility system.

The role of regulation and regulation authorities is very important for the development of the MaaS ecosystem. The regulatory environment in Finland is seen as a major driver for the ecosystem, and the future-oriented regulatory reform[50], requiring the transport operators to open their data interfaces[51], is often referred to in international benchmarks. However, the currently ongoing implementation has not been without problems as many large operators are unwilling to share their data as the regulation does not include any incentives for that. This is seen as one important bottleneck for the development of the ecosystem.[52]

The regulation has been developed irrespective of the Smart Mobility Ecosystem (Growth Engine), and regulators or public authorities are not officially part of the ecosystem. However, some members of the ecosystem have been active in discussing the regulatory issues with the authorities. Regulation is also mentioned as one key area in the national growth programme (*Liikennealan kasvuohjelma*) for the transport and mobility sector[53].

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[48] Ministry for Employment and the Economy (2017).

[49] e.g. https://techcrunch.com/2020/05/04/confirmed-intel-is-buying-urban-mobility-platform-moovit-in-a-900m-deal/

[50] An important landmark was the large-scale regulatory reform on transport sector regulation in 2016-2019, resulting into new Act on Transport Services (in three parts, 2016, 2017, 2019) as well as modifications to 58 other acts. One key aim for the reform was to create conditions for the adoption of new technologies, digitalisation and business models within the transport sector, leading to better, more efficient as well as environmental and customer friendly transport services. Fostering the MaaS ecosystem was specifically mentioned.

[51] A key regulation is the Act on Transport Services (320/2017) . One part of the act (§4 in Chapter 2) is related to the inter-operability of data and opening up of data interfaces of transport operators. In practice, the regulation requires the actors to provide (other service providers) access to their data.

[52] The role of the Act on Transport Services in supporting the MaaS ecosystem is discussed in Salminen, V. (2020) Innovaatiomyönteinen sääntely: Nykytila ja hyvät käytännöt. Valtioneuvoston kanslia.

[53] Ministry for Employment and the Economy (2017). Liikennealan kansallinen kasvuohjelma. https://tem.fi/liikenteen-kasvuohjelma

Besides regulation, the role of the public sector is very important as a large share of the transport services is currently provided by public sector actors. Thus, they are both important clients and data producers for the MaaS companies. This emphasises also the central role of innovative public procurement in supporting the ecosystem (see section 4).

THE SHARED PLATFORM OF THE ECOSYSTEM

The aims of the MaaS-platform of the Kyyti Group are to provide more efficient, user-friendly and sustainable mobility services for consumers. In practice, the platform brings together different public and private mobility services (e.g., public transportation, taxis, care sharing, on-demand ride sharing etc.). The idea of the platform is to provide a single customer-friendly access (e.g., via smart phone app) to the services across different transportation modes.

The shared platform provides a technical solution to support the business model, but does not support the ecosystem dynamics itself, e.g. collaboration between the ecosystem actors. Instead, the ecosystem operates through various projects between Kyyti Group and other (project-specific) partners.

MAIN MODELS OF INTERACTION, COLLABORATION, AND OTHER ACTIVITIES AIMED AT DEVELOPING THE ECOSYSTEM AND CREATING MUTUAL BENEFITS

Originally the plan was to organise joint meetings and events with the ecosystem members, to facilitate the dynamics within the ecosystem in a more systematic manner (e.g. networking events, etc.). However, as the market has not developed as expected, also the collaboration has taken different forms than originally planned. The focus has been in scanning and finding different client cases and business opportunities rather than building on the collaboration with the original partners. Examples of (publicly announced) collaboration projects include, a collaboration with Matkahuolto to develop a nation-wide MaaS solution[54] and a project with the City of Linköping[55].

GOVERNANCE MODEL

The governance of the ecosystem is solely in the hands of the platform company. There is no shared board or 'neutral' organisation that facilitates collaboration and shared activities in general within the ecosystem.

[54] https://www.matkahuolto.fi/news/matkahuolto-ja-kyyti-group-toteuttavat-maailman-ensimmaisen-maanlaajuisen
[55] https://www.kyyti.com/linkoping-will-be-the-first-to-develop-a-city-wide-maas-operation/

As for all Growth Engines, besides the general funding terms, there are specific criteria and indicators for each loan instalment, agreed separately between Business Finland and the Growth Engine platform company. The indicators are confidential, but include both company-specific indicators as well as indicators regarding the development of the ecosystem (e.g. number of joint solutions, collaboration projects, etc). Each Growth Engine platform company has their own 'key account manager' at Business Finland (BF ecosystem leads). The indicators and the development of the ecosystem is discussed between Business Finland and the company in regular meetings.

ANALYSIS OF THE STRUCTURE OF THE ECOSYSTEM

As in all Growth Engines (with capital loan funding), the structure of the ecosystem is very light and highly focused around the one anchor company. In this respect, the Growth Engines differ significantly from the "orchestrated" Business Finland funded ecosystems as there is no neutral orchestrator or joint strategy facilitation (with all ecosystem members). This (systematic joint strategy facilitation) was also not organised by the ecosystem members themselves.

Value of the ecosystem

ADDED VALUE OF THE ECOSYSTEM

The focus of Growth Engine is on the development of the MaaS platform. The broader added value and spill-overs for other companies largely depends on the success and scaling of the platform. If successful, the platform would help to integrate the different technology and service providers into one offering and create a new type of service concept, which would help to generate new business opportunities for all ecosystem members. Given that most core ecosystem members are small startups, this type of joint approach is essential for being able to access international markets and build international client cases. At best, the platform would also help to develop more customer-friendly and cost-efficient public transportation and mobility services.

However, as discussed above, the market and value chains are still evolving, and it is too early to assess the actual value and impact on the ecosystem partners – especially in the current market situation.

STRATEGIC IMPORTANCE NOW AND IN THE FUTURE

The strategic importance of the ecosystem and the MaaS concept is in its potential to radically disrupt the broader

transportation and mobility sector. It represents a shift from 'service-provider-centric' model towards user/consumer-centric model. It is closely related to other emerging technologies and innovations such as autonomous vehicles, blockchain technologies and fintech solutions.

ANALYSIS OF THE VALUE OF THE ECOSYSTEM

The Smart Mobility Ecosystem represents the type of radical and disruptive innovation associated with Business Finland's objective of supporting potential world-class ecosystems. At the same time, the ecosystem is a good example of the "winner takes it all" nature of the platform economy. This represents both high risks and high rewards, also from the policy perspective.

Although the success and added value of the ecosystem remains to be seen, it is clear that some type of collaborative approach is necessary if Finland wants to achieve the objectives of generating a world class MaaS ecosystem in Finland.

As the ecosystem is still in the 'start-up phase' and a lot will depend on finding (international) success of the MaaS platform, relatively little effort is being put on classic business ecosystem activities typical for more mature markets (shared strategy development, dealing with shared challenges, supply chain optimalisation and division of labour, shared R&D, etc.).

Role of Business Finland and public support

WHAT HAS BEEN THE ROLE AND ADDED VALUE OF BUSINESS FINLAND AND ITS INSTRUMENTS IN SUPPORTING THE ECOSYSTEM IN DIFFERENT PHASES?

From the perspective of this case study and the Smart Mobility Ecosystem, the main role of Business Finland has been the Growth Engine capital loan funding for Kyyti Group. The instrument is seen as very 'startup-friendly' as it does not dilute ownership, and it is more flexible than traditional Business Finland R&D loans (in terms of accepted costs and activities). The volume of the funding is also seen as sufficient for developing and scaling of new disruptive platforms.

Besides funding, an important element of the Growth Engine initiative has been the company specific 'tailored' services and introduction of Business Finland (and Team Finland network) services for all Growth Engine platform companies ("key accounts"). In the case of Kyyti Group, especially the internationalisation and "go-to-market" services have been important in opening doors for international markets. Also, the joint events for the different Growth Engine platform companies were seen useful.

Business Finland has been active in the mobility and MaaS sector also prior to the Growth Engines. Many of the ecosystem companies have received R&D funding

from Business Finland, either "bottom up" or as part of the Business Finland (or Tekes) programmes such as the currently ongoing Smart Mobility Finland programme (2018–2022)[56].

WHAT COULD BUSINESS FINLAND DO (IN COLLABORATION WITH OTHER PUBLIC ACTORS) IN THE FUTURE TO BETTER SUPPORT THE DEVELOPMENT OF THE ECOSYSTEM?

Regarding the Growth Engine funding, some of the interviewees highlighted that in order to better support the broader ecosystem, the Growth Engines should include more incentives and/or requirements for collaboration as well as more systematic monitoring of the collaboration by Business Finland. As discussed above, incentives for collaboration have been included in the Growth Engine model, but activities for collaboration have not materialised as planned. In addition, a more systematic facilitation of collaboration between the Finnish smart mobility actors (beyond Growth Engine members) – possibly by "a neutral facilitator" – were called for.

The internationalisation services provided by Business Finland and the Team Finland network were seen as valuable, especially as there are no large companies with existing international networks in the ecosystem. Business Finland and other public actors can help to provide access to other countries' public authorities. Business Finland can also continue to help actors identify potential collaboration partners and other important actors, both in Finland and abroad.

The main bottlenecks for the growth of the ecosystem are, however, related to the broader policy issues. A key issue seems to be the lack of incentives for public authorities (cities, transport operators) to open the data interfaces and pilot new solutions. Here, further developing the innovative public procurement practices and utilising the opportunities of recently refined procurement regulation are seen as crucial. These issues are already being discussed as part of the national growth programme, in which Business Finland is also active, but it seems that more efforts are still needed.

ANALYSIS OF THE ROLE OF PUBLIC SUPPORT

As such, the Growth Engine instrument with its flexibility (no strict restrictions for accepted costs) and balanced risk-sharing (capital loan instead of grants) seems well suited for supporting the development of platform companies with high ambitions and risk-level. However, it seems that in some cases it might be very difficult for the platform companies to take a facilitator role while focusing on developing their own platform and business model.

[56] Business Finland: Smart Mobility Finland programme. https://www.businessfinland.fi/en/for-finnish-customers/services/programs/smart-mobility-finland

For the development of the broader ecosystem and generating spill-over effects, the orchestration of broader ecosystem collaboration and joint strategy facilitation is nevertheless essential.

The case also highlights the important role of other types of support needed for supporting the growth of business ecosystems (e.g., regulation, support for internationalisation, matchmaking etc.). When funding ecosystems, it is important to understand this broader context and ensure that the funding is aligned with supportive regulation and other policy initiatives.

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VAMOS. Project website. https://vamosapi.com/vtt/

INTERVIEWS

Pekka Möttö, Kyyti Group
Pekka Niskanen, Kyyti Group
Karin Wikman, Business Finland
+ 3 other interviews with original ecosystem members (anonymous)

BATCircle

General information identifying the ecosystem

OFFICIAL ECOSYSTEM NAME

BATCircle – Finland based Circular Ecosystem of Battery Materials

SCOPE AND FOCUS OF THE ECOSYSTEM

The underlying rationale for the ecosystem is based on the growing global markets of electric vehicles and particularly batteries needed in them. These batteries contain valuable metals, which can be recovered and recycled into the manufacture of new batteries.

The main argument for favouring the development and use of electric vehicles is that they are ecologically more sustainable and less harmful than traditional ones. While the primary focus is often on emissions and climate impact, the assessment of environmental impact over the complete life cycle of the vehicle emphasises also how the different materials and components are manufactured and recycled. Mining and manufacturing of metals, materials, and components can have significant environmental impacts, and some of these materials can be harmful to the environment if not treated properly. Hence, to minimise the environmental impacts over the whole life cycle of the vehicle, it is important to manage the environmental impacts of the raw material and component production, and to ensure recycling.

The ecosystem aims at improving the manufacturing processes of mining industry, metals industry and battery chemicals, and to increase the recycling of lithium-ion batteries. Its goal is to strengthen the cooperation between companies and research organisations in Finland, and to find new business opportunities. BATCircle also contributes to building the European vision and identification of R&I needs by leading the Raw Materials and Recycling Working Group within the European Technology and Innovation Platform Batteries Europe, the R&I arm of the European Battery Alliance.

The ecosystem focuses on:

- Sustainable primary resources
- Value addition in metal refining
- Battery recycling
- Precursors and active materials
- Circular business ecosystems

LAUNCH DATE

The ecosystem was officially launched in March 2019. The current first stage is planned to continue until the end of April 2021.

A SHORT HISTORY HOW THE ECOSYSTEM HAS DEVELOPED INTO WHAT IT IS NOW

The metal and mineral processing companies have a long history of collaboration with the local universities and other research organisations. This leads back to the late 1980s and 1990s and the first national technology programmes. Since then, the collaboration has continued and developed largely with the support of Business Finland and its predecessor Tekes. Companies have received funding for their own proprietary projects often on the condition that they collaborate with research organisations and/or SMEs. Research organisations have received funding for their public research projects provided, that they also get support from companies. This has led into a culture where especially large companies typically allocate some funds from their research budgets annually for supporting public research.

The idea for this ecosystem was expressed in a response of a professor at Aalto University to an inquiry from industry to propose new topics for collaborative research and developed in a SRC funded project CloseLoop which published a policy brief on the topic in January 2018. After discussions with companies at events, bi- and multilaterally, the idea was proposed to Business Finland, which eventually led into a 5-month co-creation project coordinated by Aalto University from April to September 2018. The co-creation project continued interactions with companies and research organisations and clarified the shared agenda. Further companies joined and the BATCircle ecosystem was formally launched in 2019 with the respective co-innovation funding decisions.

The BATCircle actors have since taken the lead at European level in the material and recycling part of the Batteries Europe initiative and participate actively in the development of the national and European battery strategies.

The ecosystem actors have planned a continuation to the current co-innovation project portfolio and subsequently submitted a new the ecosystem application in December 2020. This new stage is planned to begin in May 2021 and last about three years. Further companies are expected to join the ecosystem in this second stage.

The ecosystem business activities are currently based on existing business models and are expected to remain so for the most part. However, there are two directions where businesses may develop into. First, businesses may move higher into the value chain. Existing actors may seek to move from battery materials into precursors, or even components (e.g., cathodes). New actors may be attracted to set up cell or battery manufacturing in the area. The second direction is recycling, which is only starting to emerge. There are existing recycling

smelteries for heterogenous waste feed materials, however specialized recycling units have started to emerge in Europe, and even more in China, close to battery manufacturing facilities. However, it is not yet known what the eventual dominant business models will be to address much larger volumes of battery waste. They may consist of numerous smaller decentralized units, or few larger centralized units, or combinations of both, and they may be close to battery manufacturing, raw material processing, collection locations of end-of-life electric vehicles, or somewhere else.

Furthermore, business models may also include the use of batteries retired from more demanding use in less demanding use (second life), such as using vehicle batteries for energy storage purposes. This may lengthen the lifetime of batteries and delay the growth of the eventual recycling volumes.

BASIC QUANTITATIVE INFORMATION

BATCircle is a joint industry-academia initiative between 9 large companies, 14 SMEs, 2 cities, 4 universities, and 2 research centres. The total budget of this joint initiative until end of April 2021 is €21m and it consists formally of 18 separate projects of which 6 are public research projects supported by the ecosystem companies and 12 are confidential company projects.

The ecosystem total turnover was estimated to be €600m in 2015. The ecosystem is expected to create €2.8b new turnover by 2025. The wider ecosystem including e.g., mining is expected to grow by €5b by 2025.

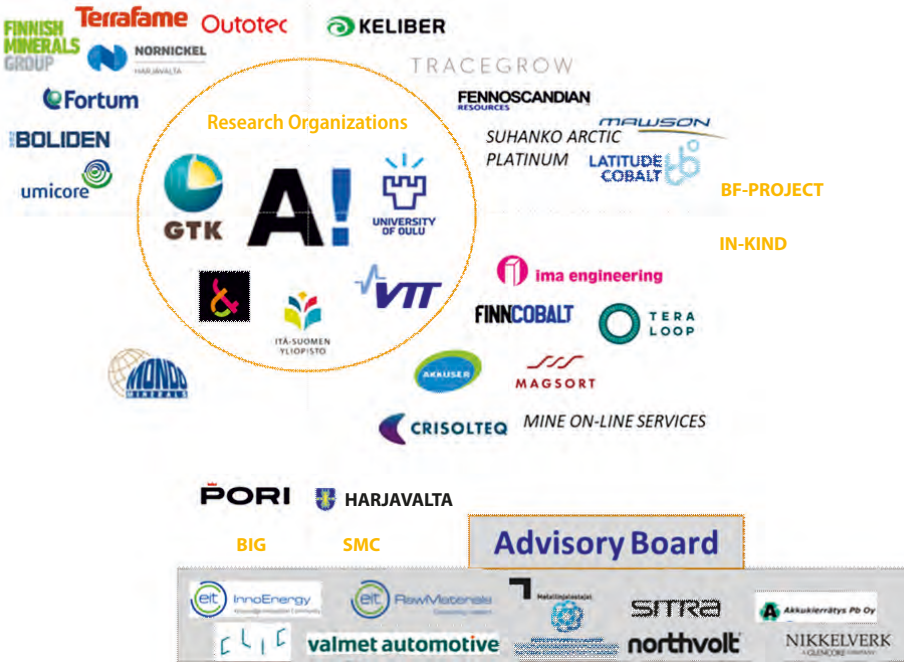
ANALYSIS OF THE GENERAL SITUATION OF THE ECOSYSTEM

The ecosystem focuses on the growing international market of electric vehicle batteries, and particularly on manufacturing and recycling of battery materials and components.

Some of the ecosystem members have collaborated with each other in different constellations and projects for several years, even decades before the launch of this ecosystem. The ecosystem originated from and is even today led by Aalto University. Its membership covers large multinationals, SMEs, research organisations and cities.

After a successful launch of several joint activities, the ecosystem is now in a process of planning continuation of its activities after the current funding period comes to an end.

Structure of the ecosystem



ECOSYSTEM LEADING AND CORE ACTORS AND THEIR RESPECTIVE ROLES

The ecosystem was launched based on an idea from an Aalto University professor. Subsequently, the professor and her research group have been the leading actor in the ecosystem.

The leading companies are Outotec as the main technology provider for most of the companies active in the ecosystem, and Fortum Battery Solutions developing and operating battery recycling processes. Other core companies include Umicore Finland (previously Freeport Cobalt), Boliden, Norilsk Nickel, Terrafame and Finnish Minerals Group, all active in manufacturing of metals, minerals or precursors used in vehicle batteries.

Fortum has already implemented a pilot process for battery recycling in Harjavalta, in the immediate vicinity of existing Boliden and Norilsk Nickel facilities.

Outotec together with Aalto University is coordinating the European efforts in developing battery raw material processing and recycling as part of the Batteries Europe R&I initiative linked to the industrial European Battery Alliance managed by EIT InnoEnergy.

The role of SMEs is largely in providing specific technologies and/or services to the larger companies, and to some extent in mining. However, there are also SMEs active in recycling (Akkuser) and developing Li production (Keliber).

ECOSYSTEM OPERATIONAL ENVIRONMENT

The core of the ecosystem is in producing metals, materials, and precursors for electric vehicle batteries from virgin raw materials and from materials recovered by recycling used batteries. The ecosystem is strongly linked to

the manufacture of electric vehicles. It is likely that the main market in this sector will be in electric and hybrid cars, but the same battery technology can also be used for energy storage purposes and other electric vehicles. In any case, it is likely that the markets for batteries will keep growing fast globally in the coming years.

While there are efforts to develop alternative and better battery technologies (e.g., solid state) and these may eventually change the markets even radically, that is not likely to happen within the next few years. Hence, there will be ample time to adjust material manufacturing and recycling processes when new battery solutions prove better than the existing ones.

The Finnish battery ecosystem is weak in battery and cell manufacturing as well as on the key client sector, automotive industry. Only one company, Valmet Automotive with facilities in Salo and Uusikaupunki represents battery and automotive manufacturing. There are no cell manufacturing facilities in the country.

The ecosystem is much stronger on the supply side as key battery metals and minerals are being mined in Finland and in neighbouring countries and refined together with large quantities of imported raw materials. Outotec is a major global technology provider in metal and mineral processing, and there are companies offering digital solutions for the industry.

The environmental awareness and the understanding how to deal with environmental problems related to mining as well as metal and mineral processing are relatively high in Finland. While the regulatory regime in Finland may be considered to be demanding and getting permits may sometimes be laboursome and lengthy, the resulting environmental footprint and its transparency may in the future be used as a strong selling argument. In fact, there are already joint initiatives in this direction.

The interest towards metal and mineral deposits in Finland has increased as the price and demand of specific metals has increased globally. Also, the centralisation of cell, battery, and battery material manufacturing industry globally into the hands of large multinationals with manufacturing largely located in China and other Asian countries has raised concerns about access to and availability of these materials. While the deposits in Europe are not sufficient to provide the necessary amounts of materials to address the market demand in Europe because of its large automotive sector, it is considered to be important that Europe is not totally reliant on imported materials and components. There are also concerns about managing and minimising environmental impacts of vehicle battery and material manufacturing and recycling. These largely explain the recent investments into cell and battery manufacturing facilities in Europe.

THE SHARED PLATFORM OF THE ECOSYSTEM

There are basically two shared platforms in the ecosystem. One is the shared knowledge needed in processing materials from mining to batteries. The other is the recycling of used batteries. The first one is a knowledge ecosystem, but also a business ecosystem as actors share both similar challenges related to knowledge and commercial business interests. The latter one is clearly a business ecosystem as it revolves around new scalable competitive business models. Battery recycling volumes are still small compared to the expected volumes when automotive, energy storage and other battery applications reach full volumes globally.

MAIN MODELS OF INTERACTION, COLLABORATION, AND OTHER ACTIVITIES AIMED AT DEVELOPING THE ECOSYSTEM AND CREATING MUTUAL BENEFITS

The main mechanisms of interaction between the ecosystem actors are their participation on one hand in the public research projects implemented by the participating research organisations, and on the other hand, the participation of companies in the European platforms and national strategy processes.

Participation in the public research projects covers most of the ecosystem companies. As many of them have parallel proprietary company projects, where they also collaborate with the same research organisations often encouraged and supported by public funding, the interaction between actors in the area of R&D is relatively intensive. However, the interests of companies are mainly focused on their own projects and those actors they collaborate directly with in them, and less on the public research. Interaction between companies is often limited to meetings organised within the public research projects. However, even this may serve as a basis of getting to know each other, build mutual trust and understanding, and identify potential future common interests, and thereby eventually lead into collaboration.

While most companies have focused mainly on their proprietary projects and some may continue to do so also in the planned stage two, there are already some collaborative arrangements between companies, and it is likely these may develop further. Also, companies' interests in influencing the public research agenda seems to be increasing, which may further increase industry relevance of the public research.

Influencing and leading the developments at European platforms gives insight into European and global developments and increases international visibility of the Finnish ecosystem. The former is important for companies and research organisations for identifying potential partners and future international collaborative efforts, and market developments as well as for influencing market developments in Europe. The latter is important in

attracting investments and international collaborations in Finland.

The ecosystem has not prepared a roadmap or a joint action plan. A joint agenda was discussed and defined for public research in collaboration with research institutes and industrial participants in the process for applying Business Finland co-innovation funding: the current BATCircle project and its planned continuation. There are some efforts in using a shared brand especially towards international actors.

The international activities have already been instrumental in increasing the international visibility of the ecosystem and its actors. For example, four Finnish companies (FMG, Outotec, Fortum, Geyser Batteries) took an active role in the new Battery Partnership implementing the European R&I strategies developed by Batteries Europe. Anchor and core ecosystem actors are currently better known internationally in this business area. While this may not have yet led into significant new investments (the possible catalysing effect of BATCircle in the Umicore and BASF investments has not been analysed), it may be expected to do so in the coming years.

GOVERNANCE MODEL

The only governance model is limited to the BATCircle project funded by Business Finland. Based on the requirements from Business Finland, the BATCircle project has a steering committee consisting of industry representatives, clear works package structure and regular progress reporting practices. However, the overall ecosystem governance model as such is coordinative, i.e., information is exchanged between actors and initiatives only to the extent companies are willing to do so as their individual projects are proprietary and thereby largely confidential. There are no joint action plans, milestones, monitoring, etc. efforts, or clear ecosystem level leadership or management. It is likely that the future governance will also be based on the same model.

There are parallel governance arrangements at the national level (national battery strategy) and EU-level (European Battery Alliance, European Batteries initiative). Ecosystem actors participate in drafting and implementing the national strategy and lead a part of the EU-level strategy.

ANALYSIS OF THE STRUCTURE OF THE ECOSYSTEM

The ecosystem is led by a research organisation, Aalto University. The ecosystem members represent both battery metal and component production as well as battery recycling. The former is an existing and globally growing business, whereas the latter is an emerging one. While there are linkages between recycling and production in terms of material flows and to extent also technologies, the ecosystem linkages are much stronger inside produc-

tion on one hand, and between recycling actors on the other. Hence, the ecosystem may also be regarded as consisting of two interconnected ecosystems.

The ecosystem and its leading actors are participating in and thereby influencing both national and European strategic actions aimed at developing the vehicle battery sector and businesses, which can support further internationalisation of the ecosystem.

One of the main challenges for ecosystem development is the fact that there is currently no cell manufacturing in Finland, and there is only one local battery and automotive manufacturer. However, the concerns related to availability, ethicality and CO_2-low production of battery materials and components in Europe are likely to ensure that further investments will be made in Europe. Currently, there are about ten large scale battery manufacturing facilities planned or under construction in Europe with the aim to reach a total capacity of 300 GWh by 2028. The ecosystem may have an important role in attracting some of these investments into Finland.

As the ecosystem structure, also the shared platforms are interconnected. The platform in battery materials and components consists of material flows and shared production technologies, whereas in recycling the platform is the flow of used vehicle batteries using the same materials and technologies. The former can be regarded as partly business and partly knowledge ecosystem as it has features of both. The latter is more like a business ecosystem, as it facilitates different business models based on alternative uses for used batteries, their components and materials.

The ecosystem governance is coordinative rather than shared, as there are no joint action plans or roadmaps for the ecosystem apart from the jointly defined public research agenda. The interaction and collaboration take place mainly in joint projects.

Value of the ecosystem

ADDED VALUE OF THE ECOSYSTEM

Added value of the ecosystem is based on the ecosystems ability to support member companies in their business efforts in the growing international markets of battery materials and recycling of automotive batteries.

Global visibility of the ecosystem, e.g., in Batteries Europe and Batteries Europe Partnership Association (BEPA), can help member companies in accessing international platforms, collaborations, and markets. This improves the ability of the ecosystem members to capture commercial possibilities, but also influences the development of the international market conditions (environmental regulations, international trade agreements, etc., e.g., national, and European battery policies and strategies).

The ecosystem allows companies to pilot and showcase their technologies and thereby convince their inter-

national clients. Access to international collaborations can help member companies identify and understand the implications of the developments of alternative battery technologies and influence national and European R&I funding strategies.

Ecosystem collaboration around public research allows companies to participate in steering public research to better serve their current and future interests, as well as have early access to relevant research results and supply of skilled researchers.

STRATEGIC IMPORTANCE OF THE ECOSYSTEM

The added value of the ecosystem indicates the strategic importance of the ecosystem to the different types of companies. For both large companies and SMEs developing business activities aimed at recycling batteries, the ecosystem and its visibility are strategic assets.

For the companies that focus on raw materials and component production the added value is more limited as they mostly opt for investing in and operating proprietary facilities. Should the situation change, shared facilities might present a future option with potential to increase the strategic importance of the ecosystem. Currently, it is important to understand the potential increase of demand in the market and the new streams of raw materials coming from recycling. In case the whole supply chain would be positioned in Finland (including cell producers that are currently missing) the ecosystem could achieve a critical mass that could benefit companies that focus on raw materials and component production as well. As it stands now, the benefit of the ecosystem is larger for companies further along the value chain (cathode, cell and battery manufacturers, and recycling). So, these companies are not as dependent on the ecosystem as the recycling companies.

ANALYSIS OF THE VALUE OF THE ECOSYSTEM

One of the main added values of the ecosystem seems to be on gaining international visibility and through that access to European strategic actions in this thematic area. International visibility may also help attract further investments into Finland, possibly also cell and/or battery manufacturing.

The strategic value of the ecosystem is evident for members developing businesses related to vehicle battery recycling, as this is an emerging market globally. The stronger the local ecosystem, the better possibilities it offers for developing internationally competitive recycling solutions and related businesses.

For the companies active in production of battery materials and components, the strategic importance of the ecosystem is currently less, but may increase if the ecosystem becomes stronger and especially if investments are made into local cell and battery manufacturing.

Role of Business Finland and public support

WHAT HAS BEEN THE ROLE AND ADDED VALUE OF BUSINESS FINLAND AND ITS INSTRUMENTS IN SUPPORTING THE ECOSYSTEM IN DIFFERENT PHASES?

Business Finland main added value has originated from funding. The preparatory stage was funded using co-creation funding model and the first (current) stage using the co-innovation funding model.

Business Finland has encouraged and supported participation at the European level, both in the Batteries Europe initiative, but also into large European IPCEI projects, of which the French project has already been launched and the German project is waiting for approval. The Finnish participation is linked to e.g., further investments at Harjavalta.

WHAT COULD BUSINESS FINLAND DO (IN COLLABORATION WITH OTHER PUBLIC ACTORS) IN THE FUTURE TO BETTER SUPPORT THE DEVELOPMENT OF THE ECOSYSTEM?

Business Finland has been active in trying to attract investments relevant for BATCircle into Finland. The aim is to get at least one industrial cell or battery manufacturing unit into Finland.

The adoption of environmental footprint models could support the development of the ecosystem. Efforts are being made and supported by Business Finland (BatTrace). Sustainability is also strongly featured in the planned BATCircle 2.0 activities.

Companies typically manage challenges and questions related to regulations and logistical issues themselves. However, the public sector could make an effort to further streamline these processes. A strict regulatory regime is not a problem as such if it is implemented in a transparent and predictable manner.

Funding for collaborative activities remains important. Ecosystem actors propose that Business Finland should consider the possibility to be more flexible in the funding, especially in view of emerging markets. Limiting co-innovation funding to max 2 or even 3 years may not be viable if the markets are expected to open in more than 5 years. Even if the funding focuses on pre-market activities, leaving a gap of several years between funding and opening of the markets is not viable, especially in view of emerging markets where business models are not yet established.

ANALYSIS OF THE ROLE OF PUBLIC SUPPORT

The ecosystem has used Business Finland co-creation and co-innovation funding, but no orchestration funding. In addition to funding, Business Finland has supported the ecosystem participation in national and European strategic activities, as well as promoted investments into local battery material and component production, battery recycling facilities, and cell and battery manufacturing facilities.

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INTERVIEWS

Professor Mari Lundström, Aalto University

Jaakko Soini, Fortum Battery Solutions

Tuomas van der Meer, Metso Outotec

Janne Marjelund, Umicore Finland

Kari Keskinen, Business Finland

AIL / MEX Finland

General information identifying the ecosystem

OFFICIAL ECOSYSTEM NAME

Advanced Industrial Loops (AIL) is a Growth Engine initiative proposed by MEX Finland ry to Business Finland. Business Finland has funded the AIL initiative as a Growth Engine orchestration project. While AIL may sometimes be referred to as the ecosystem, in practice the ecosystem is structured around MEX Finland and AIL is merely one of the initiatives in which the actors are currently engaged.

SCOPE AND FOCUS OF THE ECOSYSTEM

The AIL initiative focuses on the orchestration of the ecosystem and the initiation of new member-driven development projects, while the actual collaboration takes place in projects.

As the members of the ecosystem participate in several initiatives, identifying a clear and concrete focus for the ecosystem is challenging. The ecosystem's core is the equipment and machine manufacturing sector, and the activities undertaken by the ecosystem actors aim to support the growth and internationalization of manufacturing companies in Finland. The ecosystem integrates product design, manufacturing and end-user processes into continuous learning and feedback loops to develop new offerings and business models leveraging digitalization and an ecosystem way of working. Sustainability and digitalisation in its various forms and industry 4.0 related themes feature strongly in the ecosystem's activities. Operationally AIL initiates new projects and demonstrations to speed up market entry and strengthen competitiveness. Key technologies to be used are robotics, AI, machine learning, cloud computing, and 5G. In addition, MEX Finland aims to strengthen the image of mechanical engineering to revitalize Finnish education and competence-building in mechanical engineering.

LAUNCH DATE

The actual launch date of the ecosystem can be defined as the date of the approval of the AIL growth engine application in November 2019. The MEX Finland association was registered by private individuals working for consultancy company Synocus during Spring 2019.

A SHORT HISTORY HOW THE ECOSYSTEM HAS DEVELOPED INTO WHAT IT IS NOW

The origins of the ecosystem are found in the shared concerns of the manufacturing industry companies regarding the access to human capital with advanced manufac-

turing competences in Finland. This concern is based on the lack of interest among students and young people towards manufacturing industry, and the subsequent narrowing of the relevant educational offering in higher education institutions. The supply of graduates with relevant competences is not enough to compensate the demand caused by manufacturing professionals retiring in increasing numbers. Another shared concern among participating companies is the competitiveness of the Finnish manufacturing sector. Additionally, leading companies have identified the vulnerability of their long supply chains during the COVID-19 pandemic putting emphasis on sustainability in its broadest sense.

The development towards the MEX Finland ecosystem started in 2016 with the formation of a network called Lean Competence Center Finland (LCCF), with Valmet Automotive as the nodal organization. Synocus was the orchestrator of this network, and later Ponsse, ABB, and Wärtsilä joined the network. Simultaneously Sandvik had initiated discussions about collaboration with RWTH Aachen in Germany. Subsequent discussions between companies and research organisations led by Synocus and Sandvik resulted in the Digital Design and Manufacturing Ecosystem (DDME) Business Finland sponsored orchestration project, which was implemented between May 2017 and June 2019. The focus of DDME was competence development, international knowledge transfer and attractiveness of Finland as a manufacturing location. One of the main outcomes of DDME was the €12M[57] Intelligent Manufacturing in an Ecosystem (IME_{58}) co-innovation project of 12 participating organisations led by Sandvik. It was launched in June 2018 and is planned to continue until the end of 2020. DDME orchestration funding was allocated to Synocus, who was responsible for planning and implementing joint activities. The Lean Competence Center Finland initiative was purely working on a commercial funding basis, and never applied for financing from Business Finland.

As Business Finland at the end of 2018 encouraged Sandvik and Synocus to apply for funding for a Growth Engine initiative it was agreed to merge the two networks where Synocus was engaged, around Valmet Automotive and around Sandvik, into MEX Finland, which was established to continue the planning and development of joint activities. The follow-up orchestration funding, i.e., the AIL initiative was allocated to MEX Finland ry. Synocus remained as the day-to-day operative actor, but the leadership of the orchestration activities as well as the ecosystem was transferred to the board of MEX Finland, representing the manufacturing industry.

[57] Volume of public research is €3m of the total
[58] Finnish abbreviation of this project is ÄVE

The current main activities of the ecosystem are the AIL orchestration project and the preparations of new member-driven development projects. MEX Finland members also participate in parallel in Business Finland programmes as well as in other collaborative research and innovation initiatives outside MEX Finland.

Discussions concerning future activities and potential new partners of the ecosystem were initiated earlier in the year under the guidance of the MEX Finland board and supported by Synocus. However, the discussions have been delayed because of three main reasons. First was the need to clarify the ecosystem leadership arrangements. The second reason has been the COVID-19 crisis. The third reason is that some of the anchor companies were waiting for decisions regarding related funding[59], which will have an impact on what they are interested in and how they are able to operate on in the MEX Finland platform. The planning for joint activities and expansion to new companies under the MEX Finland ecosystem umbrella continued throughout 2020 in the board of MEX Finland and are expected to be further stepped up based on the Challenge Competition results in December 2020.

In June 2020, MEX Finland selected a new board, where Wärtsilä took over the chair from Sandvik. The current leadership of MEX Finland is more balanced between anchor, midcap and SME companies. New activities are being planned as the identification and attraction of new anchor and member companies continues. The day-to-day operations of the ecosystem are still managed by Synocus.

BASIC QUANTITATIVE INFORMATION

The core of the ecosystem consists of MEX Finland members, which are anchor organisations, member organisations and observers. During 2019 MEX Finland had 15 companies as paying members, 7 anchor organisations, large and mid-cap companies operating in their respective international markets, and 8 SME companies.

The total turnover the ecosystem actors within the scope of the MEX Finland AIL initiative was €4.42b in 2018, At the same time, total exports was €4.23b and the number of jobs was 9010. The ecosystem roadmap projects that the new turnover, exports, and jobs created by 2025 in Finland will be €1.43b, €1.27b and 740, respectively. Further growth is expected outside Finland. By 2029, new turnover is expected to reach €2.4b and exports €2.17b, hence increasing current business volumes by 50%. Naturally, there are other contributing factors enabling this growth as well.

[59] Some of the leading companies have applied funding from the Business Finland Challenge Competition for Leading Companies scheme. Decisions were originally supposed to be made in the summer but have been delayed e.g. because of COVID-19.

ANALYSIS OF THE GENERAL SITUATION OF THE ECOSYSTEM

AIL is an ecosystem orchestration project focusing on the equipment and machine manufacturing sector in Finland. It aims to support the development of an ecosystem which integrates product design, manufacturing and end-user processes into continuous learning and feedback loops to develop new offerings and business models leveraging digitalization and an ecosystem way of working.

MEX Finland ry was initiated by Synocus, which still manages the day-to-day operations of MEX Finland ry. However, participating companies are now organized into the board of MEX Finland which has the legal and strategic responsibility of MEX Finland ry.

New ecosystem activities are being planned, but not yet implemented because of COVID-19 and because the ecosystem is currently waiting for some of the leading companies to clarify their plans towards the ecosystem and its activities. These plans foresee e.g., gradual increase in ecosystem membership.

Structure of the ecosystem

ECOSYSTEM LEADING AND CORE ACTORS AND THEIR RESPECTIVE ROLES

Ecosystem leading actors are 7 large and mid-size anchor companies. These are ABB, Fastems, Ponsse, Roima Intelligence, Sandvik, Valmet Automotive and Wärtsilä. These are all active in different product markets but have identified similar AIL related challenges in their manufacturing operations.

Among these anchor companies, Sandvik and Valmet Automotive were originally the most active ones in developing ecosystem level collaboration. However, all other anchor companies have experience in collaboration both within their respective value chains, and with other companies in public research initiatives. Currently, the ecosystem leadership is quite balanced between the anchor companies with Wärtsilä chairing the MEX Finland board. Other anchor companies represented in the MEX Finland board are Sandvik, Fastems and Roima Intelligence.

The core actors also include several SMEs and a consultancy company. Paying MEX Finland SME members in 2020 were 8 SME members Creanex, Johnson Metal, JTA connection, Metlab Nomet, Salon Konepaja, Synocus, and Tasowheel. Tasowheel acts as the SME representative in the MEX Finland board.

The orchestrating partner of the ecosystem is Synocus. Their role is to orchestrate the ecosystem and its activities at the practical level. Synocus has been supporting the preparation of the ecosystem roadmap, establishment of MEX Finland, and other ecosystem activities. This has been necessary for two reasons. First, there has been a need for a trusted third party to facilitate the mutual discussions and identification of common interests. Second,

MEX Finland is an association run by a board without any staff, so there has been a need to engage people for managing day-to-day operations. The first role is still highly now focusing on generating new projects but also looking to attract potential new members. The latter will remain relevant as long as the association remains without staff. Synocus has their own representative at the MEX Finland board. Synocus receives a compensation for their work, partly from the Business Finland AIL funding and partly from the ecosystem companies (AIL project fee).

ECOSYSTEM OPERATIONAL ENVIRONMENT

The ecosystem extends to four directions. First one is the companies in the respective supply chains of the anchor and member companies. The second one is the clients of the anchor and member companies, and depending on business models, possibly also clients of these clients. The third direction are companies in competing ecosystems, and the fourth one is companies with similar challenges active in different product markets.

Anchor companies already have experience collaborating in the first two directions, i.e. supply chains and clients. There is clearly less interest in collaborating with competitors, although geographically these may be divided into two groups: European and non-European. Collaboration with the former ones is a valid option, especially under the European research and innovation initiatives and programmes. Interest in collaborating with non-European might be seen less attractive, especially with ones coming from low-cost countries.

The fourth direction seems to be the most interesting direction for the ecosystem to develop, at least for the coming few years. Efforts are already made to identify and attract new partners for the coming new joint ecosystem activities. Here Synocus has been actively engaging members from another ecosystems initiative it orchestrates, Intralogistixx, to identify common interests in the intersection between manufacturing and logistics.

The main issue in the political dimension is how international trade policies, possible sustainability and safety concerns, and potential international trade conflicts shape the landscape. This is especially the case with respect to the attractiveness of geographical locations in view of different manufacturing activities. For example, the previous trend of manufacturing mostly in low-cost countries, such as China, has changed – at least partially – towards more effective, flexible, and increasingly digitalised manufacturing units in Europe closer to core research, development and innovation activities.

This is also how locations such as Finland may be competitive globally, subject to the availability of necessary skills and competences. The manufacturing skills and competences has been one of the main concerns of manufacturing industry companies already for a long time, in fact this concern has been the origin of this eco-

system. Here the established research collaboration with Professor Takahiro Fujimoto, leading expert of the Toyota Production System, from University of Tokyo has been involved in discussions about new MEX Finland projects.

THE SHARED PLATFORM OF THE ECOSYSTEM

The ecosystem has no local shared virtual or physical platform, that would support the ecosystem development locally or internationally. The only "shared platform" the ecosystem has is the shared understanding of similar challenges each manufacturing company is facing and will face in the future. The ecosystem might be better described as a knowledge ecosystem rather than a business ecosystem.

MAIN MODELS OF INTERACTION, COLLABORATION, AND OTHER ACTIVITIES AIMED AT DEVELOPING THE ECOSYSTEM AND CREATING MUTUAL BENEFITS

The main mechanisms of interaction between the ecosystem actors are their participation in the activities initiated and run under MEX Finland. One of the most important of these has been the roadmap work done in the context of the AIL Growth Engine orchestration initiative and the subsequent discussions about new joint projects. The role of the MEX Finland board has been and will likely be very important, supported by the practical day-to-day work of Synocus.

The other context where companies interact with each other and with research organisations is the collaborative research projects, particularly in the light of two of the anchor members, ABB and Sandvik, emerging as winners in the Business Finland Challenge Competition. However, this work is not coordinated with the work done as part of AIL.

GOVERNANCE MODEL

The governance model of the ecosystem consists of the MEX Finland board managing the strategic level and Synocus managing the day-to-day implementation. MEX Finland acts as the body for defining the scope and focus of shared activities. The governance model is relatively clear in terms of leadership and management. However, it is mostly coordinative in practice, i.e., information is exchanged between actors and initiatives. The information sharing with external parties seems to be rather limited, e.g., universities do not seem to be aware of the underlying causes for the suspension of the ecosystem activities. The ambition for 2021 is to establish a way that universities more easily could join MEX Finland ry as members.

ANALYSIS OF THE STRUCTURE OF THE ECOSYSTEM

MEX Finland has a rather balanced membership consisting of large multinational corporations, mid-cap companies and SMEs. While its origins are in the Tampere re-

gion, the ecosystem sees clear potential to grow much further in Finland.

The ecosystem builds on various earlier collaborations between the members, as well as on important global manufacturing industry trends, especially sustainability, industrial internet, and digitalisation. Internationalisation is also strongly featured in the activities of the ecosystem.

The ecosystem does not have an identifiable shared platform to facilitate business development. The common denominator for the ecosystem actors is knowledge and skills related to sustainability, digitalisation and industrial internet. Hence, AIL is not a business ecosystem, but rather a knowledge ecosystem.

The ecosystem members interact and collaborate in several different ways and constellations. MEX Finland and AIL cover only parts of these interactions.

Value of the ecosystem

ADDED VALUE OF THE ECOSYSTEM

Most of the added value of the ecosystem originates from joint activities executed by the MEX Finland association. MEX Finland provides a platform where manufacturing companies come together to discuss common interests, identify common challenges, and prepare joint actions to address these challenges.

Another clear added value of joint activities has been the knowledge transfer from Germany and Japan. Further knowledge transfer is foreseen in the roadmap from Europe as well as USA and Japan. This represents a potential added value at least to the extent companies favour local competences and collaboration over internal ones.

STRATEGIC IMPORTANCE OF THE ECOSYSTEM

Strategic importance of advanced manufacturing technologies and competences may – at least temporarily – be very high for some companies, especially in view of industrial internet and increasing intelligence of their products and services.

However, there is one direction which may create significant added value and therefore be of strategic importance. That is adopting advanced manufacturing competences and technologies from more advanced sectors to less advanced sectors, much like Nokia did by adopting advanced logistics and manufacturing models from the automotive industry to create a major competitive advantage in the telecom sector. Another more recent example is the strong growth of Valmet Automotive, and its recently awarded IPCEI project.

ANALYSIS OF THE VALUE OF THE ECOSYSTEM

The main added value of the ecosystem originates from joint activities launched to implement the MEX Finland

roadmap, including knowledge transfer between the companies and internationally.

The strategic importance of the topics included into the MEX Finland roadmap is undoubtedly high for all manufacturing companies as industry 4.0 developments and digitalisation continue in global manufacturing networks and businesses. However, to what extent members implement the necessary developments under joint ecosystem activities and to what extent individually or in other collaborative constellations, will eventually decide how important the ecosystem strategically is for the member companies.

ROLE OF BUSINESS FINLAND AND PUBLIC SUPPORT

WHAT HAS BEEN THE ROLE AND ADDED VALUE OF BUSINESS FINLAND AND ITS INSTRUMENTS IN SUPPORTING THE ECOSYSTEM IN DIFFERENT PHASES?

The main added value of Business Finland has clearly originated from funding. Funding has been received for several different ecosystem and other joint projects. The currently active project is the AIL orchestration project which is funded using Growth Engine orchestration funding. The already ended IME co-innovation project was funded using the co-innovation funding model.

In addition to the funded projects, Business Finland has supported the development of MEX Finland and especially encouraged the anchor companies to take stronger leadership of MEX Finland and joint activities. While it may have been necessary for a third party – in this case the orchestration partner Synocus – to lead the initial build-up of the ecosystem, a business ecosystem cannot continue to develop under the leadership of an actor who is not dealing with the same key challenges the ecosystem is established to address.

WHAT COULD BUSINESS FINLAND DO (IN COLLABORATION WITH OTHER PUBLIC ACTORS) IN THE FUTURE TO BETTER SUPPORT THE DEVELOPMENT OF THE ECOSYSTEM?

According to ecosystem members, funding for research, competence development and transfer of international knowledge are both areas where Business Finland should continue its support. Furthermore, the support should better align with the needs, especially with respect to time. This is particularly relevant in areas where competence development requires longer-term research activities. There should also be more flexibility in timing, as not all companies can start activities exactly at the same time.

Ecosystem members also feel that current policy measures and schemes are not suitable to address shared concerns of companies. For example, little or no support is available for addressing concerns related to education and training.

According to ecosystem members, Business Finland has been pushing to set a very high ambition level for the ecosystem, possibly too high. While high ambition can be good, too high may be unrealistic and result in reducing commitment of companies. This refers on one hand to the vision of the ecosystem (globally leading), and on the other hand to the requirement for all participating SMEs to have the ambition to go into international markets immediately. This may often not be realistic, and SMEs can also benefit and grow from supplying large international companies.

Business Finland is perceived by ecosystem members to offer many isolated and narrow initiatives without a clear underlying strategic direction. In this respect the guidance of Business Finland is also actively asked for by the board of MEX Finland, and this relates to innovation activities both in the national context, with possible financial support from Business Finland, and the engagement in larger Horizon Europe undertakings. Business Finland has been actively presenting the evolving opportunities on a quarterly basis to MEX Finland.

ANALYSIS OF THE ROLE OF PUBLIC SUPPORT

The ecosystem has been able to benefit from ecosystem orchestration funding as well as co-innovation funding for joint activities. While these have been successfully used for their respective purposes, the ecosystem has identified further needs to which they have not been able to find support, e.g., education and training. Furthermore, the Business Finland offering is perceived as rather fragmented and limited by the ecosystem members.

Ecosystem members are somewhat critical towards the need to set very ambitious, yet loose and far-fetched, objectives for the ecosystem.

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Professor Kari T. Koskinen, Tampere University

Juha Päivike, Wärtsilä Finland Oy, Chair of MEX Finland since May 27, 2020

Pasi Julkunen, Mexlink Oy (formerly Sandvik and Chair of MEX Finland)

Kari Koskela, Business Finland

APPENDIX D. STUDY RESULTS: WEBSCRAPING AND NETWORK ANALYSIS

INTRODUCTION & METHODOLOGY

In this chapter we present the results of the network analysis based on webscraping the websites of ecosystem organisations. In order to get an understanding of the level of collaboration we analysed whether the websites of ecosystem members mentioned other ecosystem members. When collaboration is publicly mentioned on a website this usually illustrates a stronger bond than when this is not the case. Clearly, results from webscraping are primarily indicative as the data does not paint the full picture. However, as the results will show, the findings are quite insightful.

Data collection: *First the URL's of the domains (websites) of the ecosystem participants were collected as a starting point for the webscraping algorithm. The algorithm visits the pages, extracts the data, and follows the hyperlinks on each page to other pages of the same domain, on which these steps are repeated till the scraper has visited all the pages of each particular domain*[60]*. For the purpose of this study we focused on the "html" and "pdf" data extractions as these are common and relevant data types for the subsequent analysis.*

Data analysis: *The data for each ecosystem participant was then searched for linkages to other participants of the same ecosystem. These linkages are identified in two distinct ways:*

- *Text references; the text scraped from the website is searched for references to the other ecosystem participants. Where relevant case-sensitivity and name variants (e.g. University of Jyväskylä, Jyväskylän yliopisto, JYU) were taken into account.*
- *Hyperlink references; the webscraped data is searched for URL-hyperlinks to the domains of other ecosystem participants.*

[60] For some very large domains the number of pages has been limited to the first 100.000 pages of the domain

Quality control: *Combining these two searches resulted in a dataframe that provided for each ecosystem participant[61] an overview of the linkages to other participants in the same ecosystem. A random sample of these linkages has been inspected for quality control. In general the linkages indeed capture references to ongoing collaboration initiatives in an ecosystem (e.g. organisation A reporting on their website: "we are starting this exciting project in collaboration with organisation B"). Encountered obvious false positives/negatives were solved in an iterative process of adapting the code, yet some abbreviations were too common to distinct (e.g. the organisation "ITS" and the possessive pronoun "its").*

Methodological limitations: *Data is limited to the online footprint of organisations, when websites are minimalistic results will be limited. Larger organisations tend to have a larger online footprint (but also collaborate more simply due to size). The data only suggests binary collaborations (yes or no), no insights into the strengths of the collaborations are available. No insights into the type of collaborations are available (ecosystem relevant or not). Some organisations bar online scrapers, although only a few were encountered in this study. Some organisation names are more prone to false positives/negatives (generic/short names).*

As already mentioned, the results of this methodology should not be interpreted as the literal (missing) collaborations between the ecosystem members as no data on for instance project collaborations was available. The data does show an indication of how connected the organisations in the ecosystem are, how many organisations are highly or not very connected and how many actors (can) fulfil a key role in connecting other actors in the network. To present this the following indicators will be shown per ecosystem in an table:

- **Total number of actors:** This shows how many organisations take part in the ecosystem. Generally speaking, ecosystems with fewer members will have the tendency to show relatively more interconnections (higher network density) as it is easier to be connected to a handful of organisations than to +50 organisations. However, as the data will show, this rule of thumb is not always true as large ecosystems can also be dense and vice versa.
- **Network density:** This shows the number of interconnections in the ecosystem relative to the theoretical maximum number of possible connections. For this analysis organisations are only included if they have at least one connection to another organisation in the ecosystem. In simple words this indicator answers the question: *"Is everybody connected to everybody?"*

[61] The domains of four organisations could not be scraped. Yet these organisations can still be part of the network analysis, as other organisations are still able to reference them.

- **Organisations with in ranges of degree centrality:** This shows the number of highly connected organisations, that are connected to more than half of the other organisations in the ecosystem. It also shows the number of not very well connected organisations, that are connected to less than a fifth of the ecosystem. As well as the organisations that are decently connected, to 20%-50% of the other organisations. In simple words this indicator answers the question: *"How many actors are highly or not very well connected to others?"*
- **Organisations with in ranges of betweenness centrality:** This shows the number of organisations that are (un)able to connect others within the ecosystem. Technically speaking the indicator calculates how often each organisation is on 'the shortest route' between two other organisations. Organisations that can be the connecting party in about 10% (or more) of the cases are labelled as important connectors and when this is 1% (or less) the organisation is labelled as not important for building relations. In simple words this indicator answers the question: *"How many actors (can) connect others?"*

Finally, to better see groupings of organisations within the ecosystem, we have forced the algorithm to apply different colours to **subcommunities** within the networks of the ecosystems. These subcommunities, also called sub-clusters, are formed mainly when organisations are better linked to each other than to other organisations in the network. Not all such forced subcommunities will make sense in practice, however when analysing the subcommunities they, in some cases, show interesting groupings of organisations with similar profiles.

RESULTS FOR INDIVIDUAL ECOSYSTEMS

In the paragraphs below the results of the network analyses based on webscraping are presented for each of the ecosystems. Ecosystems are presented in alphabetic order. At the start of each ecosystem paragraph a short description of the ecosystem is presented as a reminder of the area/sector in which the ecosystem is active.

NETWORK ANALYSIS: **Adaptive Industrial Loops (AIL)**

Adaptive Industrial Loops is the ecosystem aimed at the digital and sustainability transformation in the engineering and manufacturing of industrial equipment and related advanced manufacturing services.

The results of the network analysis show overall that the organisations within the AIL ecosystem are, relative to the other ecosystems, averagely connected to each other. In Table 6 it shows that more than a third of all possible connections are present within the network of the eco-

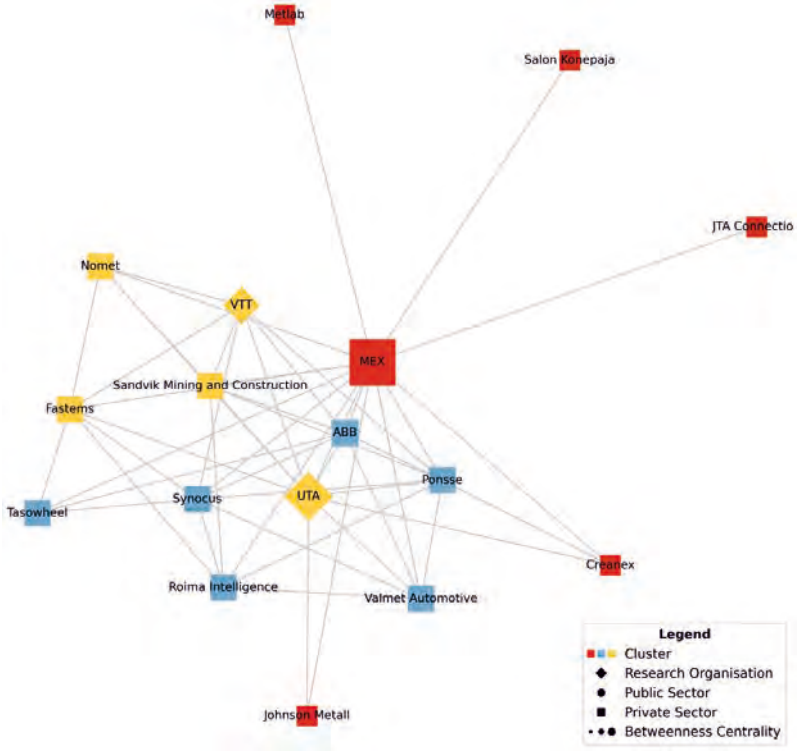
TABLE 6. Key network indicators of the Adaptive Industrial Loops ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?"*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
17	36%	>50%	3	>10%	1
		20-50%	9	1-10%	7
		<20%	5	<1%	9

system. Quite a large amount of organisations, 3 out of a total of 17, are connected to more than half of the other organisations in the ecosystem. Where one organisation, MEX Finland, is linked to nearly everyone and is clearly the best positioned in the ecosystem to build relationships between other organisations in the network.

Figure 36 shows a schematic overview of the network of the AIL ecosystem. In this graph the central position of MEX is shown very clearly. The companies linked to MEX are, however, not always well connected to others in the ecosystem. The bottom left of the network shows a higher density, that is mostly revolving around research organisations, like the University of Tampere (UTA) and VTT, and a hand full of large companies, like ABB, Sandvik and Ponsse. Synocus is a consultancy firm that runs the practical organisation of the ecosystem and is therefore also well connected to others. The subcommunities shown all include quite similar organisations often focusing on manufacturing and automatisation.

FIGURE 36. Schematic overview of the network of the Adaptive Industrial Loops ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **BatCircle**

BatCircle is the circular ecosystem of battery metals consortium aimed at improving the manufacturing processes of the mining industry, metals industry and battery chemicals, and to increase the recycling of lithium-ion batteries.

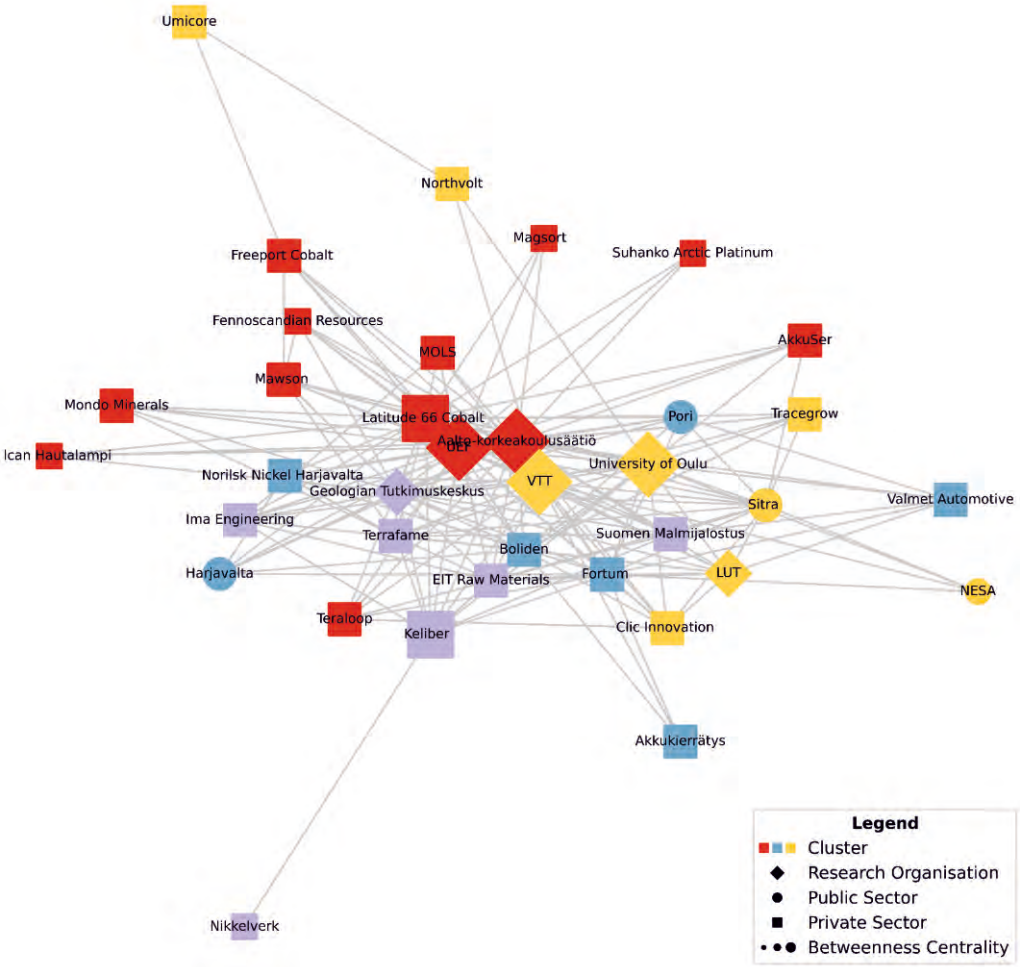
The BatCircle ecosystem includes 38 actors, which are active in bio and circular economy sectors. However, for two of these actors no connections to any of the other members in the ecosystem were found. As presented in Table 7, the BatCircle network is an averagely dense network, realising 30% of the total possible connections. The core of the network is quite dense, as seven organisations are linked to more than half of the ecosystem. However many actors are outside the core of the network, almost half of the organisations is linked to less than 20% of the other organisations. Four actors can play a strong role in linking network members to each other as they are well positioned for this.

Most actors in this ecosystem are private organisations. However, the most central actors in this ecosystem are research organisations, Aalto University (Aalto-korkeakoulusäätiö) and the University of Eastern Finland (UEF), as they are connected to over 80% of organisations in the ecosystem. Similarly, also VTT, Geologian Tutkimuskeskus, and the University of Oulu also have many connections with others in the ecosystem. Latitude 66 Cobalt and Fortum are companies that are highly connected within the BatCircle ecosystem. As depicted in Figure 2, the ecosystem shows 4 subcommunities. However, when looking into the actors of the specific subcommunities no thematic difference could be recognised.

TABLE 7. Key network indicators of the BatCircle ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
36 (+2 with no connections to other organisations)	30%	>50%	7	>10%	4
		20-50%	12	1-10%	10
		<20%	17	<1%	22

FIGURE 37. Schematic overview of the network of the BatCircle ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **CleverHealth**

CleverHealth is the health technology ecosystem in which companies and health care experts develop better treatment solutions for Finns and successful export products for companies based on health, welfare and healthcare data.

The CleverHealth ecosystem consists of 18 organisations. The network density is relatively high (54%). This could be partially attributed to a small size of the network. Nearly all organisations in the ecosystem are collaborating with at least 20% of network members, and about half of all organisations are connected to more than 50% of actors in the CleverHealth ecosystem. For one organisation, Noona Healthcare, no connections to other network members were found. As the network is so dense, few organisations in the network are likely to act as a bridge to access other members. HUS (Helsinki University Hospital) and Tieto (digital services and software company), are in that respect best positioned, but all actors can be reached through other parties as well.

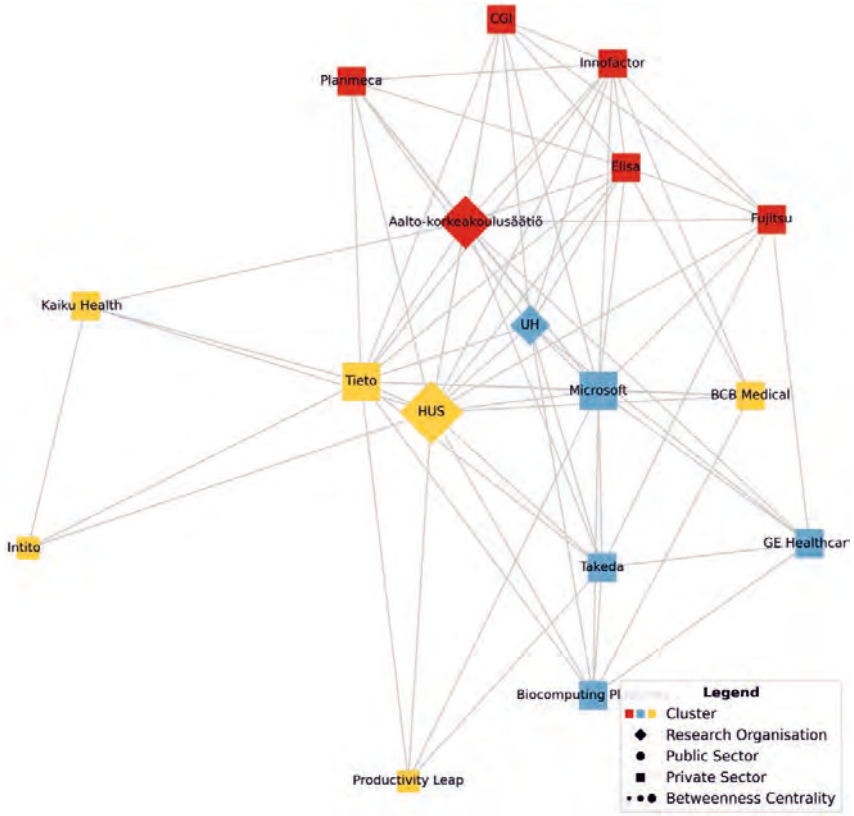
Figure 38 provides a view on the network of the CleverHealth ecosystem. HUS (Helsinki University Hospital), Microsoft, Tieto and Aalto University (Aalto-korkeakoulusäätiö) are connected to over 70% of organisations in the network. Thus, research organisations and large software companies form the core of the network. The red subcommunity mainly consists of software/IT companies,

such as Elisa, Innofactor, Fujitsu, CGI. However, Microsoft is more connected to UH (University of Helsinki), pharmaceutical companies and manufacturers of health technologies within the blue subcommunity, such as Takeda, Biocomputing Platforms, BCB Medical. Private companies in the yellow cluster are all more connected to HUS (Helsinki University Hospital). These companies are active in IT, digital health and business consultancy areas.

TABLE 8. Key network indicators of the CleverHealth ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
17 (+1 with no connections to other organisations)	54%	>50%	8	>10%	2
		20-50%	8	1-10%	8
		<20%	1	<1%	7

FIGURE 38. Schematic overview of the network of the CleverHealth ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **Elastronics Connected Health**

Elastronics Connected Health is the ecosystem aimed at developing small, wireless patient monitors and wearable electronics and a surrounding ecosystem for third-party value creation.

The Elastronics Connected Health ecosystem consists of 16 organisations. However, the scraping of websites revealed no connections for two organisations to the network. Out of 14 actors in the network, seven are connected to more than half of all network members. The network density is above average, since 44% of all possible connections are realised in the network. Within this relatively densely connected network, four organisations are well positioned to introduce organisations to each other. These organisations are VTT (Technical Research Centre of Finland), GE Healthcare, UTA (University of Tampere) and Suunto.

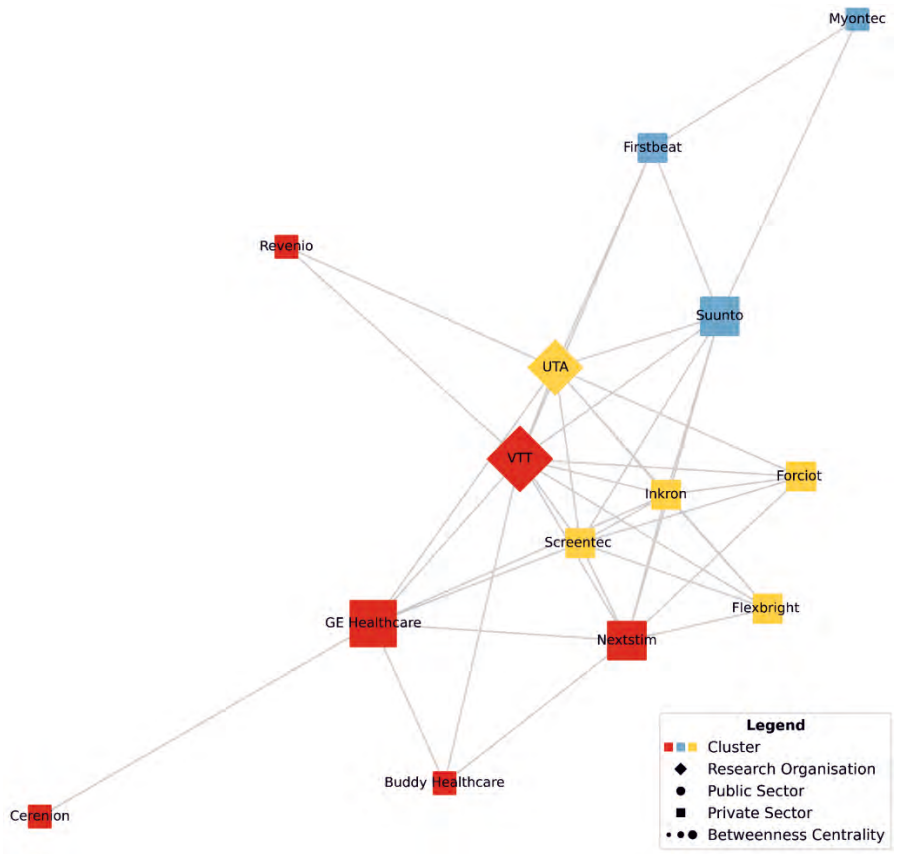
Table 9 presents the results for the ecosystem. Out of 14 actors in the network, seven are connected to more than half of all network members. The network density is above average, since 44% of all possible connections are realised in the network. Within this relatively densely connected network, four organisations are well positioned to introduce organisations to each other. These organisations are VTT (Technical Research Centre of Finland), GE Healthcare, UTA (University of Tampere) and Suunto.

Figure 39 illustrates that the network could be divided into three subcommunities. In the red cluster VTT has a central role and is connected to predominantly large medical/health technology companies, such as GE Healthcare and Nextstim. The subcommunity also includes a smaller company, Revenio, as well as two start-ups/spin-offs Cerenion and Buddy Healthcare. The yellow cluster also consists of (medical) technology companies, with a mix of mature and start-ups companies. The University of Tampere, VTT, Screentec and Nextstim are the connecting organisations between the two subcommunities. The smallest, blue cluster of companies (Myontec, Suunto and Firstbeat) includes companies that produce smart and health clothing.

TABLE 9. Key network indicators of the Elastronics Connected Health ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
14 (+2 with no connections to other organisations)	44%	>50%	7	>10%	4
		20-50%	4	1-10%	4
		<20%	3	<1%	6

FIGURE 39. Schematic overview of the network of the Elastronics Connected Health ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **FinnGen**

FinnGen is the personalized medicine ecosystem aimed at better understanding how our genome affects our health in order to develop new, personalised and/or more efficient drugs as well as create more reliable solutions for health care and anticipation and prevention of diseases.

The FinnGen ecosystem comprises 22 actors, of which one organisation was not linked to other organisations. The density of the network is relatively high (45%). Out of 21 organisations, only three are collaborating with less than 20% of the network. Other network members have linkages to many organisations within the FinnGen ecosystem. As a result, only 2 actors (Biocomputing Platforms and the University of Helsinki) in the ecosystem are likely to act as connectors between network members.

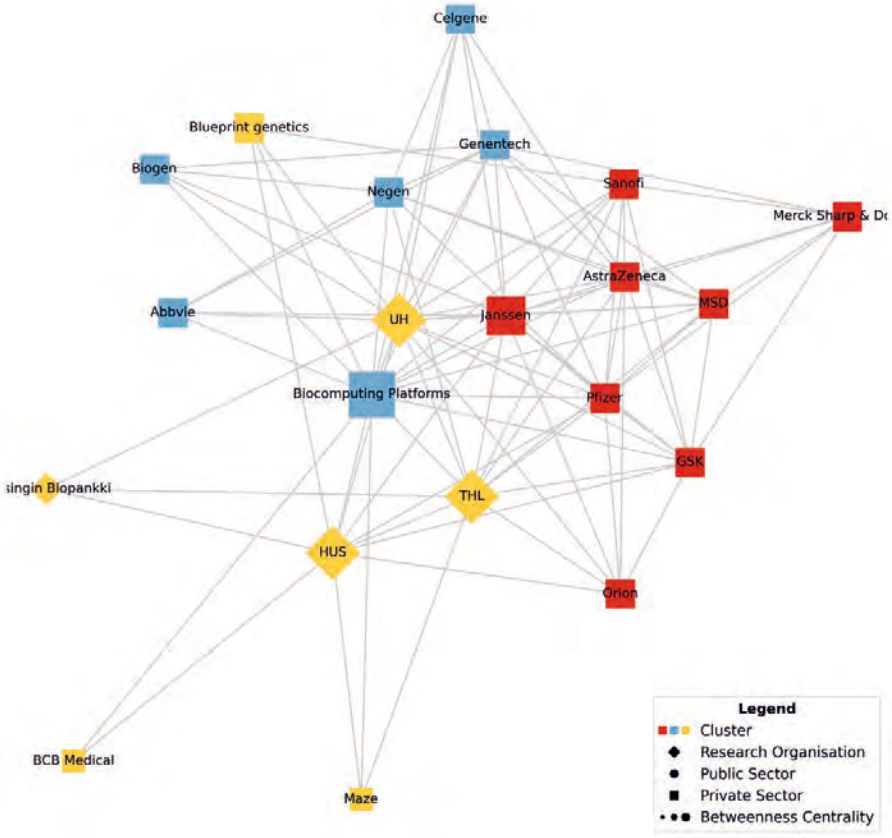
Based on Figure 40, Biocomputing Platforms, University of Helsinki (UH) and Janssen have a central role in the ecosystem and in their respective subcommunities. The network is dominated by private companies. Only the yellow cluster has four research organisations, which form the core of this subcommunity. Among these organisations are UH, the Finnish institute for health and welfare (THL), Helsinki University Hospital (HUS) and Helsingin Biopankki. The red cluster consists of large pharmaceutical companies/corporations, such

as AstraZeneca, Pfizer, GSK (GlaxoSmithKline), Sanofi, Orion, Merck Sharp & Dohme and its 'daughter' company MSD. The blue cluster includes a combination of biotechnology companies (Genentech, Biogen), (bio)pharmaceutical companies (Abbvie, Celgene) and other health research companies (Negen).

TABLE 10. Key network indicators of the FinnGen ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
21 (+1 with no connections to other organisations)	45%	>50%	9	>10%	2
		20-50%	9	1-10%	9
		<20%	3	<1%	10

FIGURE 40. Schematic overview of the network of the FinnGen ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **ForBest**

ForBest is the ecosystem aimed at developing technologies for producing highly processed products from agricultural residues and wood biomass to replace the use of fossil and other environmentally harmful raw materials.

The ForBest ecosystem has 29 organisations, however, 5 of these do not have linkages to other organisations in this ecosystem. The share of realised connections in the network is 27%, which is below the average across all ecosystems. The network does not seem to have many central actors which are connected to more than 50% of network members, except three – Fortum, Aalto University (Aalto-korkeakoulusäätiö) and Åbo Akademi University. Thus, research organisations are the best-connected members in the network.

TABLE 11. Key network indicators of the ForBest ecosystem. Technopolis Group 2020

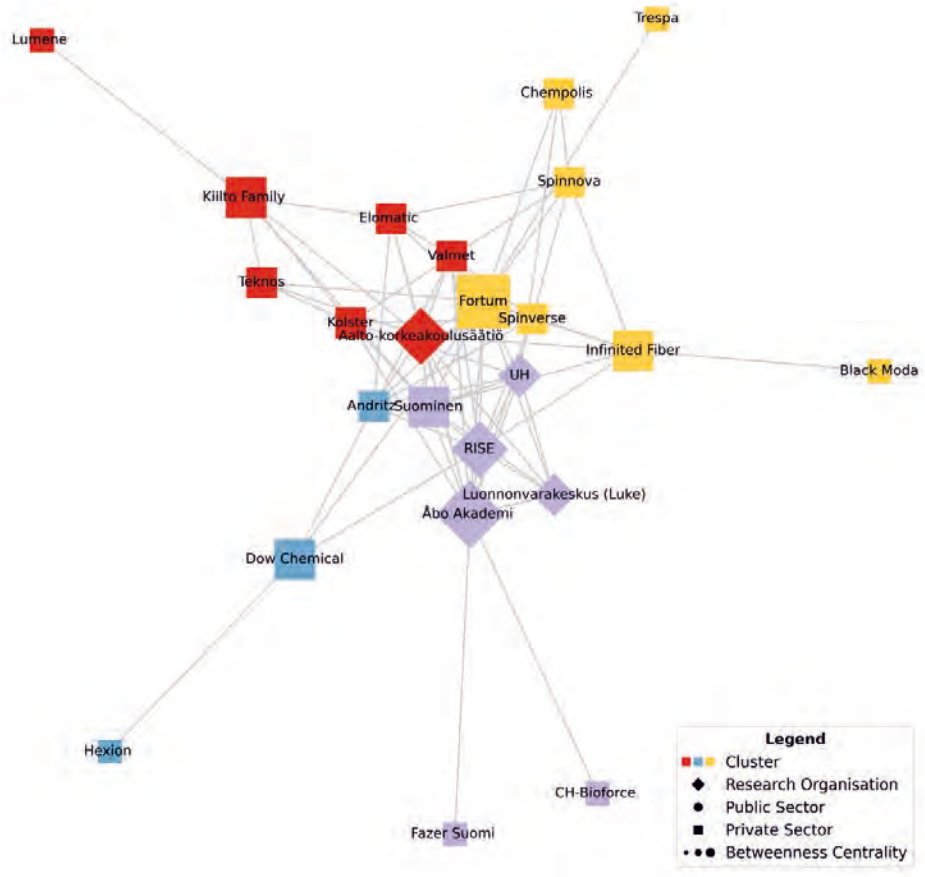
TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
24 (+5 with no connections to other organisations)	27%	>50%	3	>10%	2
		20-50%	12	1-10%	13
		<20%	9	<1%	9

The ForBest ecosystem has only two organisations which could fulfil the role of a connecting organisation between network members. These organisations are Fortum Åbo Akademi University.

In Figure 41 an overview graph of the network of the ForBest ecosystem is presented. Looking at the overview it shows that the core of the network is relatively dense, while the organisations on the edge are often only connected to one or a few actors in the core. Despite a relatively small number of members, it consists of 4 sub-communities. The cluster depicted in purple includes 4 research organisations which are connected to 3 Finnish private companies active in different sectors: Suominen (produces nonwovens for wiping and hygiene products), CH-Bioforce (biotechnology company) and Fazer (largest corporations in the Finnish food industry).

The red cluster is dominated by Aalto University (Aalto-korkeakoulusäätiö), which is connected to companies related to the engineering sector, such as Elomatic, and the construction sector, such as Valmet (supplier of biomaterials and technologies for bio-based industries), Teknos (supplier of interior and exterior painting) and Kiilto (construction and professional hygiene company). In addition, Kolster, an intellectual property consultancy, is connected to several actors in this group.

FIGURE 41. Schematic overview of the network of the ForBest ecosystem. Technopolis Group 2020



The yellow cluster comprises companies in the energy (Fortum, Chempolis) and textile (Infinited Fiber, Spinnova, Black Moda) sectors. The smallest cluster (depicted in blue) consists of only three companies, active in a chemical industry. With the exception of Andritz, Hexion and Dow Chemical have few collaborations with other members in the network.

NETWORK ANALYSIS: **Internet of Locations**

Internet of Locations is the ecosystem revolving around collecting constantly updated satellite-based data from around the globe. With the help of machine intelligence, this data can provide reliable and up-to-date information to enable better decision-making for both government and commercial entities.

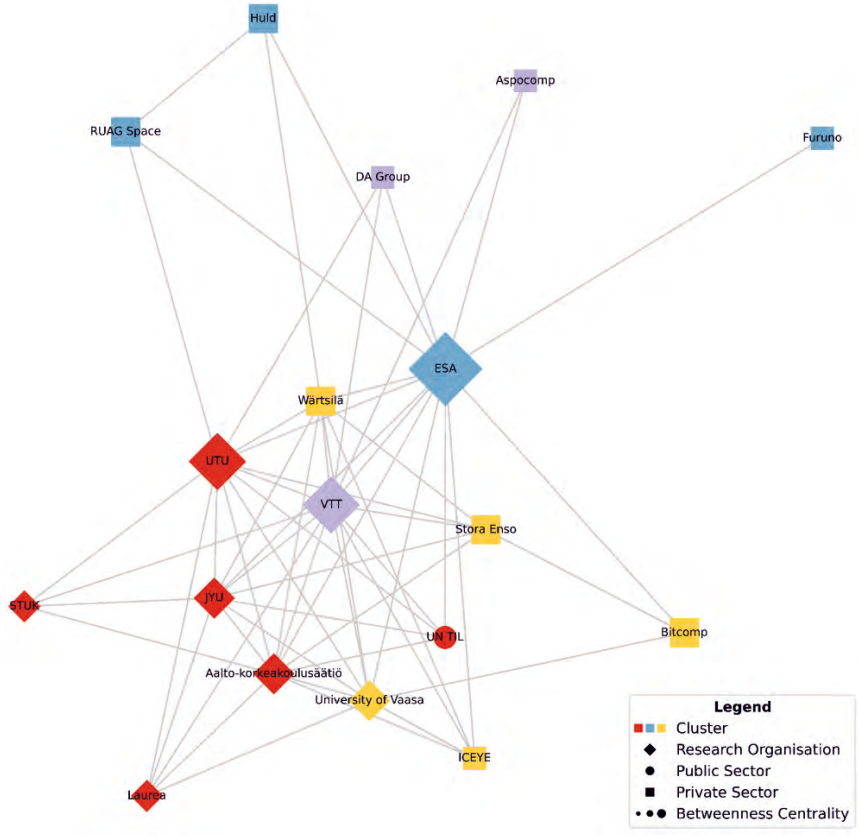
The Internet of Locations ecosystem has 18 organisations in its network. There are a total of eight research organisations in the ecosystem. The network has an above average density of connections. The ecosystem also has many strongly connected organisations, seven out of 18 actors. At the same time a similar amount of six actors are not very well connected to others. Three organisations can act as intermediaries for connecting network members with each other. These organisations are the research organisations European Space Agency (ESA), VTT and the University of Turku (UTU).

Figure 42 depicts the network of the Internet of Locations ecosystem. According to the overview, the network has four subcommunities. The red cluster comprises five research organisations and one public organisation. The most collaborative actor in this cluster is the University of Turku (UTU). The yellow cluster seems to connect actors related to forests, such as two geographic information system companies (ICEYE, Bitcomp) and two manufacturers of forest products or technology for working in forests (Stora Enso, Wartsila). In addition, this cluster has one research organisation – University of Vaasa. The blue and purple clusters mostly consist of private companies, both of them have a core research actor. In the blue cluster, ESA (European Space Agency) collaborates with several radar/satellite system and space-related companies (Furuno, Huld, RUAD Space). In the purple cluster VTT collaborates with two advanced electronic companies (DA Group and Aspocomp).

TABLE 12. Key network indicators of the Internet of Locations ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
18	39%	>50%	7	>10%	3
		20-50%	5	1-10%	5
		<20%	6	<1%	10

FIGURE 42. Schematic overview of the network of the Internet of Locations ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **LuxTurrim 5G**

LuxTurrim 5G is the ecosystem that creates the digital backbone for smart cities, combining fast 5G connectivity, relevant data from a variety of sensors and a secure data platform to build new data-driven services. The aim is to help cities tackle challenges regarding urbanization and climate change, boost sustainable development and enable their digital transformation to smart cities.

The LuxTurrim 5G ecosystem includes 14 organisations in its network. The network density in the LuxTurrim 5G ecosystem is very high. Eleven organisations are connected to more than half of the actors in the ecosystem.

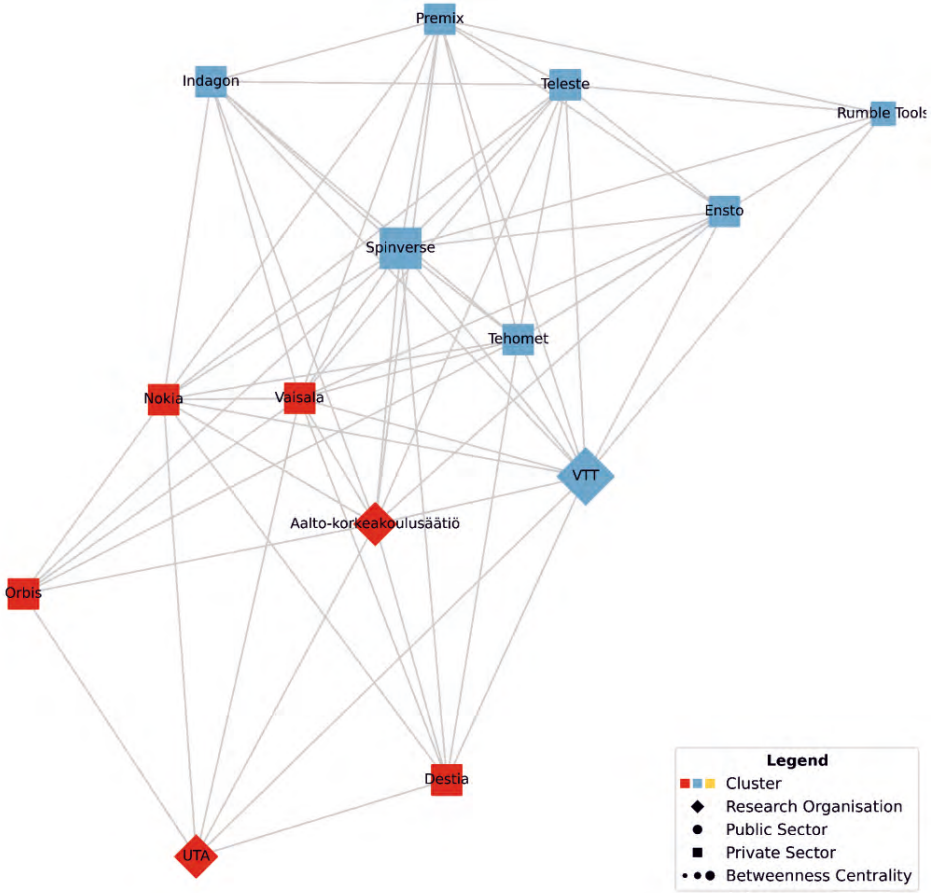
TABLE 13. Key network indicators of the Lux Turrim 5G ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
14	70%	>50%	11	>10%	0
		20-50%	3	1-10%	8
		<20%	0	<1%	6

As a result, few actors are well positioned to connect network members with each other (as they already collaborate).

According to Figure 43, the network can be divided into two subcommunities. The blue cluster comprises 8 actors, one of which is a research organisation (VTT) and 7 are companies. The companies in the cluster focus on development of smart electric and digital systems, including software development, robotic systems, solutions on data connectivity. The red cluster includes two research organisations (Aalto University and the University of Tampere), while most companies in the cluster are related to digital and physical infrastructure. Among them are companies that provide infrastructural services (Destia), specialise in environmental and industrial measurement (Vaisala) and mobile/digital network providers (Orbis, Nokia). Spinverse (consultancy in the area of automation, electronics and ICT), VTT and Vaisala (manufacturer of products and services for environmental and industrial measurements) are connected to nearly all members of the ecosystem. Thus, they are actively engaged in both red and in blue clusters.

FIGURE 43. Schematic overview of the network of the Lux Turrim 5G ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **One Sea**

One Sea is the ecosystem working towards an operating autonomous maritime ecosystem, minimizing accidents, decreasing the environmental footprint of marine traffic, and advancing possibilities for new commercial ventures.

The One Sea ecosystem has 34 network members. However, based on the webscraping, two organisations do not have any connections in the ecosystem. The network within the One Sea ecosystem is dense, as 52% of all possible connections between its members are realised. A total of 20 organisations are highly connected, as they are connected to more than 50% of network members. The likelihood that an actor could be involved to engage two network members into collaboration is low as nearly all actors already collaborate.

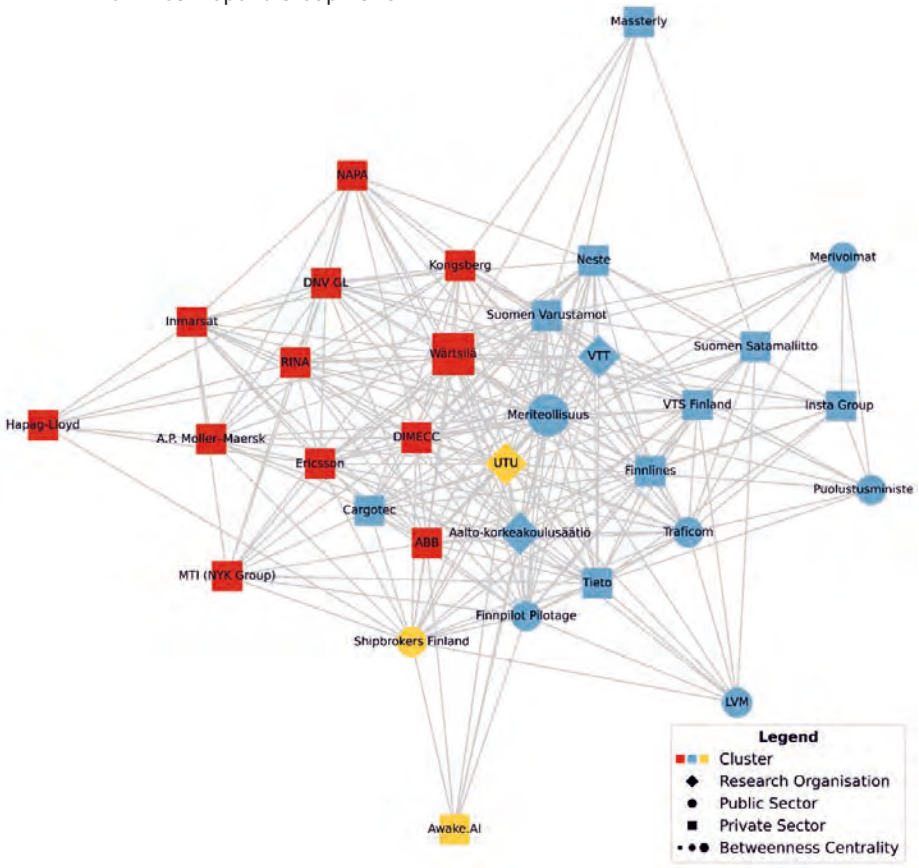
Due to high density and a large number of actors in the One Sea ecosystem, Figure 44 presents a complex set of interlinkages. Overall, the collaborations can be split into three subcommunities. The red cluster consists of predominantly large private companies, which are technology leaders in their respective sectors – maritime technology (Wärtsilä, DNV GL, MTI NYK Group), telecommunications (Ericsson, Immarsat) and advanced technology and electric equipment (ABB, Kongsberg). The yellow cluster is the smallest in the network, as it includes only 3 network members - University of Turku, public or-

ganisation Shipbrokers Finland (Finnish Shipbrokers Association) and a private company Awake.AI that provides various digital solutions for maritime businesses. Lastly, the blue cluster encompasses a combination of private, public sector actors and research organisations. All of these actors are related to maritime traffic management, transportation and maritime trade.

TABLE 14. Key network indicators of the One Sea ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
32 (+2 with no connections to other organisations)	52%	>50%	20	>10%	0
		20-50%	10	1-10%	18
		<20%	2	<1%	14

FIGURE 44. Schematic overview of the network of the One Sea ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **Plastic Waste Refining Ecosystem**

Plastic Waste Refining is the ecosystem aimed at tackling the problem of increasing plastic waste, using various solutions for plastic waste recycling, as well as mechanical, chemical and biodegradation processing methods that have the potential to significantly increase the recycling rate of plastics.

The Plastic Waste Refining ecosystem includes 29 actors, although 5 of them do not have any noticeable linkages with other actors. Based on the data, the network density is low, only 11%. Actors do not seem to engage with many partners in the network, given that most members, namely 19, are collaborating with less than 20% of actors in the network. Five actors in the network are well positioned to act as connectors within this ecosystem. These actors are VTT, Griffin Refineries, Korkia, BMH Technology and ÅFPöyry.

According to Figure 45, the Plastic Waste Refining ecosystem has 6 subcommunities. Thus, actors in the network seem to focus on collaboration in small groups rather than to explore a greater variety of partnerships within the ecosystem.

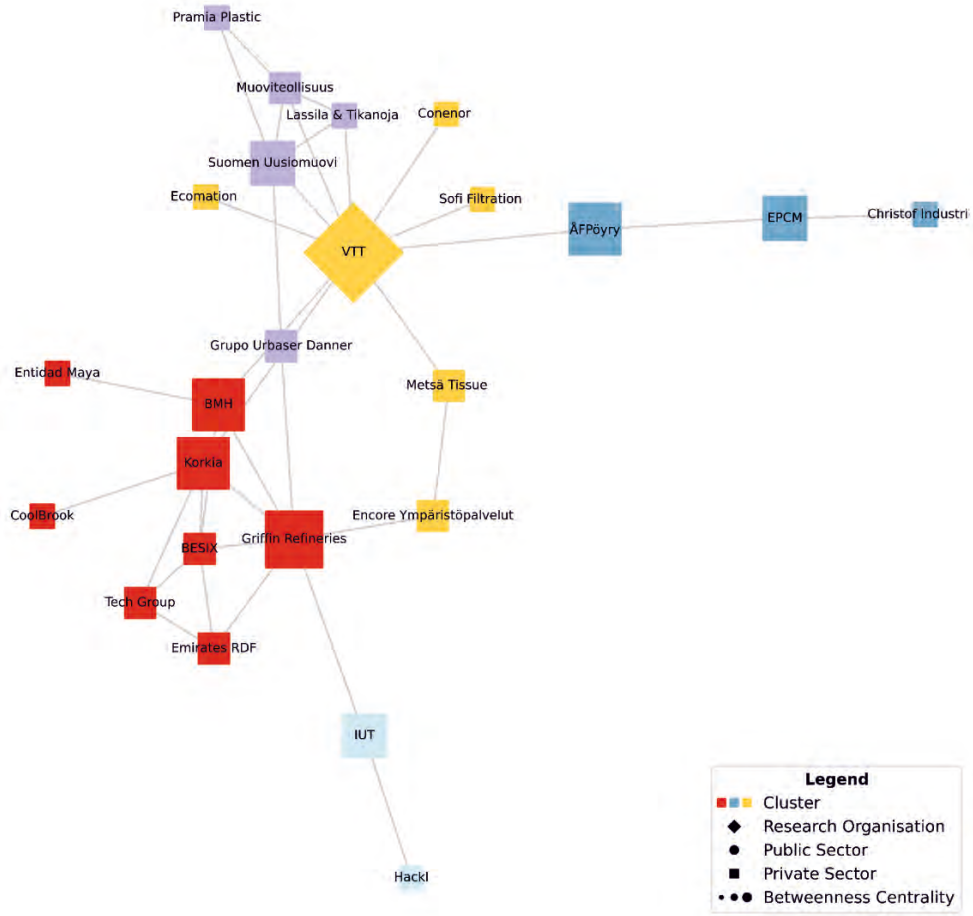
The red cluster includes companies that produce raw materials and environmental technology solutions (Griffin Refineries, BMH Technology, CoolBrook), construction companies (BESIX, Emirates RDF) and engineering companies (Tech Group, Maya). In the yellow cluster, VTT connects private companies that operate in the cleantech sector (Ecomation, Sofi Filtration, Encore Ympäristöpalvelut), engineering and manufacturing from natural materials (Conenor and Metsä Tissue).

The blue cluster includes only 3 private companies, while one of them ÅFPöyry is connected to the yellow cluster through VTT. The companies in this cluster are providing a set of services, including construction, engineering and design for industrial companies. The purple cluster comprises recycling and waste management companies (Suomen Uusiomuovi, Grupo Urbaser Danner, Lassila & Tikanoja, Pramia Plastic), most of which are focused on

TABLE 15. Key network indicators of the Plastic Waste Refining ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
24 (+5 with no connections to other organisations)	11%	>50%	0	>10%	5
		20-50%	5	1-10%	8
		<20%	19	<1%	11

FIGURE 45. Schematic overview of the network of the Plastic Waste Refining ecosystem. Technopolis Group 2020



plastics industry. In addition, this cluster includes the Finnish Plastics Industry Federation (Muoviteollisuus) that represents Finnish plastics manufacturing companies and the Finnish plasticssector.

The light blue ecosystem includes only two private companies, both of which are German, namely IUT Ingenieurgemeinschaft Innovative Umwelttechnik GmbH and Hackl Container GmbH. Similarly, the last cluster, consisting of Reclay Group and ÖPG (ÖPG Pfandsystem GmbH), is formed due to geographic affinity of companies. Both of them are operating in Germany. This last cluster is completely separated from the rest of the network (and thus not presented in Figure 45).

NETWORK ANALYSIS: **Smart Mobility**

Smart Mobility is the ecosystem focusing on more efficient, easier and sustainable transport solutions based on mobility data analytics. Using data to develop full transportation systems, linking transport solutions and services together.

The Smart Mobility ecosystem is a decently sized ecosystem with 46 organisations, connected in a network that is not very dense. The ecosystem includes seven organisations that are not linked to any of the other ecosystem members. The statistics of the network are shown in Table 16. As we can see there are three organisations in

TABLE 16. Key network indicators of the Smart Mobility ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
39 (+7 with no connections to other organisations)	22%	>50%	3	>10%	3
		20-50%	13	1-10%	10
		<20%	23	<1%	26

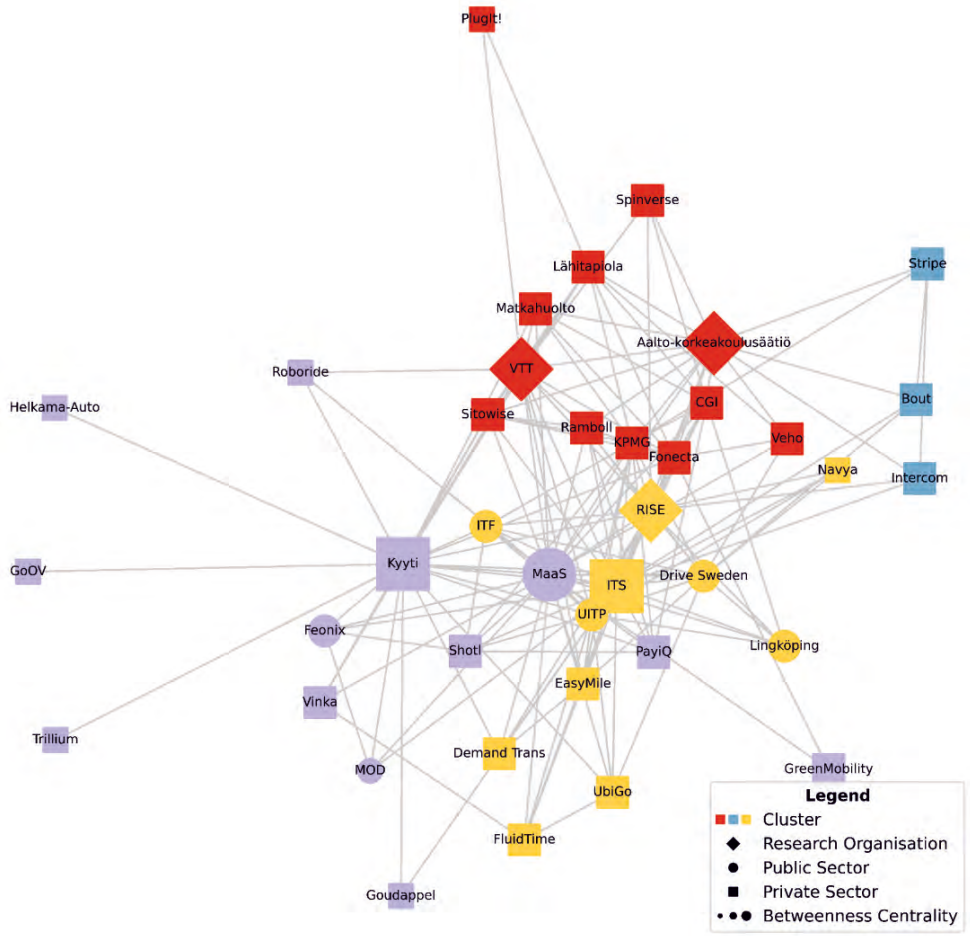
the ecosystem that have ties to (more than) halve of the other organisations, these three organisations are also well positioned to introduce ecosystem members to each other. It also becomes clear that quite a large part of the ecosystem is linked to only a few other organisations.

In Figure 46 an overview graph of the network of the Smart Mobility ecosystem is presented.

The most central and well connected organisations in the Smart Mobility ecosystem are ITS, MaaS Finland and Kyyti. ITS is a co-operation forum for promoting the digitalisation of the transport sector, bringing together public and private organisations. MaaS Finland is the main platform of the ecosystem, as it stands for Mobility as a Service. Kyyti is a company that is developing services through the MaaS platform. Next to these players you see that large international organisations like KPMG, are well connected, as are the research organisations RISE (from Sweden), Aalto University (Aalto-korkeakoulusäätiö) and VTT.

When looking at the subcommunities in the ecosystem we see that in the purple cluster includes the two main players, MaaS Finland and Kyyti, as well as a range of (international) organisations that focus on specific parts of mobility, like (electric) cars/vehicles, bikes or solutions for people with mental disorders or elderly. In blue we see a few additional players with a similar profile that are not collected well to the purple clusters, they focus on aspects like payment services and maritime transportation. The yellow cluster shows a variety of organisations that focus on integrated mobility issues as well as public players like the Finnish Transport and Communications Agency and the International Transport Forum. Finally, in red we find the more general support organisations working on insurance, consultancy or IT services.

FIGURE 46. Schematic overview of the network of the Smart Mobility ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **Smart Otaniemi**

Smart Otaniemi is the ecosystem aimed at smart energy solutions in building, for mobility and energy networks, by collecting, sharing and analysing data and using enabling technologies ranging from AI to blockchain as well as modelling and simulation.

The Smart Otaniemi ecosystem is the largest ecosystem in this analysis. The ecosystem has over 67 organisations. Of these 67, twelve organisations don't have any connections with other organisations in the ecosystem. Overall, the ecosystem does not have a dense network, see the statistics in Table 17. There are two organisations that are linked to (more than) halve of the organisations in the ecosystem and there are three organisations that are well positioned to set up connections between other organisations in the ecosystem. A large amount of organisations is not well connected to others within the ecosystem.

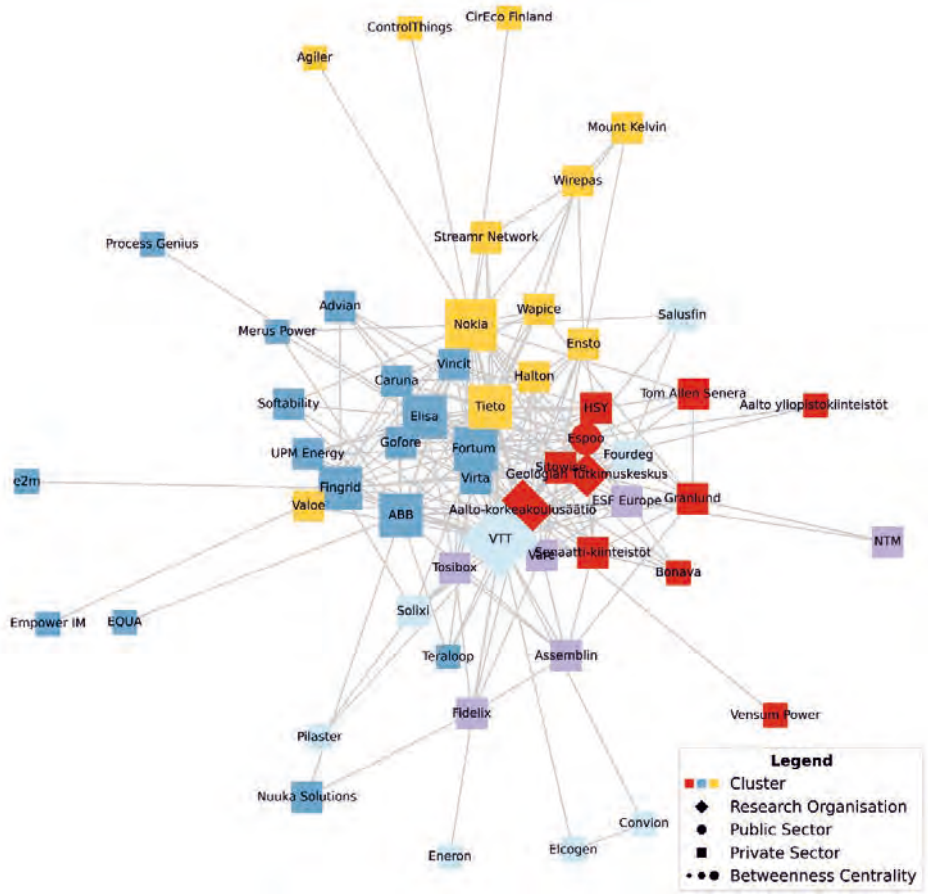
In Figure 47 an overview graph of the network of the Smart Otaniemi ecosystem is presented. When looking in more detail at the structure of the network in the Smart Otaniemi ecosystem it becomes clear that the core of the ecosystem is denser than the overall statistics of the network let to believe. In the core a number of large organisations are strongly tied together while surrounding this core there is a group of organisations with only few connections within the ecosystem. In the core the two players

TABLE 17. Key network indicators of the Smart Otaniemi ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
55 (+12 with no connections to other organisations)	16%	>50%	2	>10%	3
		20-50%	15	1-10%	10
		<20%	38	<1%	42

with the highest number of connections are two research organisations, VTT and Aalto University (Aalto-korkeakoulusäätiö'). Next to that there is a group of large companies that are located in Espoo/Helsinki. These include large telecommunication and IT companies like Nokia, Tieto, ABB, Elisa and Fortum. These companies are, next to the research organisation, also the main players that could build connections between other organisations in the ecosystem. Smaller companies in the ecosystem are often positioned further outside the core. Softability for instance is a company in AI, that has a few connections to the core companies and research organisations. Similarly, in the purple subcommunity you find companies that work on remote solutions in the building environment.

FIGURE 47. Schematic overview of the network of the Smart Otaniemi ecosystem. Technopolis Group 2020



NETWORK ANALYSIS: **Telaketju 2**

Telaketju 2 is the circular ecosystem of textiles working on novel circular economy business models aimed at better material efficiency and increased material and product life, as well as business related to textile recycling.

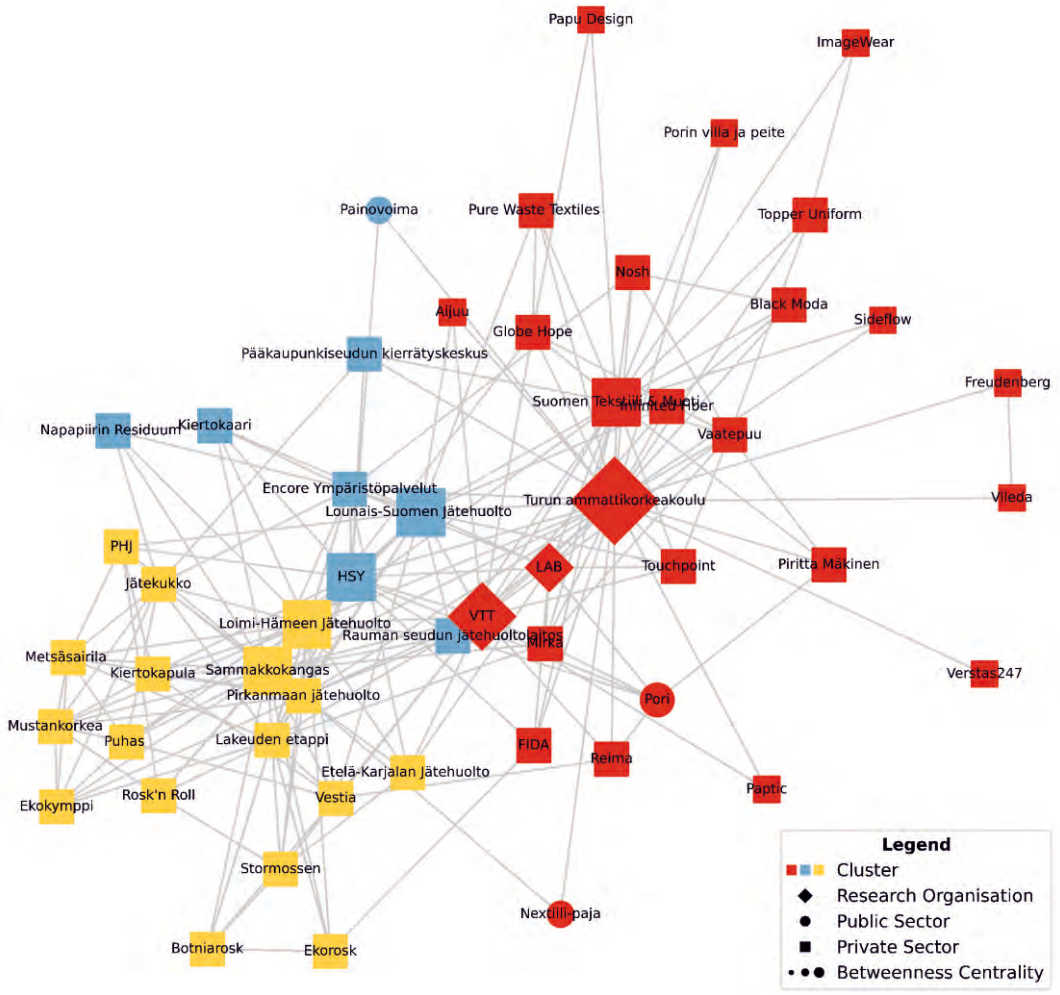
The Telaketju 2 ecosystem is, with nearly sixty members, one of the larger ecosystems in this analysis. In total 52 organisations were included in the network analysis, while six organisations are not linked to any other organisation. When looking at the indicators of the network analysis, see Table 18, it shows that the network of the ecosystem is not very dense. There is only one organisation linked to (more than) half of the ecosystem, while 40 organisations are linked to (less than) a fifth of all other actors. Three organisations are well positioned to introduce organisations to others.

In the schematic overview of the ecosystem, see Figure 48, three subcommunities are visible. The blue and the yellow cluster include many waste and recycling organisations, while the red cluster outlines textile, clothing and fashion companies as well as the research organisations. The research organisations, mainly Turku University of Applied Sciences (Turun ammattikorkeakoulu) and to a lesser extent VTT and LAB, have a central position in the ecosystem. Turku University of Applied Sciences is also the organisation with the most connections in the ecosystem. Together with two waste and recycling organisations that also have many connections, Suomen Tekstiili & Muoti and Loimi-Hämeen Jätehuolto, they are best positioned to link up other parties in the ecosystem. Within the red cluster some textile and clothing companies can be found that specifically aim at using recycled materials, like for example Touchpoint, Global Hope, Sustainable Workwear and Pure Waste Textiles.

TABLE 18. Key network indicators of the Telaketju 2 ecosystem. Technopolis Group 2020

TOTAL NUMBER OF ACTORS	NETWORK DENSITY	ORGANISATIONS WITH IN RANGES OF DEGREE CENTRALITY		ORGANISATIONS WITH IN RANGES OF BETWEENNESS CENTRALITY	
All private and public sector and research organisations.	Total realised connections in a network as share of the total number of possible connections. *"Is everybody connected to everybody?"*	Total realised connections by an organisation as share of the total number of possible connections. *"How many actors are highly or not very connected?*		Likelihood of an actor being on the shortest path between any two actors in the network. *"How many actors (can) connect others?"*	
52 (+6 with no connections to other organisations)	16%	>50%	1	>10%	3
		20-50%	11	1-10%	11
		<20%	40	<1%	38

FIGURE 48. Schematic overview of the network of the Telaketju 2 ecosystem. Technopolis Group 2020



APPENDIX E. STUDY RESULTS: DATA ANALYSIS

METHODOLOGIES USED IN STATISTICAL ANALYSES AND ECONOMIC MODELLING

The analysis is based on the statistical data at company level regarding employment, turnover and export. Survey data were used to enrich this data for a sample of the companies. This sample was used to extrapolate some of these findings for the entire data set. A key example of this is to extrapolate the *"relevance towards the ecosystems"* of business activities. The data was thoroughly checked and cleaned. A outlier analysis and segmentation analysis by company size was performed to make sure single companies could not too large effects in the results. In the modelling midpoint estimates were used and future predictions were based on scenario's to model ranges of findings and build in uncertainty margins. For key statistical analysis correlation analyses were used, based on regression analyses.

TURNOVER AND GROWTH

Table 19 presents an overview of companies in ecosystems, classified by size. In addition, the table presents the number of new firms (companies that started their economic activity in the period 2013-2018) and companies that discontinued their economic activity in 2013-2018.

Table 20 – Table 26 show the turnover of the companies in the ecosystems, relevant turnover (2018) and relevant turnover in a specific year (2013-2017). Table 22 and Table 23 classify companies by their lifecycles, and size classes. Table 24 indicates performance of companies with and without Growth Engine support, while Table 25 compares the turnover of new companies and other companies that already existed in ecosystems. Table 21 presents modelled scenarios of turnover in 2028 under two situations (1. based on past turnover growth; 2. based on past turnover growth plus the contribution of public policy).

TABLE 19. Overview of companies in business ecosystems. Technopolis Group 2021

NAME OF THE ECOSYSTEM	COMPANIES	MICRO COMPANIES	SMALL COMPANIES	MEDIUM-SIZE COMPANIES	LARGE COMPANIES	VERY LARGE COMPANIES	NEW COMPANIES	COMPANIES THAT DISCONTINUED
Adaptive Industrial Loops	13	1	4	3	4	1	1	0
BatCircle	26	9	4	2	7	4	3	0
CleverHealth	14	2	3	0	8	1	1	1
Elastronics Connected Health	14	4	5	1	4	0	1	0
FinnGen	14	1	3	1	8	1	2	0
ForBest	21	4	5	2	9	1	3	1
Internet of Locations	9	0	2	3	2	2	1	0
LuxTurrim 5G	12	1	3	1	5	2	1	0
One Sea	15	1	4	0	7	3	2	0
Plastic Waste Refining Ecosystem	13	5	3	0	4	1	0	0
Smart Mobility	17	8	1	1	6	1	4	0
Smart Otaniemi	58	22	9	5	18	4	14	2
Telaketju 2	42	8	8	2	23	1	9	3

TABLE 20. Total and relevant turnover of companies in business ecosystems. Technopolis Group 2021

TOTAL NUMBER OF COMPANIES IN ALL ECOSYSTEMS	TOTAL TURNOVER OF ALL COMPANIES IN ECOSYSTEMS (MLN. €)	RELEVANT TURNOVER (MLN. €)	RELEVANT TURNOVER IN 2013 (MLN. €)	RELEVANT TURNOVER IN 2014 (MLN. €)	RELEVANT TURNOVER IN 2015 (MLN. €)	RELEVANT TURNOVER IN 2016 (MLN. €)	RELEVANT TURNOVER IN 2017 (MLN. €)	MEDIAN[62] TURNOVER OF COMPANIES IN 2016-2018 (MLN. €)
244	43447	1174	943	972	984	1051	1115	8.79%

[62] The median value (the value in the middle of a series of sorted values from lowest to highest) of turnover is presented in the table, instead of a mean (average) value. This allows to avoid screwedness of results due to high turnover values in large companies.

TABLE 21. Scenarios of turnover in 2028. Technopolis Group 2021

TURNOVER OF ECOSYSTEMS BASED ON PAST GROWTH (MLN. €)			TURNOVER OF ECOSYSTEMS DUE TO PUBLIC POLICY (MLN. €)		
Mean relevant turnover in 2028	Lowest relevant turnover in 2028	Highest relevant turnover in 2028	Mean relevant turnover in 2028	Lowest relevant turnover in 2028	Highest relevant turnover in 2028
1531	844	2352	2036	1139	3093

TABLE 22. Turnover in companies of different lifecycles. Technopolis Group 2021

LIFECYCLE	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL TURNOVER OF COMPANIES IN ECOSYSTEMS (MLN. €)	RELEVANT TURNOVER (MLN. €)	RELEVANT TURNOVER IN 2013 (MLN. €)	RELEVANT TURNOVER IN 2014 (MLN. €)	RELEVANT TURNOVER IN 2015 (MLN. €)	RELEVANT TURNOVER IN 2016 (MLN. €)	RELEVANT TURNOVER IN 2017 (MLN. €)
1	75	6951	479	345	363	397	424	440
2	108	18303	435	347	366	346	391	418
3	61	18194	261	252	243	240	235	257

TABLE 23. Turnover in companies of different sizes. Technopolis Group 2021

SIZECLASS	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL TURNOVER OF COMPANIES IN ECOSYSTEMS (MLN. €)	RELEVANT TURNOVER (MLN. €)	RELEVANT TURNOVER IN 2013 (MLN. €)	RELEVANT TURNOVER IN 2014 (MLN. €)	RELEVANT TURNOVER IN 2015 (MLN. €)	RELEVANT TURNOVER IN 2016 (MLN. €)	RELEVANT TURNOVER IN 2017 (MLN. €)
Large	94	8733	709	495	505	595	621	648
Medium-sized	21	900	81	49	53	55	76	69
Micro	62	31	7	2	2	3	3	5
Small	49	164	31	17	18	22	26	28
Very Large	18	33619	346	380	395	309	325	364

TABLE 24. Turnover in companies with and without ecosystem Growth Engine support. Technopolis Group 2021

ECOSYSTEM	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL TURNOVER OF COMPANIES IN ECOSYSTEMS (MLN. €)	RELEVANT TURNOVER (MLN. €)	RELEVANT TURNOVER IN 2013 (MLN. €)	RELEVANT TURNOVER IN 2014 (MLN. €)	RELEVANT TURNOVER IN 2015 (MLN. €)	RELEVANT TURNOVER IN 2016 (MLN. €)	RELEVANT TURNOVER IN 2017 (MLN. €)
Ecosystems without Growth Engine support	166	20616	767	544	569	588	650	708
Ecosystems with Growth Engine support	78	22831	408	400	403	396	401	406

TABLE 25. Turnover in new companies and other/existing companies. Technopolis Group 2021

NUMBER OF COMPANIES THAT STARTED THEIR ECONOMIC ACTIVITY	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL TURNOVER OF COMPANIES IN ECOSYSTEMS (MLN. €)	RELEVANT TURNOVER (MLN. €)	RELEVANT TURNOVER IN 2013 (MLN. €)	RELEVANT TURNOVER IN 2014 (MLN. €)	RELEVANT TURNOVER IN 2015 (MLN. €)	RELEVANT TURNOVER IN 2016 (MLN. €)	RELEVANT TURNOVER IN 2017 (MLN. €)
New firms (companies that started their economic activity)	40	991	68	0	0	0	30	47
Other firms in ecosystems	204	42456	1107	943	972	983	1022	1068

TABLE 26. Turnover of companies in business ecosystems. Technopolis Group 2021

NAME OF ECOSYSTEM	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL TURNOVER OF COMPANIES IN AN ECOSYSTEM (MLN. €)	RELEVANT TURNOVER (MLN. €)	RELEVANT TURNOVER IN 2013 (MLN. €)	RELEVANT TURNOVER IN 2014 (MLN. €)	RELEVANT TURNOVER IN 2015 (MLN. €)	RELEVANT TURNOVER IN 2016 (MLN. €)	RELEVANT TURNOVER IN 2017 (MLN. €)
Adaptive Industrial Loops	13	1189	44	24	31	42	44	57
BatCircle	26	4005	402	290	313	343	364	381
CleverHealth	14	2984	94	82	87	97	98	99
Elastronics Connected Health	14	359	35	31	35	36	38	36
FinnGen	14	1398	37	32	33	32	32	36
ForBest	21	1124	44	47	49	32	33	55
Internet of Locations	9	4903	39	39	40	42	43	39
LuxTurrim 5G	12	9509	134	111	118	113	117	121
One Sea	15	13280	153	165	149	135	126	140
Plastic Waste Refining Ecosystem	13	937	25	16	18	23	22	25
Smart Mobility	17	2061	78	95	101	87	96	78
Smart Otaniemi	58	5774	146	68	65	79	108	128
Telaketju 2	42	2506	53	30	30	44	47	50

EMPLOYMENT

Table 27 – Table 32 show the number of employed, relevant employment (2018) and relevant employment in years 2013-2017 in companies of business ecosystems. Table 28 and Table 29 classify companies by their lifecycles, size classes. Table 30 indicated performance of companies with and without Growth Engine support, while Table 31 compares the performance of new companies and other companies that already existed in ecosystems.

TABLE 27. Total and relevant employment in companies of business ecosystems. Technopolis Group 2021

TOTAL NUMBER OF COMPANIES IN ALL ECOSYSTEMS	TOTAL NUMBER OF EMPLOYED	RELEVANT EMPLOYMENT	RELEVANT EMPLOYMENT IN 2013	RELEVANT EMPLOYMENT IN 2014	RELEVANT EMPLOYMENT IN 2015	RELEVANT EMPLOYMENT IN 2016	RELEVANT EMPLOYMENT IN 2017
244	69031	2761	2237	2220	2196	2528	2725

TABLE 28. Employment in companies of different lifecycles. Technopolis Group 2021

LIFECYCLE	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL NUMBER OF EMPLOYED	RELEVANT EMPLOYMENT	RELEVANT EMPLOYMENT IN 2013	RELEVANT EMPLOYMENT IN 2014	RELEVANT EMPLOYMENT IN 2015	RELEVANT EMPLOYMENT IN 2016	RELEVANT EMPLOYMENT IN 2017
1	75	13468	945	734	778	756	919	917
2	108	30957	1226	1068	1085	1045	1086	1180
3	61	24606	590	435	358	394	523	628

TABLE 29. Employment in companies of different sizes. Technopolis Group 2021

SIZECLASS	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL NUMBER OF EMPOYED	RELEVANT EMPLOYMENT	RELEVANT EMPLOYMENT IN 2013	RELEVANT EMPLOYMENT IN 2014	RELEVANT EMPLOYMENT IN 2015	RELEVANT EMPLOYMENT IN 2016	RELEVANT EMPLOYMENT IN 2017
Large	94	28017	1977	1594	1608	1633	1789	1860
Medium-sized	21	1554	141	90	85	77	113	109
Micro	62	272	78	15	13	15	18	35
Small	49	991	202	111	94	120	148	190
Very Large	18	38197	363	427	420	351	460	533

TABLE 30. Employment in companies with and without ecosystem Growth Engine support. Technopolis Group 2021

ECOSYSTEM	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL NUMBER OF EMPOYED	RELEVANT EMPLOYMENT	RELEVANT EMPLOYMENT IN 2013	RELEVANT EMPLOYMENT IN 2014	RELEVANT EMPLOYMENT IN 2015	RELEVANT EMPLOYMENT IN 2016	RELEVANT EMPLOYMENT IN 2017
Ecosystems without Growth Engine support	166	29278	1602	1292	1356	1314	1485	1566
Ecosystems with Growth Engine support	78	39753	1159	945	864	881	1043	1159

TABLE 31. Employment in new firms and other/existing firms. Technopolis Group 2021

NUMBER OF COMPANIES THAT STARTED THEIR ECONOMIC ACTIVITY	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL NUMBER OF EMPOYED	RELEVANT EMPLOYMENT	RELEVANT EMPLOYMENT IN 2013	RELEVANT EMPLOYMENT IN 2014	RELEVANT EMPLOYMENT IN 2015	RELEVANT EMPLOYMENT IN 2016	RELEVANT EMPLOYMENT IN 2017
New firms (companies that started their economic activity)	40	1410	114	0	0	27	47	59
Other firms in ecosystems	204	67621	2647	2237	2220	2169	2481	2667

TABLE 32. Employment in companies of business ecosystems. Technopolis Group 2021

NAME OF ECOSYSTEM	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	TOTAL NUMBER OF EMPOYED	RELEVANT EMPLOYMENT	RELEVANT EMPLOYMENT IN 2013	RELEVANT EMPLOYMENT IN 2014	RELEVANT EMPLOYMENT IN 2015	RELEVANT EMPLOYMENT IN 2016	RELEVANT EMPLOYMENT IN 2017
Adaptive Industrial Loops	13	5219	129	122	61	68	140	215
BatCircle	26	8054	773	627	613	588	800	879
CleverHealth	14	9174	363	363	356	359	355	359
Elastronics Connected Health	14	1292	123	111	110	114	122	118
FinnGen	14	2937	72	55	58	58	59	61
ForBest	21	2769	136	133	144	113	114	156
Internet of Locations	9	6687	150	91	69	93	121	131
LuxTurrim 5G	12	9057	248	250	255	255	241	237
One Sea	15	8772	161	103	101	133	131	139
Plastic Waste Refining Ecosystem	13	6658	107	90	95	69	89	108
Smart Mobility	17	9077	385	342	337	308	344	344
Smart Otaniemi	58	8971	338	265	260	269	274	319
Telaketju 2	42	6346	155	99	116	121	144	126

EXPORT

Table 33 – Table 38 show the volume of export, relevant export (2018) and relevant export in years 2013-2017 in companies of business ecosystems. The tables classify companies by their lifecycles, size classes. Table 36 indicates performance of companies with and without Growth Engine support, while Table 37 compares the performance of new companies and other companies that already existed in ecosystems.

TABLE 33. Total and relevant export of companies in business ecosystems. Technopolis Group 2021

TOTAL NUMBER OF COMPANIES IN ALL ECOSYSTEMS	EXPORT OF ALL COMPANIES IN ECOSYSTEMS (MLN. €)	RELEVANT EXPORT (MLN. €)	RELEVANT EXPORT IN 2013 (MLN. €)	RELEVANT EXPORT IN 2014 (MLN. €)	RELEVANT EXPORT IN 2015 (MLN. €)	RELEVANT EXPORT IN 2016 (MLN. €)	RELEVANT EXPORT IN 2017 (MLN. €)
244	24723	648	481	548	604	631	692

TABLE 34. Export in companies of different lifecycles. Technopolis Group 2021

LIFECYCLE	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	EXPORT OF COMPANIES IN ECOSYSTEMS (MLN. €)	RELEVANT EXPORT (MLN. €)	RELEVANT EXPORT IN 2013 (MLN. €)	RELEVANT EXPORT IN 2014 (MLN. €)	RELEVANT EXPORT IN 2015 (MLN. €)	RELEVANT EXPORT IN 2016 (MLN. €)	RELEVANT EXPORT IN 2017 (MLN. €)
1	75	3985	331	191	226	275	319	314
2	108	8390	158	123	131	114	126	134
3	61	12348	159	167	191	215	187	244

TABLE 35. Export in companies of different sizes. Technopolis Group 2021

SIZECLASS	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	EXPORT OF COMPANIES IN ECOSYSTEMS (MLN. €)	RELEVANT EXPORT (MLN. €)	RELEVANT T EXPORT IN 2013 (MLN. €)	RELEVANT EXPORT IN 2014 (MLN. €)	RELEVANT EXPORT IN 2015 (MLN. €)	RELEVANT EXPORT IN 2016 (MLN. €)	RELEVANT EXPORT IN 2017 (MLN. €)
Large	94	3228	406	234	247	338	372	376
Medium-sized	21	236	22	7	6	8	15	18
Micro	62	6	1	0	0	0	1	1
Small	49	42	7	3	3	5	5	5
Very Large	18	21210	212	236	292	253	239	293

TABLE 36. Export in companies with and without ecosystem Growth Engine support. Technopolis Group 2021

ECOSYSTEM	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	EXPORT OF COMPANIES IN ECOSYS-TEMS (MLN. €)	RELEVANT EXPORT (MLN. €)	RELEVANT EXPORT IN 2013 (MLN. €)	RELEVANT EXPORT IN 2014 (MLN. €)	RELEVANT EXPORT IN 2015 (MLN. €)	RELEVANT EXPORT IN 2016 (MLN. €)	RELEVANT EXPORT IN 2017 (MLN. €)
Ecosystems without Growth Engine support	166	11777	458	290	327	358	410	415
Ecosystems with Growth Engine support	78	12946	190	191	221	246	222	277

TABLE 37. Export in new companies and other/existing companies. Technopolis Group 2021

NUMBER OF COMPANIES THAT STARTED THEIR ECONOMIC ACTIVITY	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	EXPORT OF COMPANIES IN ECOSYSTEMS (MLN. €)	RELEVANT EXPORT (MLN. €)	RELEVANT EXPORT IN 2013 (MLN. €)	RELEVANT EXPORT IN 2014 (MLN. €)	RELEVANT EXPORT IN 2015 (MLN. €)	RELEVANT EXPORT IN 2016 (MLN. €)	RELEVANT EXPORT IN 2017 (MLN. €)
New firms (companies that started their economic activity)	40	165	15	0	0	0	9	12
Other firms in ecosystems	204	24558	633	481	548	604	622	680

TABLE 38. Export of companies in business ecosystems. Technopolis Group 2021

NAME OF ECOSYSTEM	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	EXPORT OF COMPANIES IN AN ECOSYSTEM (MLN. €)	RELEVANT EXPORT (MLN. €)	RELEVANT EXPORT IN 2013 (MLN. €)	RELEVANT EXPORT IN 2014 (MLN. €)	RELEVANT EXPORT IN 2015 (MLN. €)	RELEVANT EXPORT IN 2016 (MLN. €)	RELEVANT EXPORT IN 2017 (MLN. €)
Adaptive Industrial Loops	13	3181	51	22	56	88	66	130
BatCircle	26	5052	332	181	247	322	342	398
CleverHealth	14	589	31	26	32	31	34	33
Elastronics Connected Health	14	238	23	22	26	25	27	25
FinnGen	14	367	5	7	7	6	7	6
ForBest	21	433	18	31	30	14	12	19
Internet of Locations	9	3298	20	28	29	34	32	23
LuxTurrim 5G	12	6893	83	62	66	64	67	66
One Sea	15	7531	84	112	101	87	83	88
Plastic Waste Refining Ecosystem	13	169	8	7	7	9	9	8
Smart Mobility	17	57	3	1	1	2	3	3
Smart Otaniemi	58	1221	39	15	14	14	22	27
Telaketju 2	42	1318	21	13	14	17	16	18

LABOUR PRODUCTIVITY

Table 39 shows labour productivity in all companies that are part of business ecosystems. Table 40 depicts labour productivity across different size classes, while Table 41 shows labour productivity across different business ecosystems.

TABLE 39. Labour productivity in companies. Technopolis Group 2021

TOTAL NUMBER OF COMPANIES IN ALL ECOSYSTEMS	LABOUR PRODUCTIVITY (THSD. €)	LABOUR PRODUCTIVITY IN 2013 (THSD. €)	LABOUR PRODUCTIVITY IN 2014 (THSD. €)	LABOUR PRODUCTIVITY IN 2015 (THSD. €)	LABOUR PRODUCTIVITY IN 2016 (THSD. €)	LABOUR PRODUCTIVITY IN 2017 (THSD. €)
244	120	98	103	126	128	120

TABLE 40. Labour productivity in companies of different sizes. Technopolis Group 2021

SIZECLASS	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	LABOUR PRODUCTIVITY (THSD. €)
Large	94	120
Medium-sized	21	127
Micro	62	88
Small	49	93
Very Large	18	363

TABLE 41. Labour productivity in companies of business ecosystems. Technopolis Group 2021

NAME OF ECOSYSTEM	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	LABOUR PRODUCTIVITY (THSD. €)
Adaptive Industrial Loops	13	70
BatCircle	26	360
CleverHealth	14	92
Elastronics Connected Health	14	104
FinnGen	14	138
ForBest	21	183
Internet of Locations	9	126
LuxTurrim 5G	12	71
One Sea	15	88
Plastic Waste Refining Ecosystem	13	118
Smart Mobility	17	79
Smart Otaniemi	58	97
Telaketju 2	42	92

SHARE OF EXPORT FROM TOTAL TURNOVER

Table 42 – Table 45 shows results of the median value of export share from total turnover in companies of business ecosystems. The median value (i.e. the value in the middle of a series of sorted values from lowest to highest) has been selected, instead of a mean (average) value. This allows to avoid screwedness of results due to high turnover and export values in large companies. The tables below depict results for different lifecycles, sizes of companies, as well, allow to compare results across the ecosystems.

TABLE 42. The median value of export share from total turnover in all companies of business ecosystems. Technopolis Group 2021

TOTAL NUMBER OF COMPANIES IN ALL ECOSYSTEMS	THE MEDIAN VALUE OF EXPORT SHARE FROM TOTAL TURNOVER
244	9%

TABLE 43. The median value of export share from total turnover in companies of different lifecycles. Technopolis Group 2021

LIFECYCLE	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	THE MEDIAN VALUE OF EXPORT SHARE FROM TOTAL TURNOVER
1	75	2%
2	108	9%
3	61	29%

TABLE 44. The median value of export share from total turnover in companies of different sizes. Technopolis Group 2021

SIZECLASS	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	THE MEDIAN VALUE OF EXPORT SHARE FROM TOTAL TURNOVER
Large	94	9%
Medium-sized	21	10%
Micro	62	2%
Small	49	13%
Very Large	18	60%

TABLE 45. The median value of export share from total turnover in companies of business ecosystems. Technopolis Group 2021

NAME OF ECOSYSTEM	TOTAL NUMBER OF COMPANIES IN ECOSYSTEMS	THE MEDIAN VALUE OF EXPORT SHARE FROM TOTAL TURNOVER
Adaptive Industrial Loops	13	8%
BatCircle	26	16%
CleverHealth	14	17%
Elastronics Connected Health	14	27%
FinnGen	14	5%
ForBest	21	34%
Internet of Locations	9	58%
LuxTurrim 5G	12	38%
One Sea	15	51%
Plastic Waste Refining Ecosystem	13	29%
Smart Mobility	17	4%
Smart Otaniemi	58	7%
Telaketju 2	42	0%

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