Smart city actions to support sustainable city development

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Abstract. Cities are at the heart of global challenges and its solutions. When occupying only 3% of Earth's land, they are both the engines of economic growth with 80% of the global GDP but at the same time cities are emitting 75% of global green house gases. The aim of this paper was to focus on how different city development programs have been developing and how they are supporting the city's strategic goals. This paper has shown self-assessment results of 37 projects from four different programs in the city of Tampere. The projects were evaluated against five themes: people, planet, propagation, governance and scalability/replicability. The results showed that the environmental indicators had high scores. Also, the governance focus had a high scores in most of the projects. The people focus was highest in project themes on smart cities. Some of the ecological projects were in nature very technical, which is the reason why they did not score that high in people theme. The results showed clearly that the scalability and replicability are becoming very important elements in the existing and coming projects in cities. This could be also clearly seen in the analyses where the scalability and replicability of the different projects has been important in last 5-10 years and it seem that especially in the recent years the importance has a high impact. From our study we could initially conclude that the program based approach in city's economic development seems to provide one strand of continuation in implementation of the city's economic development policy and that the impact of its implementation improves. The hierarchical roles of different sets of projects as well as that of the sub-ecosystems that have carried out the project(s) indicates that the ecosystem approach is a useful one. The results also highllighted the role of programs as platforms for for innovation and co-creation between citizens, companies, research organizations and public sector. In these ecosystems value is created to all stakeholders. The value may be direct financial value but may well be also indirect such as R&D related, community value etc. The role of the cities is very important in this ecosystem value creation as they are considered to be a neutral body with focus on the public interest, not a vested one. As the role of cities is growing to be paramount also in innovation, this should be reflected in regional, national and EU level innovation policies, funding schemes and regulations as well as in execution of innovations.

Keywords: Smart City, Sustainability, Strategy

Introduction

Cities are at the heart of global challenges and its solutions. When occupying only 3% of Earth's land, they are both the engines of economic growth with 80% of the global GDP (UN-Habitat, 2015), also most of innovations are created in cities, at the same time 75% of global green house gases are originated from cities (UN, 2016). Therefore, cities can be seen as main couse and victims of climate change (Alberti et al., 2003). However, cities are also in best position to solve such grand challenges through efficiency (Rode & Burdett, 2011) and innovation (Airaksinen et al., 2016). Consequently, they have recently been put in the centre of several major political agreements, such as the Sustainable Development Goals (United Nations, 2018) and the New Urban Agenda (UN-Habitat, 2016). Due to rapid urbanisation (UN Habitat, 2015), additional challenges are created e.g. social. This further highlighting cities' urgency to strive to urban sustainability, i.e. to equitably meet the social, economic, environmental, and governance needs.

The technical development to tackle these problems is accelerating with such technologies as sustainable energy solutions, construction technologies, IoT, robotics or data science. This puts cities as the key stakeholder in the middle of innovation development to solve these problems. Therefore cities have an increasingly important role in the innovation ecosystems (Finnish Ministry of Economic Affairs and Employment, 2017). This has led to the current role of cities globally in solving these challenges through a variety of initiatives often termed smart cities. Another megatrend is the empowerment of citizens and the new values of work-force of the 21st century. The cities are to be transformed only with their citizens co-creating the new city.

The situation is new for cities and they need to acquire novel ways of working with companies, research organizations and citizens. While small-scale such developments have taken place gradually over the years, the scale and impact of the current transformation requires ecosystems. Ecosystems beat individual organizations. They are dynamic and co-evolving communities of diverse actors who create and capture new value through both collaboration and competition. Ecosystems accelerate learning and innovation as well as foster sharing and co-creation. They can create and serve communities and harness their creativity and intelligence. Ecosystems create new ways to address fundamental human needs and desires and drive new collaboration to address rising social and environmental challenges.

The city of Tampere was a typical European midsized industrial city until late 1980s and early 1990s. Due to changes in its economic structure it was forced to reinvent its economic development strategies. The city put all its economic development eggs in one basket: capitalizing on the knowledge generated at the educational institutions from vocational schools to universities and it in a manner we now term ecosystems: all stakeholders have been involved ever since. This shift in strategy did not prevent the vanishing of textile industry from the regions but it did its share in transforming the traditional metal manufacturing industries to an interesting European hub of intelligent mobile machinery. Further, the city became the largest global R&D site of the Nokia corporation at its peak due to the decades long development of relevant technologies and skills in the region.

The city has carried out its economic development strategy via focused development programs first e.g. on manufacturing, ICT, health technologies and now more recently e.g. on sustainable development, creative industries and open innovation and smart cities. The role of these programs is to serve as a catalyst in enhancing respective industries, start-up generation and university-industry collaboration as well as city transformation. These programs have been combined with national funding means as well as with private investments and have generated typically a return on city's investments with factor of 10-30.

In this paper we will discuss impact of projects carried out un-

ISSN online: 2239-0243 | © 2018 Firenze University Press | http://www.fupress.com/techne
DOI: 10.13128/Techne-23569

der four umbrella programs (termed for the purposes of this paper ECO2, INKA, 6Cities and SMART). We also study whether these programs have created a logical development continuum from one program to another or whether they have been isolated projects that serve only one-time purpose. This study is done utilizing the CITYKEYS (www.citykeys-project.eu) framework.

Methods

Development programs studied

In this paper, we have chosen to study four programs (ECO2, INKA, 6Cities and SMART) that have been somewhat differently initiated programs but all these are under the umbrella theme sustainable development of cities. ECO2 (ECO2, 2016 and Välimäki et al. 2013) is a city initiated multiyear multimillion program that was followed in Tampere by Open Tampere (2010-2016), a similar development program as ECO2 but focused on open innovation. INKA, on the other hand, was a national government program to enhance city development. This was intertwined in Tampere with its own ECO2 and Open Tampere programs. 6Cities is a joint undertaking of the six largest cities and jointly funded by European Union and the cities. In Tampere, this was again intertwined with the local development strategy and funding tool Open Tampere.

We also try to track how projects in these programs paved the way to the current large Smart Tampere initiative of the city which focuses on various aspects of smart city development. Smart Tampere was started in 2016.

ECO2 development program 2010-2015 started as a co-operation initiative between the city of Tampere and the Finnish innovation fund Sitra. The target was to decrease greenhouse emissions and develop eco efficient and low-carbon procedures to do so while creating opportunities for businesses to develop their emerging green business ideas or to provide solutions to that parties involved in the program. The operational model was much the same as of the earlier development programs, i.e. ecosystem approach.

During the last two years of ECO2, its activities were intertwined with the national government innovative city program INKA and its smart city theme (2014-2016) the coordination of which was allocated to the city of Tampere by the national government. By the end of 2015, in Tampere there were 18 INKA projects initiated or underway with financial value of some 14 M€. Smart mobility, smart lighting, energy efficient buildings and industrial symbioses were the major topics under INKA Smart City theme.

As the ECO2 program raised the awareness among the six largest cities on sustainability issues, the cities soon decided that they would attack some challenges jointly. A tool for this was available in the new European Union structural funds program and its city focused ITI initiative. The six largest cities in Finland

Scalability and Replicability
Score 10 High Scalability and replicability, the solution/process can be implemented in at European/Global level
Score 7 Rather high scalability and replicability, the solution/process can be implemented in at national level
Score 4 Low scalability and replicability, the solution/process can be implemented in at regional level
Score 1 Lowest scalability and replicability, the solution/process is city specific
Planet
Score 10 High eco-efficiency/planet indicators, minimises the energy and resource use, uses holistic approach and best available technologies
Score 7 Uses best practices
Score 4 minimum requirements based on legal requirements
Score1 Low eco-efficiency, no specific attention to Planet indicators
People
Score 10 High eco-efficiency/people indicators, high social inclusiveness
Score 7 Uses best practices
Score 4 minimum requirements based on legal requirements
Score1 Low social aspect, no specific attention to People indicators
Prosperity
Score 10 High long term economic performance/prosperity indicators,
Score 7 Uses best practices
Score 4 minimum performance
Score1 Low long term economic performance, no specific attention to Prosperity indicators
Governance
Score 10 High multilevel governance and all stakeholders engagement/governance indicators high
Score 7 Uses best practices
Score 4 minimum requirements based on legal requirements
Score1 Low governance efficiency, no specific attention to Governance indicators

TAB. 1 | Assessment scale

created a joint strategy (termed 6Cities strategy) to attack joint challenges The execution of this 6Cities strategy started in 2014 and continues until the end of this structural fund period 2020. The broad focus of 6Cities falls under three themes: open data and interfaces, open innovation platforms and open participation and co-creation.

The city of Tampere continues its program based regional development now through Smart Tampere initiative (2017-2022) where the goals are to achieve growth and value for all smart Tampere ecosystem participants, to increase smart Tampere ecosystem participants international competitiveness, to attract and grow talent, knowledge and skills in smart Tampere ecosystem to contribute to a sustainable Tampere community and to increase the quality of life in Tampere.

Assessment methods of the programs and projects

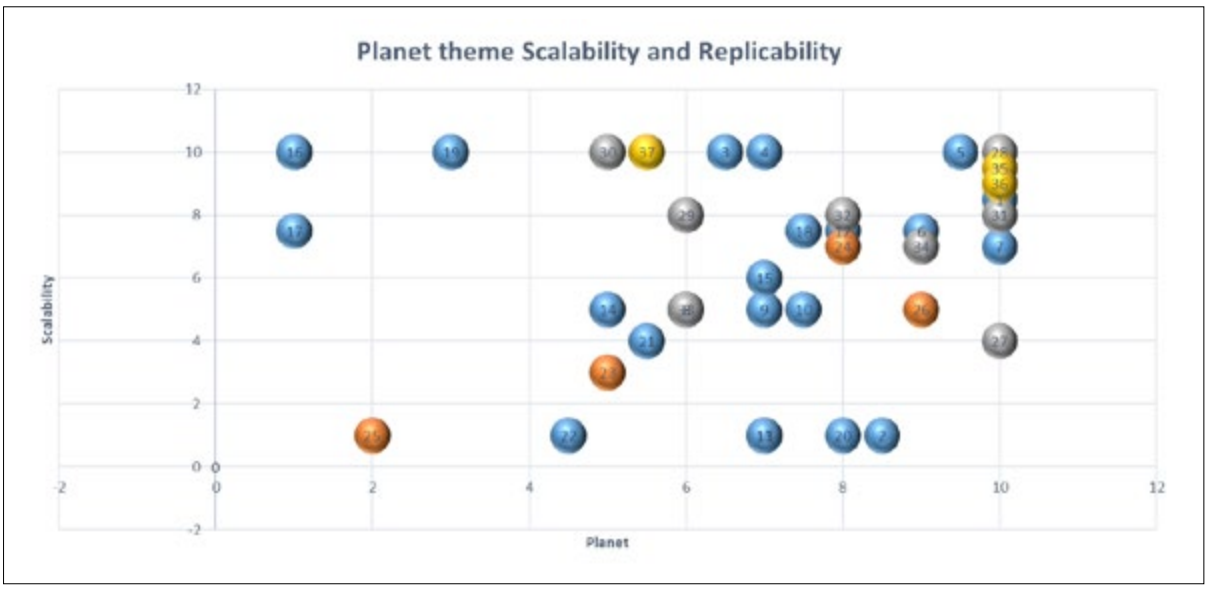
All together 37 projects from years 2010 to 2017 were assessed. From the projects 22 were included in the ECO2 program, 5 to Inka, 7 projects to 6Cities and 3 to SMART. The assessment has four main themes; People, Planet, Prosperity and Governance as well as Scalability and Replicability according to CITYkeys (www.citykeys-project.eu). The projects were assessed with the following scale shown in Table 1. The projects were evaluated by using self-evaluation method and by investigating the finishing reports of the projects.

Results

Planet

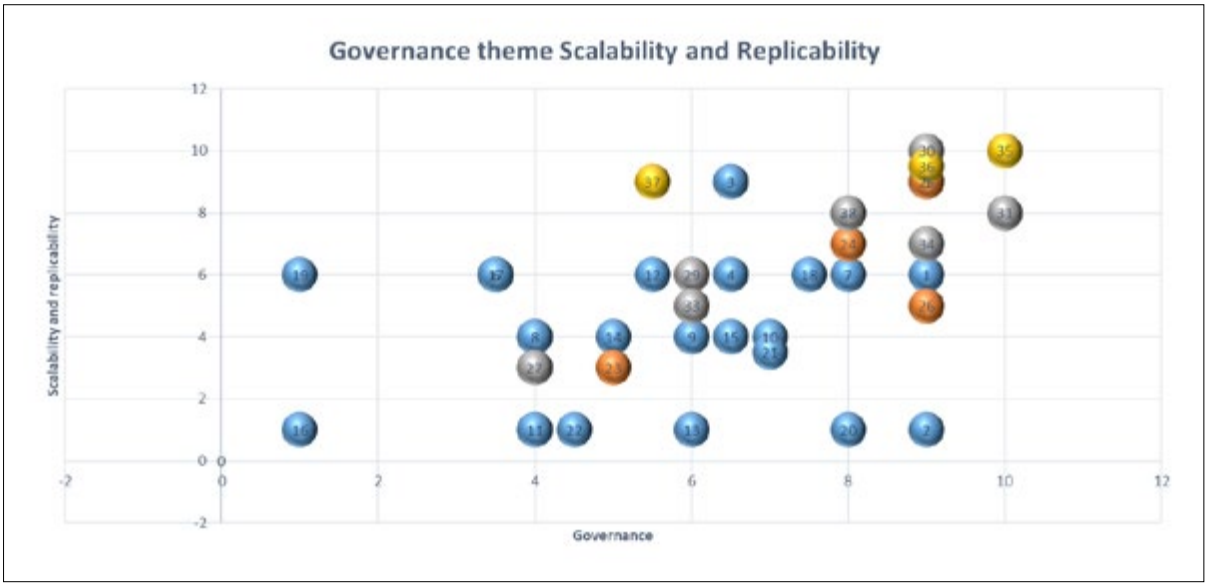
Planet diagram shows that Planet theme scalability and replicability are above average in most of the projects. Also the scalability and replicability tends to be on satisfactory level or higher. The planet theme has been one of the main goals of the ECO2 projects. Even in the first three-year-period the focus has been in developing the new eco efficient and low carbon procedures and co-operation with partners working in the field of energy efficient building and innovative solutions in renewable energy sources (RES). Planet diagram also shows that there are continuums, one project serves as a base towards next project. That is why e.g. project KEKO (#1) stands up as one of the most eco-efficient (high score in Planet theme) and scalable projects. In KEKO project calculation and estimation tool was developed for the carbon footprint and eco efficiency comparison. In Tampere pilot targets of the project were Härmälänranta 2 city plan and blueprint of the Vuores Isokuusi area. Another project that is valued as a base for new projects is #7 OKRA where main goal was to develop control mechanisms for sustainable building methods and roadmap for that. Recommendations from the ERA17-roadmap enables anticipation of the tightening regulations of the energy efficiency especially in the construction field. Härmälänranta pilot area has a continuum in the new project like Horizon 2020 lighthouse project called

01 |



01 | The assessment of Planet theme. Blue circle corresponds to ECO2 program, orange to INKA, yellow to SMART and grey to 6Cities

02 |



02 | The assessment of Governance theme. Blue circle corresponds to ECO2 program, orange to INKA, yellow to SMART and grey to 6Cities

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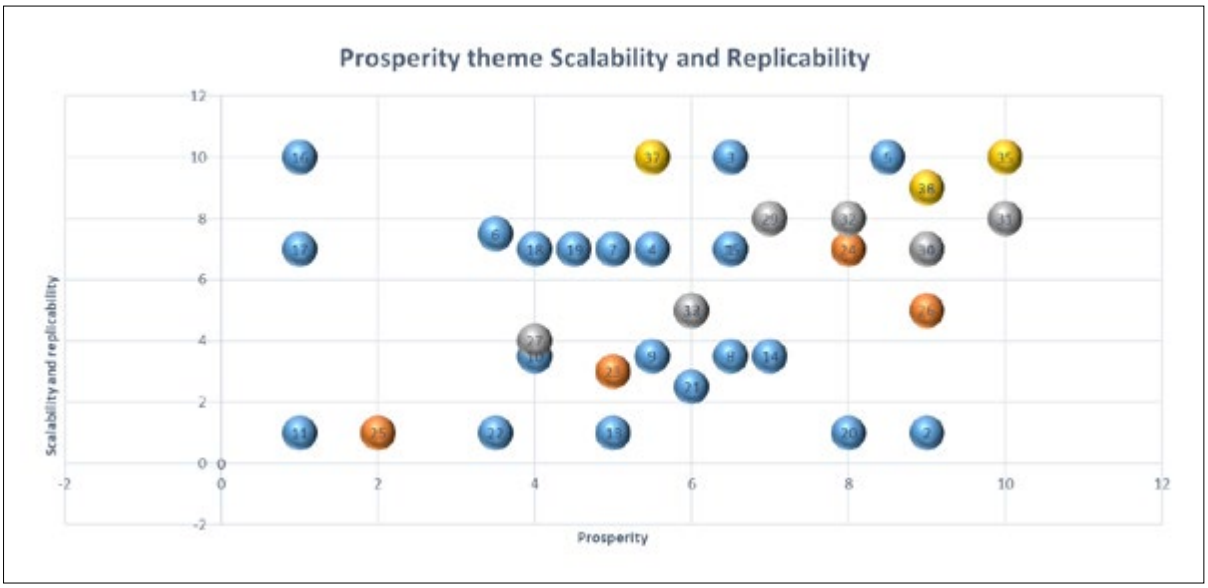


03 | The assessment of Prosperity theme. Blue circle corresponds to ECO2 program, orange to INKA, yellow to SMART and grey to 6Cities

Stardust where Tampere city wants to promote cooperation between actors in seeking the best energy concept which balances the best way the energy supply and energy use by using the best available technologies.

Governance The systematic involvement and coordinated work is visible also in the diagram describing the effectiveness in governance theme and scalability in that side. ECO2 program has implemented e.g. the city strategy of the low carbon and other clean climate targets by coordinating and planning eco efficient procedures and carrying out projects involving solutions in the areas of the green energy, building and smart mobility.

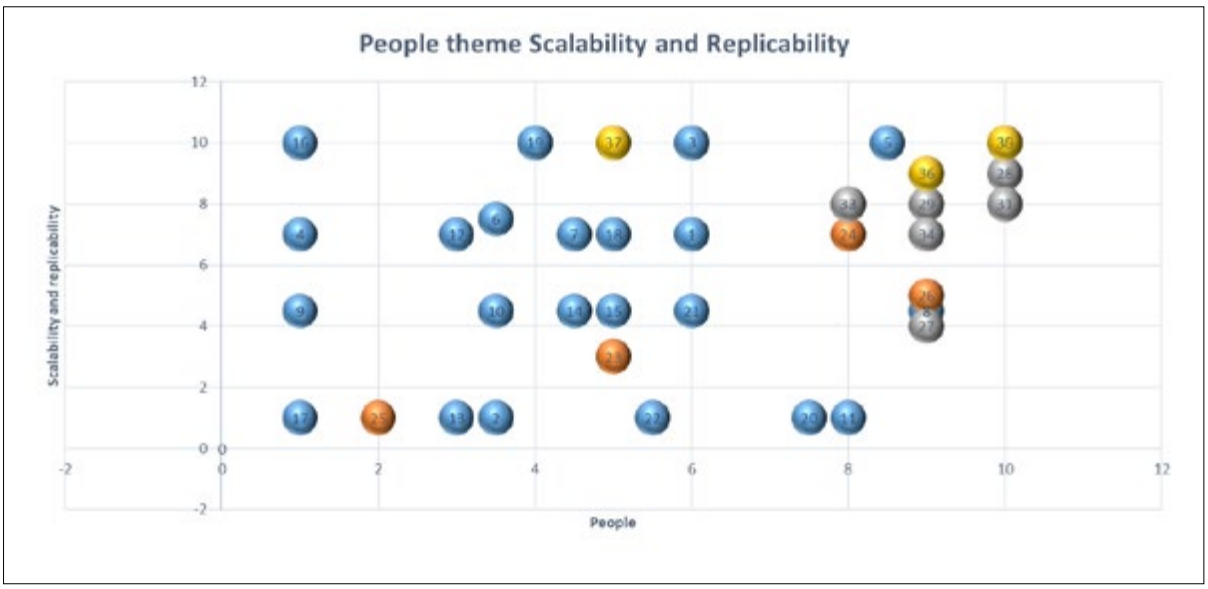
The co-operation between different units within the city organization and with external partners has been important. Communication has been an essential part of the way of acting in the projects. Participation in the EU Covenant of Mayors and targets set by the program were made possible with the determined work done in the ECO2 program. From the diagram we can pick as an example a 6Cities project SenCity which is building a smart LED lighting and digital service platform with sensors in six cities in Finland. In the pilots the aim has been to employ lighting infrastructure as a service platform forming a backbone for internet of things for the cities and partners. The extent to which administrative departments contribute to smart lighting system has been high, and instead of piloting we can talk about

business as usual as lighting has clear plans to be renewed in the entire city and work has been started, and also censoring innovative systems are planned in several areas. Energy efficiency and clear savings were the accelerators that made fast decisions possible. Tampere is also preparing its own 3D model, project #30, and open data and interface project has brought data about the city closer to the citizen.
The city's substantial role as a facilitator and coordinator shows in the governance theme effectivity.

Prosperity

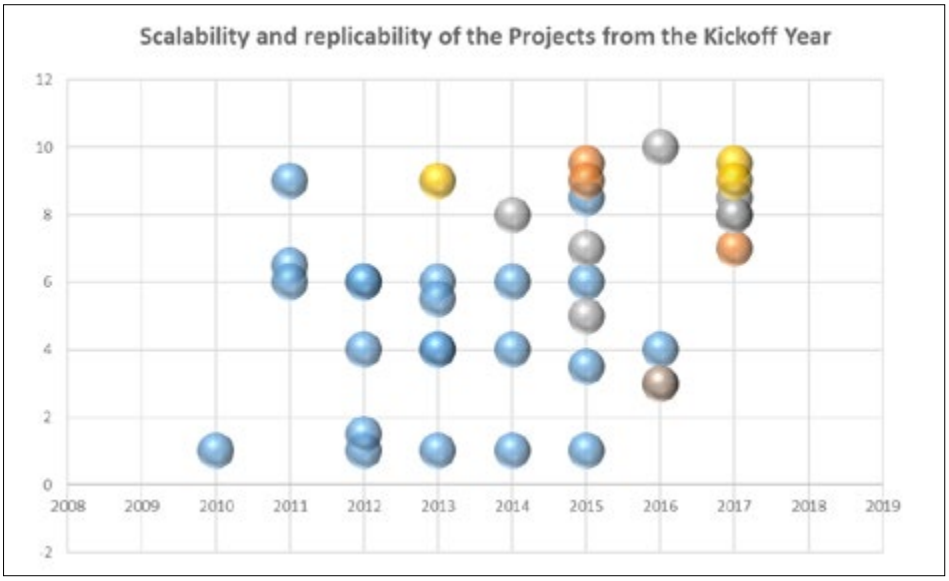
The intention behind each smart city program is to improve outcomes for citizens. In a smart city, digital systems are supporting infrastructures, e.g. using information and communications technology that monitors the safety and operations of energy and water systems, transportation networks, and other services. Prosperity comes from better connected, more efficient and environmentally friendly resulting in a more attractive city people for people to live in and work in. When examining the third diagram (prosperity vs. scalability) it can be seen that projects are spread more evenly in different quarters and effectiveness is more adequate and situated in the middle rather and in the left or right. Prosperity is value that is hard to measure. Project's direct impact towards unemployment rate is difficult to verify. New business models, on the other hand, can be seen as part of the effectiveness of the prosperity theme and correlation towards project can be identified. Projects EU-GUGLE #37 and TARMO (and TARMO+) #8 have made good co-operation and interest amongst housing cooperatives towards energy efficiency has increased in Tampere. Pilots in these projects has been in the essential in boosting up the energy efficient and innovative repairing in the city. CITIKEYS #5 the common key performance indicator projects to smart cities has increased the awareness of the prosperity indicators thus e.g. latest EU Horizon lighthouse projects Stardust #35 and Unalab #38 will have the prosperity indicators as part of the measurements with business modelling and ecosystem implementation, thus the expectations with scalability and effectiveness are high with these projects. Construction business is material intensive field that uses various kind of materials, and also produces tons of waste. Even though waste gets exploited efficiently challenge is the circulation and increasing the level of re-usage of the materials. The sixcity project #31 CircHubs also holds great expectations towards prosperity. It targets to find new business models and activities within hubs of the circular economics and using digitalization. Innovations evolved are planned to be commercialized with co-operation between Finnish cities and with means of transparency overlapping work gets avoided. Overall the effectivity in prosperity theme remains to lower level than in planet and governance themes. Challenge in INKA and other corresponding projects is that operating models and innovation platforms are developed in the schemes that tend to stay disconnected from the city's and other stakeholders' strategic work, and thus the business model creation is deficient. In part of the projects the operation fragmented se-

04 |



04 | The assessment of Planet theme. Blue circle corresponds to ECO2 program, orange to INKA, yellow to SMART and grey to 6Cities

05 |



05 | The assessment of scalability and replicability based on the kick-off of the project. Blue circle corresponds to ECO2 program, orange to INKA, yellow to SMART and grey to 6Cities

verely and projects were lacking collaboration between working partners. The vitality of the city is more often seen as more beneficial outcome than the concrete growth in the business world.

People

Smart city ideology has concentrated on city infrastructure like connectivity and sensors, but the focus has started to move closer to heart of the cities - citizens, people who live and work in the cities. It is important to take into account people aspect also in the measures of effectiveness in the project. People diagram shows the diffused bubbles from left to right. Scalability can be great, but the effectivity of the same project is thought to be low. E.g. in the program #16 TZIIP application for carpool was created. Basically readiness for using carpool is there and the need exists, but for some reason Tziip-application has no users. Reaching people is difficult which in turn affects to the accessibility to city services. In order to get the data closer to citizen, meaning people and companies, communication and dissemination is essential within the projects. EU Horizon projects have clear dissemination plans both global and local ones in order to get visibility and increase the awareness of the smart city projects.

Overall scalability and replicability of the evaluated projects

Comprehension to possibilities as well as problems in efficient city planning in Finland and also in Europe has increased within almost ten years during which eco efficiency projects as well as other innovative and smart schemes have been managed and coordinated. Peer support and learning are important in order to put activities done in the own city into perspective and compare to plans outside own "backyard". Therefore, scalability and replicability are becoming very important elements in the existing and coming projects. This can be also clearly seen in Figure 5, the scalability and replicability of the different projects has been important in last 5-10 years and it seem that especially in the recent years the importance has a high impact. One observation is that there seem to be evolution in time in all scalability vs. planet/governance/prosperity/people diagrams. Namely, when looking at the temporal relation of projects it may be concluded that the later the project has started, the more they are located in the upper right hand corner, having higher scalability and also higher effectiveness on the x-axis (planet, governance, prosperity or people). This would indicate a learning pattern towards projects with larger impact. The same could be observed in Figure 5 (scalability vs. project starting year).

What we may initially conclude from the above, is that the program based approach in city's economic development seems to provide one strand of continuation in implementation of the city's economic development policy and that the impact of its implementation improves. The hierarchical roles of different sets of projects as well as that of the sub-ecosystems that have carried out the project(s) indicates that the ecosystem approach is a useful one.

The projects that are being and have been carried out under the umbrellas of the economic development programs show the increasing role of cities in national or local innovation systems. The role of cities and city regions in innovation has clearly shifted from a solely enabling one to that of an actor. Another crucial change is that cities are now considered as platforms for innovation and co-creation between citizens, companies, research organizations and public sector. The more active cities are in this, the better they will succeed in capitalizing on the novel role of cities in an environment where the speed of chance is unprecedented.

In these (sub)ecosystems value is created to all stakeholders, large and small, private or public. The value may be direct financial value but may well be also indirect such as R&D related, community value etc. The role of the cities is very important in this ecosystem value creation as they are considered to be a neutral body with focus on the public interest, not a vested one.

Discussion and conclusion

The aim of this paper was to focus on how different city development programs have been developing and how they are supporting the city's strategic goals. This paper has shown self-assessment results of 37 projects from four different programs in the city of Tampere. The projects were evaluated against five themes: people, planet, propagation, governance and scalability/replicability. The

themes were based on CITYkeys assessment framework.
As well known, many cities have very ambitious goals for environmental sustainability. This was also clearly shown in the analyses of the projects in Tampere. The planet indicators had high scores. Also, the governance focus has had a high importance in Finnish cities which can be seen also in high scores in governance themes in most of the projects.
The people focus is highest in project themes on smart cities. Some of the ECO2 projects were in nature very technical, e.g. focusing on developing renewable energy generation technologies, which is the reason why they did not score that high in people theme.
One of cities main goals is to scale and replicate good solutions. In addition, the other important goal is to increase the impact of the development project on desired topic. The results clearly showed that the scalability and replicability are becoming very important elements in the existing and coming projects in cities. This could be also clearly seen in the analyses where the scalability and replicability of the different projects has been important in last 5-10 years and it seem that especially in the recent years the importance has a high impact.
In addition to scalability and replicability the importance of enabling and creating new ecosystems and new models for value creation has increased. There is a clear evidence that the urban areas are becoming crucial for supporting new innovations. From our study we could initially conclude that the program based approach in city's economic development seems to provide one strand of continuation in implementation of the city's economic development policy and that the impact of its implementation improves. The hierarchical roles of different sets of projects as well as that of the sub-ecosystems that have carried out the project(s) indicates that the ecosystem approach is a useful one.
Also it can be seen that the development programs in city show the increasing role of cities in national or local innovation systems. The cities are not anymore solely enablers but also active actors. In addition, the city platforms are seen as as platforms for innovation and co-creation between citizens, companies, research organizations and public sector. The more active cities are in this, the better they will succeed in capitalizing on the novel role of cities in an environment where the speed of chance is unprecedented.
In these ecosystems value is created to all stakeholders. The value may be direct financial value but may well be also indirect such as R&D related, community value etc. The role of the cities is very important in this ecosystem value creation as they are considered to be a neutral body with focus on the public interest, not a vested one.
As the role of cities is growing to be paramount also in innovation, this should be reflected in regional, national and EU level innovation policies, funding schemes and regulations as well as in execution of innovations.

ACKNOWLEDGMENTS OF VALUE

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In order to stear the city towards its strategic goals, evidence based research is needed to support and guide cities actions towards sustainability. Therefore this research has much importance for the whole city development frame work.

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