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Spatineo Inc.
www.spatineo.com

Jaana Mäkelä
Author & Project Manager
jaana.makela@spatineo.com

Luukas Raatikainen
Author & Designer
luukas.raatikainen@spatineo.com
Content

1. Introduction ........................................................................................................................................ 1
   1.1 General .......................................................................................................................................... 1
   1.2 Method and materials ..................................................................................................................... 1
   1.3 Reference estimation ..................................................................................................................... 2
   1.4 Big Data and Digital platforms .................................................................................................... 2

3. Geospatial Platform ............................................................................................................................... 3

4. Results ................................................................................................................................................ 4
   4.1 Spatial data in future ecosystems ............................................................................................... 4
   4.1 Bioeconomy .................................................................................................................................... 5
   4.2 Built environment .......................................................................................................................... 7
   4.3 Health and social services ............................................................................................................. 10
   4.4 Traffic ............................................................................................................................................ 12
   4.5 Spatial data in business in general ............................................................................................... 13

5. Discussion ............................................................................................................................................ 14

References ............................................................................................................................................... 15
Abstract

Only about 22% of the annual potential economic benefits from the use of spatial data has been realised in Finland. The annual economic benefits are about EUR 13 billion but only about EUR 3 billion of the potential has so far been realised. The estimated value of the direct economic benefits of the Geospatial Platform is about EUR 150 million and indirect benefits about EUR 400 million, totally EUR 550 million per annum starting in 2025 when the services of the platform are operating in full extent.

This study focused on four ecosystems: Bioeconomy, Built environment, Health and social services and Traffic. The biggest potential, EUR 5.9 billion, exists in the built environment because the value of the business is huge and spatial data and technologies can be used in almost all business sectors both in public sector and private companies. In the more mature ecosystems bioeconomy, potential EUR 1.2 billion, and traffic, potential EUR 1.9 billion, spatial data and technologies have been used for a long time, but new technologies enable new and ever-growing possibilities for the use. The total economic value and potential from the use of spatial data in health and social services is difficult to estimate because good examples do not exist or are hard to find. However, it is clear that the role of spatial data is essential in the new health and social services reform in Finland as the few examples in this study show.

The national Geospatial Platform provides essential spatial data and services to all four ecosystems. The platform is under development but some use cases introduced in this study show already the potential, such as the use of laser scanning data in municipalities to check and correct property taxation. Or how more accurate national address database enables faster response time of first aid and can prevent loss of lives.

This study is a meta-analysis of international and Finnish studies in which the economic impacts of the use of spatial data have been analysed. Results from international studies are introduced as well as how these has been applied to Finnish conditions.

During the project Finnish professionals have been interviewed to get more precise and reliable information for the analysis.
1. Introduction

1.1 General

The assessment of economic value of the use of spatial data and technologies is an interesting but challenging task. A big number of international studies about the topic exist and some Finnish studies as well but this is the first attempt to build a comprehensive understanding about the value that the use of spatial data in products, services and solutions enable to citizens, public organisations and private companies or to the Finnish society.

The need for this study originated from two projects: Public administration’s common spatial data platform project which is a part of the government key project "Digitalisation of Public Services" (Ministry of Agriculture and Forestry, 2018a) and the Report on Spatial Data Policy. The first project builds the Geospatial Platform that harmonises the spatial data of the state, regions and municipalities and makes them available for companies and communities. The platform is introduced in Chapter 3. In the second project the Report on Spatial Data Policy was developed during spring 2018, and it was introduced to the Parliament in May 2018 and is now dealt in committees. The Report discuss the types of spatial data that are needed in the Finnish society, how their production, management and distribution is developed, and how their use is promoted. The vision of the report is: Finland has the most innovative and secure spatial data ecosystem in the world (Ministry of Agriculture and Forestry, 2018b).

The goal of this study was to estimate the economic value of spatially enables services used in Finland and the share of the benefits provided by the Geospatial Platform. In this context spatial data has a broad meaning covering data that has location as an attribute such as topographic data, satellite images, meteorological data, sensor data etc. In general, 80% of all information is spatial information.

This study did not concentrate on assessing the impact and value of open data. Finnish public organisations at national, regional and local level have opened huge amount of their spatial data both for public and business use. Therefore, good availability of open data contributes to the assessed benefits as well. And the contribution is stronger in future when all the services of the Geospatial Platform are available for users.

The study has mainly focused on four ecosystems: bioeconomy, built environment, social and health care, and traffic. There were few main reasons for that. Firstly, bioeconomy and traffic ecosystems have good examples of beneficial use of spatial data since the first digital data bases were available, but all the time bigger potential arise because of new technologies. Secondly, the economic goals of the new health and social services reform are ambitious and the use of spatial data and technologies play an important role in planning and executing the services and meeting the goals. Thirdly, the maturity of the use of spatial data and technologies in built environment is still very low and huge potential exists. Fourthly, the Geospatial Platform will provide spatial data and services that are essential for these four ecosystems.

1.2 Method and materials

This study is a meta-analysis of international and Finnish studies in which the economic impacts of the use of spatial data have been analysed. Results from international studies has been applied to Finnish conditions so that national statistics related to number of users, revenues, salaries etc. have been used. One core requirement for the existing studies that has been utilized in this study is that spatial data has been an essential part of application, service or product that produces the benefits to users. Without spatial data the economic benefits would not have been realised.
The study is based on several use cases that do not represent all possible use cases of the analysed ecosystems. However, they give a realistic understanding of the level of benefits that are achievable. For the assessment of the potential economic value of the Geospatial Platform information the cost-benefit analysis and use cases that has been done of the platform has been used. During the study professionals have been interviewed to get more precise and reliable estimates of the potential and realised benefits and adoption rates in the application areas.

In the results introduce only estimated benefits in euros, costs to achieve the benefits has not been analysed. The economic benefits are shown both as potential values and realised values. Realised values are based on estimated adoption rates of the use of spatial data in each application area.

1.3 Reference estimation

Before the assessment a reference estimation about the economic value of spatially enabled services was calculated. AlphaBeta (2017) has estimated that productivity benefits enabled by geospatial services to retail, transportation, natural resources, real estate, agriculture, utilities, government are more than 20 times the size of geospatial industry itself. Finnish Location Information Cluster (2016) estimated that in 2015 the value of the geospatial industry in Finland was about EUR 230 million. Based on these the economic benefit from services and products that utilize spatial data and are used by private companies and public sector should be already EUR 4.6 billion per annum.

1.4 Big Data and Digital platforms

Big data is large amounts of data produced by people, machines and sensors such as climate information, satellite images, GPS signals or digital pictures and videos. Big data and algorithms are the new super power fuel of the economy (European Commission, 2016a). Spatial Big Data comes from many different sources such as satellites, drones, vehicles, geosocial networking services, mobile devices and cameras. A significant portion of big data is in fact spatial big data (Niemi).

Industrial companies are expected to save 3.6% of their costs per annum by using big data in their daily business. The use of big data for better planning and supply chain analysis enables more efficient use of resources such as waste prevention and reuse. This could bring annual net savings for EU businesses of up to EUR 600 billion. Data-driven decision making has enabled 5-6% better productivity in large companies. The estimation is that digital platforms will capture 30-40% of the value in industrial chains (European Commission, 2016a).

Gartner consulting (2017) has studied Digital Platforms in the context of government and the role of location in these environments as a part of ELISE program. The study was based on analysis of 27 digital platforms representing both private and public sectors. Some of the conclusions are that platforms that are owned or funded by government are more often based on international API standards than consortium specific platforms, digital platforms succeed in 2 or multi-sided markets and ecosystems are an important driver that enables the networking that is essential for digital platforms. And, spatial data plays an essential role in almost all digital platforms that were studied. Spatial data is delivered as a service, it personalizes the service, is an integral part of the service or adds intelligence to the service.
3. Geospatial Platform

The Geospatial Platform (Paikkatietoalusta in Finnish) promotes efficient use of spatial data for better society. The Platform harmonises the spatial data from the state, regions and municipalities and makes them available to users in communities and companies. The aim of the platform is to harmonise and extensively improve e-services provided by the public administration, to improve data-based decision-making and increase transparency, as well as to save public administration costs (Geospatial Platform, 2018). One of the important goals is also to provide spatial data that meet the needs of private companies. Companies have for example requested topographic database that includes feature specific metadata and life cycle information, and accurate 3D data model that contains also buildings (Aalto-yliopisto, 2014).

The Geospatial Platform will offer the following spatial data:

- National Topographic Database
- National Address Information system
- Land Use Plans
- Satellite images

The National Topographic Database will include 3D buildings and structures, traffic network, hydrography, land cover and elevation data. In addition, the database includes geographical names, aerial images, digital elevation models and laser scanning data.

The first phase of the project will be completed at the end of 2019. Ministry of Finance, the Ministry of the Environment, the Finnish Environment Institute, the National Land Survey of Finland are participating in the preparation and implementation of the project as well as numerous partners from the private and public sectors (Ministry of Agriculture and Forestry, 2018b). The beta version of the Platform was published in September 2018 and the Platform will be in full operation in 2025. The common goal of is that the Geospatial Platform is an important part of a successful ecosystem. For example, the KTP service that offers harmonised spatial data already from 40 municipalities (about 3 million inhabitants) is another essential component in the ecosystem (Kuntaliitto, 2018a). Finland is one of the top countries in Europe where this kind of project has been launched.
4. Results

The results of this study are introduced in the following chapters. The estimates of the total benefits are shown in the beginning of each ecosystem. After that use cases and calculations of chosen application areas are described. Figures 2-5 list spatial data that are essential for the application areas in each ecosystem and should be available to reach the analysed benefits.

4.1 Spatial data in future ecosystems

Spatial data has not only value in the four ecosystems that has been analysed in this study but also in other ecosystems such as energy, finance, maritime, manufacturing industry, safety and security and space. For example, in safety and security and maritime the maturity of the use of spatial data and technologies is already at high level. Figure 1 shows the share of each ecosystem of the GDB of Finland (EUR 223.5 billion in 2017), both the potential and realized economic value of the use of spatial data as well as the impact of the Geospatial Platform in the potential benefits. The values of the share of the ecosystems of the GDP have been received from Finnish Location Information Cluster (2018), Balance Consulting & VALOR (2018), The Ministry of Economic Affairs and Employment (2014), Nordic Growth (XXXX), Ministry of Defence (2018), Confederation of Finnish Construction Industries RT (2018) and the RASTI project (2018). Our recommendation for future studies is to estimate the economic value of spatial data in the ecosystems that have not been analysed in this study.
4.1 Bioeconomy

The estimated potential economic benefits from the use of spatial data in bioeconomy are EUR 1.2 billion and the realised benefits are EUR 305-550 million. The share of the Geospatial Platform of the potential benefits is estimated to be EUR 59 million as shown in Figure 2.

In forest industry the impact of the use of spatial data and technologies is divided evenly in different business areas: wood processing, guidance of wood supply, harvesting, remote transportation, wood production and promotion of forestry. The benefits are more versatile than just cost-efficiency (Metsäteho, 2017). The biggest benefits are gained in logistics and wood production. It is assumed that the adoption rate of use of spatial data is already very high 70% because forest industry has used spatial data and technologies as early as digital spatial data was available. However, new technologies and data services enable enhanced use and bigger benefits as forecasted in the Vision2020 of forest industry.

The efficient use of spatial information in forest industry produces annual cost savings of over EUR 100 million.

VISION 2020: The goal for cost savings is EUR 350 million.

Source: Metsäteho, 2018 and Esri Finland Customer Magazine 1/2013

In agriculture the effective use of spatial data and technologies can at best produce 27% savings from the total costs (Allen Consulting Group, 2008). The savings comprehend from following: decreased use of insecticide 33%, labour costs 39%, seed spray and labour 15%, logistics and fuel 25% and machinery investments 25%. In Finland use of insecticides is comparatively low and mainly plant pesticides are used. According to European Commission (2016b) applications for agriculture that use Sentinel-1 and Sentinel-2 data have helped farmers to increase their productivity and efficiency up to 20%. The adoption rate of spatial data in agriculture in Europe is about 50% (ResearchGate, 2015) and the focus is in precision farming. The adoption rate in Finland is estimated as 10%.
The costs of agricultural production in Finland in 2015 were EUR 7 billion\(^1\). The small size of farms, main production lines of cereals and grass and low investing capability enable potential annual cost savings of about EUR 500 million at most.

Source: Luonnonvarakeskus: Suomen maa- ja elintarvikelaitos 2016/2017

Easy-to-use and applications to assess the benefits and costs from the use of renewable energy should be available for citizens. The assessment should be based on reliable and high-quality source data. In this study, only the potential benefits of solar energy were analysed. The Geospatial Platform provides nationwide data such as laser scanning data, topographic data, 3D buildings and trees for companies that develop applications for calculation of the potential of solar energy for buildings. In Finland 34% of households use electrical heating (Statistics Finland, 2016) and the cost is on average EUR 1700 per annum for a detached house (Ollikainen, 2014). For example, potential saving in electricity costs when using solar panels in a detached house in Helsinki is EUR 390 per annum (sunenergia.com). It is estimated that the adoption rate of using spatial data in estimating and choosing solar energy is 3% in Finland.

990 000 households have possibilities to save about 10% of the costs of electrical heating using solar energy.

Estimated total savings are EUR 167 million per annum.

To prevent flood damages City of Pori has made analysis of possible flood damages that cover the whole drainage basin of river Kokemäenjoki. The analysis is based on spatial data such as Digital Terrain Model, soil data, ground water, weather, utilities, flowing waters, elevation data and temperature. Laser scanning and use of multi-beam fathometer enable fast gathering of big amount of accurate data. Information about current situation and past changes are needed for predictions and decision making (City of Pori, 2018).

The study of EuroSDR shows that accurate 3D spatial data can improve considerably the accuracy of flood models which are used to produce flood risk maps. The estimated benefit-cost ratio is 3.3:1. Based on the analysis by the City of Pori the ratio can be much better. According to the study of United Nations preparedness planning for floods that is based on spatial data can prevent even 34% of damages directed to infrastructure. New satellite images from the disaster area should be received in three days to assess the damages (UNOOSA, 2013).

The analysis of the City of Pori revealed that in the worst imaginable but realistic case a flood could course damages worth of EUR 3 billion. The value of direct property damages is estimated to be 50% or EUR 1.5 billion and the other 50% covers indirect damages to business and public sector (City of Pori, 2018). The value of damages caused by floods during 2012-13 in Finland was EUR 20 million (environment.fi). The adoption rate of municipalities using spatial data for flood risk analysis is estimated to be 50%.

37 municipalities have flood risks on their areas.\(^1\)

It is estimated that use of essential spatial data in flood risk analysis can prevent case-by-case property damages even worth EUR 10-500 million.

Source: Flood Map (Finnish Meteorological Institute and SYKE)
4.2 Built environment

The estimated potential economic benefits from the use of spatial data in built environment ecosystem are EUR 5.9 billion and the realised benefits are about EUR 780 million per annum. The share of the Geospatial Platform of the potential benefits is estimated to be EUR 327 million as shown in Figure 3.

Built environment constitutes 80% of the national wealth of Finland. Therefore, it is essential to adapt digital solutions and innovative planning to improve the quality and productivity of operations and speed up the maintenance and repair (ROTI, 2017).

New technologies such as LIDAR, GNSS augmentation, machine guidance, machine learning, sensors and augmented reality enable use of smart 3D spatial data models in planning and construction of buildings and infrastructures e.g. roads, railways, utilities and harbors. The integration 3D data models of built environment produced by private companies and public sector and making those available for potential users, even 20% of planning and construction costs can be saved (Acil Allen Consulting and CRC for Spatial Information, 2017).

In this study the planning in Figure 3 consists of the design and consulting engineering that private consulting companies are doing for built environment. It consists of land use planning, planning of traffic and traffic and buildings and infrastructure. Also, land acquisition and land use decisions as well as building permission procedures that are managed by municipalities are covered here.

The City of Espoo has estimated that they would save IN 2018 even 30%, about EUR 4.8 million, in planning costs of infrastructures if source data would be available as data models (City of Espoo, 2018). The turnover of consulting companies doing design and consulting engineering for built environment in Finland is about EUR 1.6 billion per annum (SKOL, 2018). It estimated that the adoption rate of consulting companies using of 3D spatial data models is 40%.

One great example of how a paper-based municipal process has been reformed into a totally digital process is the building permit process. The digital building permit process is based on several spatial data themes that municipalities and national level organisations produce and the process can’t be executed without spatial data. Municipal building inspection units in Finland get over 1,5 million
customer contacts and handled over 100 000 permits per annum. Over 200 municipalities use digital building permit service. 21 cities (cover 1.68 million citizens) use the digital building control communication system provided by Trimble Solutions Finland and 185 municipalities use Lupapiste.fi application. City of Hyvinkää has estimated that the use of Lupapiste.fi saves building inspectors time 50% or 2.5 hours per one permit (Mäkelä, Tiihonen and Toikka, 2018). According to Ovalgroup (2014) 100 digital building permits bring cost savings of EUR 20 000 to a municipality. The annual cost savings for municipalities of use of digital building permit services is at least EUR 12 million based on the adoption rate of 60%.

The estimated potential cost savings in planning of built environment are EUR 320 million per annum.

The value of construction business in Finland is over EUR 30 billion. However, in current working processes for examples technicians use about 30% of their working time on productive work. Their time is spent on fetching goods, searching for tools and sorting out things. The fragmentation of information is the worst obstacle for the development of productivity (Kauppalehti, 2018). The productivity could be improved if all actors use common data sources and have a common real time situation picture in use. In addition, planning that is based on data models will enhance productivity (Kauppalehti, 2018 and ROTI, 2017).

In Finland the value of new building construction is EUR 12.9 billion and annual investments in civil engineering (roads, railways, utilities etc.) are EUR 4.9 billion. The use of new spatial technologies, 3D data models and real time situation pictures is estimated to reduce annual construction costs as much as 20% (Acil Allen Consulting and CRC for Spatial Information, 2017). The estimated adoption rate of use spatial data in construction in Finland is 10%.

The use of spatial data in construction enables annual cost savings worth of EUR 3.5 billion.

Based on the study by Acil Allen Consulting and CRC for Spatial Information (2017) the use of spatial data in local infrastructure assets management improves productivity by 5%. Continuous use of 3D models integrated into building management systems and facility management decreases operating costs by 1-2% over the life of any building or piece of infrastructure. By introducing building information models (BIM) and related software, services and standards facility management costs could be cut by 30%.

The value of municipal infrastructure assets (streets and public areas, water and wastewater networks, electricity and district heating networks, waste treatment plants) in Finland is about EUR 30 billion. Municipal investments in infrastructure are about EUR 3 billion per annum (Kuntaliitto, 2017a). The use of spatial data is estimated to increase productivity by 5% or produce cost savings of EUR 150 million. The value of annual investments (purchase, use and maintenance) in municipal buildings (schools, kindergartens, sports facilities, office buildings, health and social centres* and rescue stations*) is about EUR 1.5 billion (Talaskivi, 2018). The integration of 3D data models into management systems can bring as much as EUR 30 million annual cost savings. The estimated adoption rate of use of spatial data in asset and facility management in Finland is 10%.

* In future the facilities of municipal rescue, social and health services will be rented to counties that take responsibilities of these services.

The estimated potential increase in productivity and cost savings of the use of spatial data in municipal infrastructure asset and facilities management is EUR 180 million per annum.

City of Kajaani has inspected from the beginning of 2017 their building and dwelling registry using aerial images and laser scanning data. They have found buildings that have no building permit and the owners do not pay tax of those. This inspection is estimated to increase annual tax revenue of the city by EUR 0.5 million (Yle, 2018a). Jari Säkkinen, the Municipal surveyor of the City of Kajaani says that “the building registry includes quite a lot of shortages that have been transferred
to registries of tax authority. As a result of our inspection, the information that the property taxation is based on will be correct and the property taxation will be unbiased for all municipal citizens.” About 100 municipalities in Finland have started or are preparing to start inspections on property taxation. Based on that information the adoption rate of use of spatial data in inspection of property taxation is 30%.

It is estimated that in municipalities the value of buildings outside property tax is EUR 200-300 million.

Source: Yle, 2018b.

Municipalities have possibilities to optimise municipal services and transportations and achieve 10-30% cost savings (Bräysy, 2007). Olli Bräysy states that “the biggest challenge in optimization in general are errors and exceptions of addresses. If you say, ‘In front of K-Store’, it is difficult for the computer to define it as an address”. The costs of Finnish municipalities in task class 9 are totally EUR 2 billion (Kuntaliitto, 2018b). Task class 9 includes: Urban planning, Building control, Environmental management, Maintenance of traffic routes, Maintenance practices of parks and public areas, Fire and rescue services*, Water, energy and waste management, Public transport. Potential annual cost savings using optimization are EUR 200-600 million. Possible overlaps with building and infrastructure maintenance are considered so that the amount of benefits is estimated to be EUR 200 million. The estimated adoption rate is 30%.

In Finland annual repair costs of buildings are EUR 12.6 billion (residential buildings EUR 7.3 billion and other buildings EUR 5.3 billion) and maintenance costs of land and water infrastructures are EUR 1.7 billion (FLIC, 2018). By using both spatial data and technologies and BIM models even 10% cost savings can be achieved in repair construction and in maintenance (Acil Allen Consulting and CRC for Spatial Information, 2017). The estimated adoption rate in use of spatial data in repair and maintenance in Finland is 10%.
4.3 Health and social services

The estimated potential economic benefits from the use of spatial data in health and social services are EUR 255-510 million and the realised benefits are about EUR 36 million per annum. The share of the Geospatial Platform of the potential benefits is estimated to be EUR 48 million as shown in Figure 4.

The costs of health and social services in 2016 in Finland were EUR 17.21 billion. The goal of the new health and social services reform (https://alueuudistus.fi/en/frontpage) is to achieve annual savings of EUR 3 billion.

The Finnish study (Leminen, Tykkyläinen and Laatikainen, 2018) is a great example how combining new health technology and spatial data and technologies can improve patient’s quality of life and reduce costs. In the region of North Karelia total annual follow-up costs of Type 2 diabetes patients are EUR 2.5 million of which travel costs are EUR 0.4 million. At national level by decreasing the Type 2 diabetes patients’ need to travel to health stations annual cost savings of EUR 35-40 million can be achieved. The savings are based on effective use of self-monitoring and analysing the

health stations. When 50% of the follow-up visits are substituted by self-monitoring and spatial analysis are used to optimise the amount and locations of health stations. This brings 60% cost savings to both total follow-up costs and patient’s travel costs.

The estimation is that the use of spatial data in planning and production of health and social services can produce cost savings of 15-30% or EUR 255-510 million.

The study made in the city of Vantaa shows that employees in home care services used 10-18% of their working time in travelling to home visits (Pentikäinen, 2011). It has been analysed that practical nurses use over 60% and nurses use over 40% of their working time in direct customer service (TEKES, 2014).

The number of customers in Finland that received regular home care was 73 806 in November 2017. The annual costs of home care were in 2016 EUR 172 per a Finnish citizen, totally about EUR 940 million (Kuntaliitto, 2017b). The use of route optimisation for home care visits can lead to 15%-time savings (Ministry of Agriculture and Forestry, 2018a). It is estimated that the adoption rate of use
of spatial data in planning home care visits is 40% in Finland.

The annual potential cost savings from the use of route optimization in home visits is estimated to be EUR 13-25 million.

Note: It should be noticed that the concentration too much on minimizing travel time may lead to bottlenecks that are not based on real customer needs (TEKES, 2014).

The improvement in response time of first aid by one minute has saved lives of 152 adults that had cardiac arrests in 2015-2016 (value $322 million) in New South Wales in Australia (Acil Allen Consulting and CRC for Spatial Information, 2017). This would not have been possible without spatial information support systems. The operation of New South Wales Ambulance is based on geographic information systems that use cadastral, topographic, aerial images and address data. Especially address data is critical to operations. In New South Wales in 2015-2016 totally 334000 people were transferred to hospital by ambulance of which 2305 had cardiac arrest. The percentage of people who survived from the cardiac arrest grew 13% from 2008-2009 (406 of 2081) to 2015-2016 (767 from 2305). It was estimated that the share of use of geographic information systems of this growth is 2-3%.

Emergency services in Finland take annually care of about 400 000 urgent first aid tasks (Suomen Yrittäjät, 2016a). If a person has a cardiac arrest or a haemorrhage the first aid should reach the patient in 8 minutes. In Finland accomplishment of this time goal varies by regions from 40-49% to 90-99% from the total amount of alarms (Yle, 2014). According to the Finnish study (Hiltunen, 2016) paramedics cared resuscitations of 2805 people that had cardiac arrests out-of-hospital in 2016. After one year 13.4% or 376 of these people were alive. Based on the experience in New South Wales it is estimated that in Finland the benefit from using geographical information systems so that first aid reaches cardiac arrests in time in Finland is EUR 14-23 million per annum. However, first aid and emergency services in Finland have used geographic information systems in their daily operations for a long time. Therefore, the faster response time could be achieved using more accurate spatial data both in emergency response centres and ambulances. The national address information system, one of the services of Geospatial Platform, that includes data of entrances of buildings improves guidance to targets and shortens response time and prevents loss of lives.

The potential economic value from the faster response time of first aid in cardiac arrests, which is enabled by accurate up-to-date national address database and geographical information systems, is estimated to be EUR 14-23 million per annum.
4.4 Traffic

The estimated potential economic benefits from the use of spatial data in traffic ecosystem are EUR 1.9 billion and the realised benefits are EUR 890 million. The share of the Geospatial Platform of the potential benefits is estimated to be EUR 56 million as shown in Figure 5.

This study analysed the economic benefits that citizens get from the use of journey planner on public transport. Deloitte (2017) made a study for Transport for London and calculated that cost saving of the use of journey planner per passenger per annum. The cost saving is on average EUR 21. The total value proportional to Finland is about EUR 12 million. Another study by AlphaBeta (2016) estimated that time saving per passenger is 6 hours per annum. The total value of savings proportional to Finland is about EUR 75 million. The calculated values for Finland are based on information that the number of employees was 2.45 million in 2016 and 24% of people use public transport (Liikennevirasto, 2017). The value of one hour is EUR 21.30.

The annual economic benefits for passengers using public transport journey planners are EUR 12 - 75 million.

The use of navigation applications in private driving saves a lot of drivers’ time. AlphaBeta (2016) has estimated that the annual time saving is 13 hours per person and the saving in fuel costs is EUR 9 per car owner. In Finland 72% of all travelled kilometres is done by private cars (Liikennevirasto, 2017). The amount of registered private cars was 2.7 million in 2017. It is assumed that adoption rate of navigation applications is 80%.

Estimated annual economic benefits from the use of navigation applications in private driving:
- EUR 24 million savings in fuel costs
- EUR 500 million in time savings

Total potential benefit is EUR 524 million.

Significant cost savings can be achieved in transportation in industry and commerce. The use of transportation planning can reduce transportation costs at least by 10% (Bräysy, 2007;
Transportation planning consists of route optimization, scheduling and load planning.

The revenue of industrial companies in Finland in 2016 was EUR 139 billion (Statistics Finland, 2016). The share of transportation of the revenue was 5.3% or EUR 7.4 billion (Liikennejärjestelmä.fi). The revenue of commercial companies in Finland in 2016 was EUR 121 billion (Kaupan liitto). The share of transportation of the revenue was 5.3% or EUR 6.4 billion. The share of transportation of the revenue has varied from 4.4% (2005) to 6.3% (2008) during 2005-2016. It is estimated that the adoption rate of transportation planning in industry and commerce is 30%.

Potential annual savings in transportation costs are:
- in industry EUR 737 million
- in commerce EUR 642 million

Potential annual cost saving in total are EUR 1.3 billion.

4.5 Spatial data in business in general

In Finland 77% of large and medium sized private companies use spatial data in their businesses. From these companies only 33% use spatial data actively and tailored for their own purposes (Karttakeskus, 2016). In 2016 the revenue of large and medium sized companies was totally about EUR241 billion or 63% of the revenue produced by all private companies in Finland. The revenue of large companies was EUR 160 billion (Suomen Yrittäjät, 2016b).

The biggest benefits are gained from logistics (Karttakeskus, 2016). Spatial information is most used in fleet management and to track people. The value of use of spatial data in transportation planning has been described in Chapter 4.4. Decision making that is based on knowledge management has led to 5-6% better productivity in large companies (European Commission, 2016a). Because 80% of all information is spatial information the share of the use of spatial information could be estimated to be at least 50% or 2-3%. The potential annual impact in large companies would be even EUR 3.2 - 4.8 billion. This value of course overlaps some of the economic benefits that has been introduced in the previous chapters of this study.
5. Discussion

In this study the economic benefits are mostly shown as cost savings. The reason for that is that many case studies or examples that were used in this study concentrate on time or cost savings. Only few examples of new spatially enabled products and services or new business that would have positive impact on the growth of the GDP of Finland have been introduced and analysed. However, for example better productivity in construction sector enables bigger volume of construction projects and thus a positive impact on the GDP.

Because the method to do this study has been quick and straightforward the results contain shortages and there might exist overlaps in the economic values. However, this study gives a realistic overall estimation of the value of spatial data for the Finnish society.

All feedback and new information are welcome.
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