

# Digitalization and smartening sustainable city development: an investigation from the high north European cities

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## Abstract

The European High North (EHN) region faces distinct challenges in terms of socio-economic, cultural and environmental infrastructure. As a peripheral region, it is usually characterised as being geographically distant, with a sparse population, relatively poor physical and economic infrastructure, and far from major administrative hubs located mostly in its southern areas. Integrating new technology as a well-established phenomenon, particularly digital innovation, in regional development strategies has been found enormously relevant and beneficial for the citizens inhabiting this region. In effect, the EHN's sustainability depends on the efficient management of land use and natural resources, economic and human activities, and services and facilities. The expansion of digital technology and its appearance in many areas of the everyday lives of people and communities provide better efficiencies in the context of service design and infrastructural development. Given that the EHN is relatively better progressed than similar peripheral regions and has therefore set an example of modern development in the area of digitalisation, this paper analyses the realities of the cities of Tromsø in Norway and Rovaniemi in Finland as case studies of providing potentially 'smarter', efficient, and modern services that combine development, sustainability, and human wellbeing.

**Keywords:** Digitalization, Smart Cities, Sustainability, Governance, European High North.

## 1. Introduction

Technological advancement is well established in the European High North countries, namely in Finland, Norway, and Sweden. The nationwide promotion of various services using technological innovation is set as an agenda for the advancement of citizens' wellbeing in these countries [1]. However, the EHN region – the region located transnationally in northern parts of these countries – presents distinct challenges in terms of socio-economic, cultural and environmental infrastructure. The region is characterised as being geographically distant and far from major administrative hubs located mostly in the southern parts of these countries. Its peripheral location, sparse population and relatively poor physical and economic infrastructure make the region dissimilar to that of the southern parts of these countries. Integrating new technology, particularly digital innovation, in regional development strategies has been found enormously relevant and beneficial in recent years for the citizens inhabiting this peripheral part. The region's

sustainability is dependent on the efficient management of land use and natural resources, economic and human activities, and services and facilities, in favour of its population.

Today, the expansion of digital technology and its appearance in many areas of the everyday lives of people and communities provide better efficiencies, particularly in the context of service design and infrastructural development. Given that the EHN region is better progressed than similar peripheral regions and has therefore set an example of modern development in the area of digitalisation, this paper examines two cities – Tromsø in Norway and Rovaniemi in Finland – as case studies of cities that provide potential efficient and modern services. In this context, the paper illustrates the concept of ‘smart cities’ and the expansion of its ‘smartness’ to surrounding geographical locations to promote the knowledge of infrastructure and other elements that are typical for such a concept. The concept of ‘smartness’ is inclusive of diverse fields, such as information technology, energy efficiency, transport infrastructure, resource consumption and digital services, in relation to social, political, economic and health-related issues. By elaborating the idea of the smart city concept as it represents a peripheral region, the paper explores the two cases as indicated and evaluates the degree of smartness vis-à-vis the human centred services and infrastructure reflective of their wellbeing. While making such an evaluation, the paper also examines the challenges and shortcomings facing the population in the provision of these services, which may negatively affect them. In the process of making this evaluation, the paper uses human security language to promote an understanding of both human and sustainable development and the threats affecting human wellbeing.

## **2. The concept of smart city**

The idea of ‘smart cities’ is about integrating modern approaches in the governance structure for a better organisation and management of urban spaces. The aim of smartening cities is to promote the most sophisticated citizen-centric services and create an infrastructure using new and innovative technologies from which those living in the cities, others from surrounding adjacent areas and tourists or visitors from beyond the cities could benefit by receiving the most modern facilities. The reality of ‘smart cities’ has been widely considered to include a vast quantity of possible characteristics, encompassing ‘almost any form of technology-based innovation in the planning, development, and operation of cities’ [2]. Even in what is regarded by the term city, the option here is for what could be considered urban spaces.

Today, in the European Union (EU), the expression ‘smart cities’ almost has an official status, after the European Parliament (EP) issued a study ranking cities based on their performance in governance, human flourishing, liveability, mobility, economy and environment. The study acknowledged the following:

“The idea of smart cities is rooted in the creation and connection of human capital, social capital and information and communication technology (ICT) infrastructure to generate greater and more sustainable economic development and a better quality of life [3].”

The EP further conceptualised a smart city as ‘a city seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership’ [4]. Yet, smartening requires other perspectives, where the use of ICT plays an integrative

role. According to Washburn et al [5], ICT offers smooth functioning of ‘critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation, and utilities – [that makes a city] more intelligent, interconnected, and efficient’. As a result, investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure are presented as the way to smarten a city and its surrounding territories because these investments ‘fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance’ [6]. Often the cities are referred to as the ‘systems of systems... [that] introduce digital nervous systems, intelligent responsiveness, and [provide] optimization at every level of system integration’ [7]. Such an integrative approach promotes the so-called ‘urban fairness or inclusiveness’ [8], where smart intelligence (from ICT to open data tools) is available and accessible for all citizens [9] and includes socio-political and environmental components – the interconnectedness of these ICT systems mirrors the physical and human system and makes use of collective urban intelligence [10].

Because cities gather large numbers of inhabitants in relatively small territories, they face more complex problems than do rural areas, such as pollution, traffic jams and massive urbanisation, and solving these complex urban problems depends on the interconnectedness of the aforementioned systems [11]. The involvement of local people with access to technology and a know-how of the usage of technology play an empowering role in governance decisions. Therefore, ensuring public involvement and their participation in the governance structure with technology-based solutions is a prerequisite of smart, sustainable, and resilient cities [12]. The creation of smart cities is about integrating local citizens, who must be treated as subjects rather than objects. The movement is, therefore, from the Internet of Things (IoT) to the Internet of Everything (IoE), making the role of citizens essential for this changing urban reality.

### ***2.1. Infrastructure***

Future cities will be characterised by a horizontal way of management, which aggregates – and integrates – the most essential services and different sectors of governance in a comprehensive way of management [13]. The areas, such as public general governance, energy, mobility, environment, water and waste, economic investment, buildings or social support, will be managed as part of an integrated strategy for each city.

Public managers, such as city mayors or metropolitan leaders, consider their cities smart once the following are present: installed light-emitting diode (LED) lighting and digital solutions for assessing their performance and functioning; analytical and digitalised traffic and transport systems, including electric or soft mobility solutions; the occurrence of management platforms and smartphone apps; efficient tools for energy or water saving systems; smart grids; crime prediction systems; free Wi-Fi connection; and open data platforms or hackathon events for younger programmers [14].

If the city is seen by local decision makers and regulators as a platform for improving governance but also innovation, sustainability and citizens’ wellbeing, the next steps are rather easier to accomplish in the path for smartening the city. Adopting tools for engaging

the community, public officials, academics, companies and families is the fastest way to have an urban space that will not only be more participated in by all but will also be more capable of adapting to change and to the challenges of uncertainty. Therefore, the public officials will have an opportunity to use most urban infrastructures to serve not only the urban dwellers, but also the communities in surrounding territories and of the other towns or villages in the region of those cities who use the cities as central hubs.

### ***2.2. Role of digitalisation and digital developments for smart cities***

The use of ICT, IoTs (or even the IoE, given that today all objects and people are sensorized) and digital tools is central to a smart city strategy. A smart city is often described as the endorsement of digital transformation whereby ‘new methods of innovation and creativity, and new sources of information, are needed to enhance experiences, increase sustainability and resilience, and improve financial and operational performance’ [15]. Without digitalisation, it is hard to see how many urban challenges could be effectively mitigated. ICT solutions placed in digital platforms provide an opportunity to solve longstanding urban challenges in both local and global contexts. The smartening of urban space brings new experiences for local authorities, businesses, citizens, local residents and communities, and for others visiting the space. Today, without digital infrastructure, it would be difficult for any physical space to become smart and sustainable, which is why sensorized and ‘algorithmic’ cities may be seen as platforms for not only economic and social development, but also environmental protection [16].

### ***2.3. Services and smart city***

A city must be understood as an urban territory – where people live, work and visit – and it must serve the surrounding territories and communities (even if they are rural) as a connecting hub. The primary function of local authorities that manage the urban territory is to provide efficient services to protect, and ensure the rights of the residents or dwellers in the territory of the city and around it. Services include monitoring and sensorizing [17] – everything that happens in a different array of sectors, which naturally eases the development of a more efficient public service by local authorities. Examples of those sectorial services include water, energy, housing, transportation, a healthy environment and even available employment opportunities. A city without these services – or characteristics – can hardly maintain its residents’ smart living within its territory.

### ***2.4. The smartening of cities complements sustainable development***

Environmental protection and the efficient use of resources is usually an essential factor of motivation for the implementation of smart city strategies. In this sense, fostering the use of ICT tools is a way of promoting more efficient solutions, which will improve the state of economic activities and, simultaneously, make better use of the resources within the territory of the city. Therefore, smartening cities essentially involves promoting sustainable development [18]. It is broadly known that the definition of sustainable development involves a (should-be-equal) balance between economic, environmental and social growth, bearing in mind the wellbeing of future generations. Smartening a city may result in sustainable development by increasing the usage of monitoring sensors for traffic congestion, transport, pollution, climate phenomena, urban waste and even for the watering of parks. Law and governance play a relevant role. The elements of regulation, enforcement

and impulse for new and innovative solutions include public participation and citizen engagement. Planning, monitoring and flexibility to adapt to technological, environmental and social changes and evolutions are inherently integrated in the process to make cities more resilient and capable of evolving not only within their territories but also among communities and residents.

### ***2.5. Smart cities: Risks and opportunities for residents***

The goal of smartening a city is to promote the overall wellbeing of city dwellers. Therefore, investing in ICT, IoT tools and analytics to make a city smarter will essentially improve the lives of the people who inhabit its territory [19]. In any smart city process, city residents are not only treated as the object; they are increasingly becoming part of the process as subjects as they participate in the city smartening processes. It is true that decision-makers and city managers naturally work to promote the wellbeing of the lives of those citizens who inhabit the urban space, but the processes of smartening urban territories must be implemented with the participation of those who are the addressees of public local policies. Therefore, putting their (public) interest and wellbeing first is negotiated through various approaches used in democratic and good governance, such as social, environmental, and human rights impact assessments. At this point, the implementation of the Aarhus Convention should be mentioned as a relevant instrument to empower people with the rights to access information, participate in decision-making in environmental matters and to seek justice. Actually, this instrument is legally binding and it has been helping states (and local public authorities, such as in cities and their surroundings) to respond to many challenges facing the world: from climate change and the loss of biodiversity, air and water pollution to poverty eradication and security (see the UNECE webpage at <https://www.unece.org/env/pp/introduction.html>).

However, possible threats to citizens in the process of expanding digital infrastructure include threats related to cybersecurity. Using smartphones and other electronic devices as sensors and connecting to human activity through digital services for services such as banking enables the dissemination of personal data, thus putting issues relating to human rights, such as the right to privacy or right to be protected from material loss, at stake. Within the institutions of the EU, a remarkable advancement on this topic was the General Data Protection Regulation (EU) 2016/679 of the EP and of the Council set on 27 April 2016. The regulation provides protection for natural persons as it relates to the processing and free movement of personal data. With this regulation, EU Law addresses the challenges of digitalisation. The regulation thus complements the requirements for smart cities with a legal backup that actually protects the rights of the citizens.

## **3. The Northern Cities**

### ***3.1. Methodology***

The following section presents the results of the analysis of primary and secondary sources of information. During 2018, qualitative interviews and formal and semi-informal conversations were carried out with local authorities or policymakers and professionals in the fields of engineering, medicine, transport, urban planning, architecture, design and energy and a few local inhabitants. The participants belonged to the public and private sectors. The interviews and conversations addressed the ongoing 'smart development' in

Tromsø and Rovaniemi. The participants were chosen based on their profiles and public visibility, as they worked with initiatives and projects that can be connected to the ‘smartening’ of the cities. Official websites and local and national newspaper sources illustrating or contrasting the idea of the smartening of the cities were also used. Additionally, local and national work plans and reports, including official plans for the ‘smartening’ of the city using ICT and innovative and environmentally friendly solutions, were used.

### **3.2. Tromsø**

#### **3.2.1. Description of Tromsø as a modern Arctic city**

Located north of the Arctic Circle, the island-city of Tromsø is the most populated city in northern Norway. An affluent Arctic capital with a population of 76,712 [20], Tromsø is connected to the mainland by Tromsø bridge and Tromsøysund tunnel. Tromsø belongs to the Troms county and is also connected to the island of Kvaløya by the Sandnessund bridge. Tromsø has been an important region and economic force for the rest of Norway for centuries, and before its status as city in 1794, it was considered the gateway to the Arctic and was used as an important meeting point and as a starting point for famous Arctic explorations. The Norwegian Sea, which surrounds and extends beyond the city, is a marginal sea in the Arctic Ocean and is rich in numerous resources. Today, the Norwegian Sea continues to be important as a means of transport and communication, and through its natural resources, it continues to foster profitable industries and a flourishing economy.

The city’s location in the Arctic has also meant that it is bounded by the harsh cycles of nature and climate. The sub-arctic climate of Tromsø is characterised by heavy snowfalls and cold winds during the long winters. Winters last about six months, and polar nights occur from the end of November to mid-January. Rainfalls also occur, often creating icy, slippery roads and, consequently, dangerous driving conditions. Tromsø has all the elements of modern cities: alongside a university, namely the University of Tromsø – The Arctic University of Norway, and important research centres, cultural centres, museums, diverse festivals and cultural events, it offers its inhabitants a great number of services, urban infrastructures, large industries and a growing entrepreneurial sector.

#### **3.2.2. Digital development/infrastructure in Tromsø**

An island-city surrounded by high, rugged mountains, Tromsø has multiple IT-based solutions for improving the management of the city. The following section discusses some of the digital infrastructure already present in Tromsø taking energy, the health sector, urbanism, transport, services, leisure and governance as starting points for further discussion.

*Electricity:* The Norwegian government made it mandatory that, by January 2019, all households in Norway should have smart meters installed [21]. A smart meter is an electronic device that monitors, records and reports the hourly consumption of electric energy in households. The information is then sent to the electricity supplier. An analysis of the information can tell much about users’ energy use and behaviour patterns. For instance, the data can report if a person is at home or away, at work or on vacation, whether they sleep, do laundry or watch TV, and reveal information on how often they use electrical



devices. Even though the premise behind smart electricity meters is that they will help to save electricity and reduce costs, the compulsory installation of such technology has been controversial. The personal information that is gathered on consumers could potentially be used by third parties for advertisement purposes or by authorities, insurance companies and employers. Numerous cases from citizens against the forced installation of smart meters have been raised in local or national newspapers. Additionally, websites and social media groups with up to nearly 15,000 members have been created, such as the Facebook groups *Nei til Smartmeter med mer*, *Stopp strømmålere*, *Nei til Smartmåler Norge* and several smaller groups. Despite the enthusiasm of electricity companies and the government assurance that the radiation is insignificant, the social media groups and public cases taken up by the newspapers show that the opinions regarding the risks and benefits of smart electricity meters or advanced metering infrastructure are quite divided. Thousands of citizens have also raised concerns about the health risks due to radiation and surveillance as another main issue concerning such technology.

*Health sector:* Tromsø is known for the early adoption of telemedicine services to serve the population living in rural, scattered and isolated areas in the Arctic. Telemedicine services have been offered for more than 25 years [22], and the Norwegian Centre for E-health Research is located in Tromsø. Its predecessor, considered the world's largest centre for research and development in telemedicine and e-health, was also based in Tromsø [23]. Noticeably, a continuous digitalisation of the health sector has increased healthcare cooperation and innovation at a regional level. Although in a limited way, telemedicine services have been used in emergency care and in the areas of radiology, ophthalmology, cardiology, dermatology, obstetrics, prenatal care, oncology, dentistry, geriatric care, diabetes control, psychiatry and mental health. Additionally, electronic journals recording patients' health data and allowing communication between users and authorised doctors and health personnel have been used since 2015 [24]. Most of the medical prescriptions are also given electronically, and medical appointments can be scheduled online. It is also worth noting that in Norway, several health-related apps have also been launched in the last few years. Some of them allow patients to have a better overview of their health conditions, helping them and doctors to monitor their treatments.

*Emergency preparedness and rescue operations:* Tromsø is surrounded by mountains, and during the long winters, people go to mountaintops to practice traditional winter sports such as skiing. Drone technology is currently used for risk assessment and management by the Red Cross in Tromsø, particularly in the occurrence of avalanches. This technology helps mountain rescue teams obtain better knowledge of what may lie ahead by sending relevant data or images of the impacted areas. This technology thus facilitates preparation before reaching the areas from which people need to be rescued. Location apps in search and rescue helicopters (also known as air ambulances) and real-time videoconferences have also made it possible for medical personnel to be better prepared before a rescued patient arrives at the hospital or medical centre.

*Smart highways:* The construction of a smart highway is also part of the city development plans for Tromsø. The E8 highway, known as *Europavei*, is a Norwegian highway going from Tromsø to the border of Finland, reaching Kilpisjärvi. During the spring of 2018, cars

were driven across the border of the county of Troms to test positioning equipment for self-driving cars on the test roadside area on the E8 highway [25]. Trailer-platooning, a system where two or more trailers are controlled by a leading vehicle through wireless communication employing radar and video technology, has also been tested [26].

This research project, known as E8 Borealis, is being conducted by the Norwegian Public Roads Administration and is currently being developed using the 40 km of road joining Skibotn to Kilpisjärvi. The project, also a result of a Norwegian and Finnish collaboration, is expected to be finalised in 2021. The project may highlight the diverse technological issues to be solved before the implementation of smart technology on highways can take place safely. For instance, special road conditions during the Arctic winters must be safely addressed. Similarly, the use and information coming from monitoring technology that provides information on traffic, roadways and drivers must be regulated and secured.

E8 is important to the industries, particularly the seafood industry and freight transport. It is equally important for the civil population in Troms county and northern Finland, populations that face issues specific to this region. Making E8 a smart highway through intelligent transport systems (ITS) could help to solve some of these issues. For instance, drivers in the High North are highly likely to meet Arctic animals crossing the roadways or highways, especially reindeer or moose, sometimes resulting in car accidents and even deaths. The new ITS may help to reduce the number of accidents [27] because self-driving cars equipped with sensors or technology that detect people, other vehicles or even arctic animals could prevent accidents and other issues that are often encountered during harsh winters. ICT can be used to establish communication between vehicles and roadways. Real-time information regarding the weather, road conditions, traffic and traffic hazards, auto-scanning of the vehicle's brakes and warnings regarding obstacles in the roadway would also be provided [28], resulting in safer, more effective and environmentally friendly driving conditions, especially in the winter months.

*A green shift in ship traffic:* Tromsø is a city that receives many tourists annually. Essential to that is the Norwegian explorer cruise line, Hurtigruten, which sails in the Arctic and Antarctic and has headquarters in Tromsø. Tromsø is located by the sea coast where ship traffic has a significant negative effect on the air quality and the sea of Tromsø is sixth place in a ranking measuring consumption of oil by ships at the port [29]. Hurtigruten builds new expedition ships using a new and environmentally sustainable hybrid technology [30]. It is expected that such technology will reduce fuel consumption and CO<sub>2</sub> emissions from ships by approximately 20% (3,000 metric tonnes of CO<sub>2</sub> per year). The aim is to sail with fully electric expeditionary ships.

*Cars and alternative transport solutions:* Currently, 1,889 electric cars are driven in Troms county alone [31] and over 140,000 in Norway [32]. Electric cars contribute to reducing air pollution, as they do not emit the pollutants that cars do, such as hydrocarbons, carbon monoxide and oxides of nitrogen. By June 2018, 94.7% of the electricity in Norway came from hydro power [33]. The biggest recharge station for electric cars in Northern Norway is being built in Tromsø, with 274 charging points in one place alone [34].



Tromsø is becoming an increasingly popular place to reside; it is estimated that it will have 15,000 (20%) more inhabitants by 2030, which would increase daily car trips by 30,000. Under the project known as ‘Think Tromsø’ (Norwegian: *Tenk Tromsø*), the local authorities’ plan for the next decade is to improve road networks and road safety by building new roads, walkways and cycle routes and creating better collective solutions [35]. The development of these sustainable transport alternatives is considered essential for meeting pre-established local and national climate targets [36].

*Emissions-free buses:* Collective environmentally friendly transport is also a priority. In 2018, the municipality of Tromsø bought the first two electric buses. Testing will be conducted in a one-year period to evaluate the bus’s performance in the harsh Arctic weather conditions and the steep hills or slopes that characterise Tromsø. The city’s goal is to have all collective transport emission-free in the near future.

Additionally, in the transport field, local transport apps such as *Troms Reise* have made a big difference for the inhabitants of Tromsø. The app features real-time information on the arrival and departure of buses, informing users of eventual delays or cancellations, which are not uncommon during heavy snowfalls or bad weather. By accessing this information, local inhabitants have been able to plan alternative transport routes better and reduce prolonged waiting times at bus stops, a situation that can be quite hard to bear in a subarctic climate.

In sum, the use of smart technology in the transport field in Tromsø can potentially lead to cleaner air and safer water. Pollution is the leading environmental cause of disease worldwide [37]. Thus, reducing or potentially eliminating CO<sub>2</sub> would enhance the quality of life of local inhabitants and contribute to reducing global carbon footprints.

*Smart governance:* The municipality of Tromsø has a website and active Facebook and Instagram accounts. These digital platforms serve to inform and communicate with citizens. Through these platforms, citizens can reach the municipality’s workers and, to a limited extent, local authorities. The active use of these online platforms is aligned with Norway’s plans and steps for e-democracy and e-governance [38].

*Smart energy:* In 2017, the Arctic Centre for Sustainable Energy (ARC) was established in Tromsø. The Centre focuses on Arctic challenges, renewable energy and greenhouse emission management and has as a goal to create sustainable societies in the north. One of the most important projects relates to the use of solar cell panels as energy systems in cold climates. A solar cell is an electrical device capable of converting solar energy into electricity. During the harsh winters, the power of the panels intensifies, aided by the cold temperatures. Additionally, the Smart Arctic Buildings project has recently obtained funding to develop different smart and renewable energy solutions that will reduce energy use in households. Although the project will start to be implemented in Narvik, a nearby city, and in Longyearbyen, it is expected to expand throughout the Norwegian Arctic [39]. The integration and installation of smart sustainable technologies, such as solar cell panels on houses or buildings, would mean for inhabitants in Tromsø the possibility to produce their own electricity, which would ensure that no additional pollutants or emissions would

be released. Producing their own electricity would also eventually result in an economic benefit, as it would decrease the amount of electricity bought from companies.

*Smart housing:* Telenor, one of the main multinational Norwegian telecommunication companies, presented a smart house built to an elder [40]. The goal was to provide the elderly with greater freedom, enhance their quality of life and provide them with better security and care. In the ‘smart house’, plants can be watered by just saying words such as ‘the plants need watering’. Moreover, the lights are automatically turned on and off when a person enters or leaves a room and a cleaning robot is present. A virtual personal assistant can tell where items such as keys or a purse are located, lock the main door and work as a system that informs or alerts the medical personnel or hospital if something serious occurred. Sensors, smart devices and voice control systems used in smart houses completely rely on Internet and the IoT. The population of elders in Norway is rapidly growing [41] and it is thus expected that smart houses will be built to assist their needs within a few years. In Tromsø, the smart house concept is rather incipient and just a few companies, such as Nordic Smart House, Arctic Installation AS and JM Hansen, have started to offer housing alternatives with integrated smart solutions.

*Design and architecture:* Just a few years ago, NODA, the biggest design and architecture centre in Northern Norway with headquarters in Tromsø, launched a *service design* programme whose aim is to help make Tromsø smarter by teaching municipalities how to design services that involve end users. It is expected that by first addressing end users’ needs and getting input from diverse sides, innovative technology or solutions can be applied to help create satisfactory services and urban spaces.

### **3.2.3. Is Tromsø smart enough?**

Despite the above progress, Tromsø still has a long way to go before it can be considered ‘smart enough’. Nevertheless, the city is steadily embarking on a path towards the smartening of its services and sectors. The preliminary results from our interviews indicate that it is in the interest of authorities to continue working towards the smartening of Tromsø. The city is also on a path to promote urban sustainable development, with policies that aim to face the challenges of the future. Currently, numerous ICT tools are used at different spheres (at the civil society level and public and private sector, for instance) to optimise time and improve efficiency, coordination, transnational cooperation, work and operability, thus reflecting in economic and social benefits for the city.

Seemingly, an analysis of some of the sectorial services in Tromsø shows that areas such as energy, transportation, health services, healthy environment, governance, and search and rescue operability have made significant progress towards the smartening of the city. Nonetheless, areas such as public governance have ample room for innovation and development, aided by ICT solutions. Tools for engaging the community that address their needs can transform the social and urban landscape in a positive way. Areas such as arts and culture, leisure, tourism, general urban development, architecture and design are other areas where smart development could contribute to the creation of inclusive and sustainable spaces that connect people and address their needs.

Similarly, the smart monitoring – and sensorizing [42] – of public services such as water, housing, public lightning, transportation or environmental factors require further development. Information security and Internet access reliability in the city working towards its ‘smartness’ is also crucial, as the digitalisation of services calls for increased security to keep its operability and efficiency.

### **3.3. Rovaniemi**

#### **3.3.1. Rovaniemi as a modern Arctic city**

Rovaniemi is characterised by a few specificities. Since the rural municipality and the city of Rovaniemi created one entity in 2006 (rovaniemi.fi), the total area of the municipality is 8,016 km (visitrovaniemi.fi). This area constitutes the biggest city area in Europe, giving a reason to analyse Rovaniemi not only as a smart city but also as a smart territory that could be understood as an urban area of the city with adjoining, sparsely populated rural areas, where inhabitants live in the administrative area of the city and partially depend on services provided by the city. The municipality has over 62,000 inhabitants (rovaniemi.fi), of which less than 10,000 live in rural areas (infopankki.fi).

The urban area of Rovaniemi is located a few kilometres south of the Arctic Circle; however, a large territory of the whole municipality lies north of the Arctic Circle. Many ongoing activities in the city relate strongly to the Arctic Region. For example, the tourism industry markets the city as the Arctic City, where tourists can experience specifically Arctic phenomena such as the northern lights and midnight sun. In addition, tourism is focused on the Christmas period, due to the presence of Santa Claus village just on the Arctic Circle. Touristic activities are strongly related to the occurrence of snowfall [43]. Both Lapland University of Applied Sciences and University of Lapland incorporate Arctic studies into their curriculum. Furthermore, Rovaniemi is characterised by a subarctic climate with long, cold winters and heavy snowfall. The climate contributes to the specificity of the city, affects the ways of inhabitants’ lives and generates the particular needs of the city management. The harsh weather conditions have to be kept in the minds of municipal services planners. The weather affects the transport, electricity, schedule of renovations and building of infrastructure. The weather may also be an obstacle to providing healthcare, especially in remote areas.

#### **3.3.2. Indicators of a smart city in the context of an Arctic territory**

The remoteness of settlements in rural areas of the municipality may be a reason for the development of ideas for establishing smart territories rather than transforming the urban area into a smart city. An example is the vision of Arctic Smart Village 2030 developed within the framework of a project: ‘Arktinen erityisosaaminen – Liiketoimintamahdollisuudet ja kilpailuetu suomalaisille yrityksille’ [44] conducted jointly by Lapland University of Applied Sciences and VTT Technical Research Centre of Finland [45]. The vision incorporates implementation of the IoTs in the infrastructure, which is supposed to make data transfer and management easier. With the IoTs, the data flow would not be limited to the Arctic; it would reach the global network.

The vision of the Arctic Smart Village incorporates a list of solutions focusing on energy saving and sustainability, which include smart lighting using LED and self-adjusting

systems and electric cars equipped with zero-emission technology. Because of poor public transport networks, private cars are the main means of transportation in the rural areas of Rovaniemi; hence, paying attention to the emissions they generate is important. The energy production in the presented vision of the Smart Arctic Village is supposed to be local, with the exclusion of big energy-providing companies. The utilisation of wind and solar energy is proposed – an intelligent distribution system should be steered with a strong use of ICTs. An element of design of the Arctic Village that is important to the energy saving process is smart housing. Houses saturated with sensors that allow users to control and adjust the energy use according to their needs should serve as accommodations for inhabitants. In addition, building materials should be ecological and energy efficient. Cross-laminated timber (CLT) is given as an example of such a building material. Construction projects should be created with strong support of new technologies with the use of Building Information Modelling (BIM) [46].

According to the former Head Architect of Rovaniemi, Professor Tarja Outila [47], ‘a smart city is a city where people can concentrate on their normal life, and not on processes’. She points out the systems existing already in the urban area of Rovaniemi, such as roads’ maintenance systems, modern district heating system and access to public services online [48]. These solutions incorporating technological innovations make everyday matters, such as keeping a house warm, transportation and tax settlement, much easier for city dwellers. Users can utilise the time and peace of mind gained by using the smart solutions to maintain, for instance, a work-life balance – a healthy ratio of time used for work and obligations and for resting and private life.

### ***3.3.3. Elements of a smart territory present in Rovaniemi and its surroundings***

Some of the abovementioned solutions are planned to be implemented in a test smart village. The company ASV Arctic Smart Village Ltd. aims to establish a built-from-scratch Arctic Smart Village (Älykylä™), in which costs of living would be lower than in contemporary settlements. One of the planned places for building the village is the area of the municipality of Sodankylä, neighbouring Rovaniemi. At the time of writing, a smart living neighbourhood was being developed in Utajärvi village in the North Ostrobothnia region (Arctic Smart Village Oy, n.d.). The concept of the smart village envisioned by the company includes the previously mentioned energy-sufficient solutions and ecological housing and introduces elements of a sharing economy and collaborative consumption; that is, ‘the peer-to-peer-based activity of obtaining, giving, or sharing the access to goods and services, coordinated through community-based online services’ [49]. In January 2019, 26% of all the apartments in Rovaniemi were listed on AirBnB, an online platform service allowing users to rent a private apartment, mainly as accommodation for tourists and other visitors of the city. Such a high percentage of AirBnB houses gives Rovaniemi the Finnish city the highest penetration of the sharing economy in the area of housing [50]. The strategy of ASV Arctic Smart Village Ltd. lists vehicles, such as cars, boats, snowmobiles and bikes, which can be shared or co-owned by inhabitants. Elements of modular houses could also be passed on or sold to increase their usability. The sharing economy component of the Älykylä™ is strongly connected to the sense of community amongst inhabitants (Arctic Smart Village Oy, n.d.).

Arctic smart rural areas that could be established in Rovaniemi municipality are now just in the planning stage. The features of a smart village are slightly different from those of smart cities. The emphasis is on lowering costs of living for inhabitants and building a strong community as a network for sharing services and goods to optimise their usability. There are some possibilities for introducing the features of the smart village to urban areas. As the CEO of ASV Arctic Smart Village Ltd., Juri Laurilla [51] stated, ‘There is a lot of work to do before we can change the way of thinking. The Arctic Smart Village [Älykylä™] could be established as a living area in cities too if the politicians are willing to let go of the old thinking and fast winnings (2018). An advantage of creating a smart rural area is that it can be built from scratch and properly designed beforehand. To establish a fully smart urban area, obstacles such as ossified ways of thinking about urban planning and existing already old-fashioned infrastructure have to be conquered. Although such adaptation of already existing urban infrastructure might be challenging, it is still possible and necessary for smartening a city. The ideas presented herein reflect these definitions of a smart city, which put emphasis on using ICTs to improve the quality of life of inhabitants and strengthen public participation.

### ***3.3.4. Elements of a smart city present in Rovaniemi***

Rovaniemi already contains elements of a smart city in its infrastructure, energy management and services. In cooperation with the Roadscanners company, in 2000, the City of Rovaniemi started the Street Doctor project ‘to provide objective information about the street network condition and its trends for city engineers and city decision makers’ [52]. The Roadscanners company uses modern digital technologies, such as ground penetrating radars, laser scanners and thermal cameras, to periodically monitor the quality of the city roads and detect maintenance problems at the early stage [53]. These technologies help to manage the road infrastructure more efficiently and cost effectively and assesses the quality of maintenance work being conducted.

Energy and water in Rovaniemi are supplied by the company Napapiirin Energia ja Vesi (NEVE), owned by the City of Rovaniemi. The district heating system provided by the company is based on green technologies and biofuels from Northern Finland (lapland.fi). In addition, the modern Suosiola power plant of NEVE located in Rovaniemi benefited from the services offered by Valmet Corporation. The service provided by Valmet was district heat network optimisation and production planning incorporated into the district heating system [54]. The outcome of this activity should be to lower the costs of the city electricity and heating production, and to improve control over processes.

Examples of accessing online services offered by the city to its inhabitants include the ability to apply for a building permit online, the online service Wilma, which allows students and their parents and teachers to communicate online, and the ability to manage administrative and organisational matters related to education. The website of the city also has a link to Lapland Library Consortium, where it is possible to access and search through resources of libraries of Lapland (rovaniemi.fi).

In the case of Rovaniemi, equal access to online services for all inhabitants of the city is strongly linked to the broadband connection availability in the sparsely populated remote

rural areas. The City Strategy 2025 incorporates elements of equal access to services through electronic and mobile means in the distant, rural areas of the city. Another important reason for the necessity of a broadband connection is access to the job market and promotion of telework (Rovaniemi Kaupunki). As Tarja Outila [55] underlined, private companies are not sufficiently interested in providing broadband connections to these areas because the low number of potential clients would make it unprofitable. The City of Rovaniemi has thus created its own company, which has taken the responsibility of providing Internet connections to all inhabitants in remote areas of the region [56]. Such a move puts the city in an excellent position on the way to full smartness. It also proves that authorities and decision makers remember that Rovaniemi is not only the urban area but that it is the wide-ranging territory, and services should be provided to all of its inhabitants equally.

### ***3.3.5. Is Rovaniemi smart enough?***

Smartening a city is a continuous, long-term process. Rovaniemi already incorporates many elements of smartness in its infrastructure and services, such as the Roadscanners monitoring the road conditions and access to governmental and medical online services. In addition, many new, not yet introduced ideas are being presented and discussed. Although some elements of infrastructure and planning may seem to be outdated and do not fully fit the smart city concept, an effort to introduce innovations and automation of processes for the benefit of inhabitants is being made. One element that still requires improvement is the lack of zero-emission technology and sharing economy in the area of transport. Using private cars that generate pollution as a main means of transportation has to be reduced to increase the smartness of the city. However, incorporating green energy solutions by energy providers and extensive use of sharing economy in housing, such as AirBnB, already contribute to the city's smartness. The progress is easy to recognise, and as the concept of smart city is and will evolve, a specific model example of a smart city in reality does not exist. The process of making changes and development is the element that constitutes a city as smart. Rovaniemi is already on the path of transforming into a smart city. Establishing its own broadband company indicates that the city's authorities understand the need for equal access to smart services for all inhabitants of the city area and proves that the measures to ensure access are undertaken.

## **4. Challenges and the way forward**

A smart city also addresses the needs of its inhabitants and helps to ensure the wellbeing of future generations. Thus, besides developing and working towards the sustainable and technological aspects often connected to the concept of 'smart', it is important to address the diversity present in the city. This implies acknowledging the different social and cultural identities and plural backgrounds in the city and addressing some of the inhabitants' main needs. Doing so could allow for the construction of inclusive smart spaces. Notably, Tromsø and Rovaniemi are inhabited not only by ethnic Norwegians or Finns, but also by indigenous people such as the Sami and by thousands of immigrants, including refugees, family, and work immigrants from different nations [57]. As such, a solid democratic urban pluralism [58] could be developed to address the diversity present in the city.



The development of telemedicine, despite its numerous advantages such as cost reduction and the ability to provide medical services to remote areas, may also constitute a challenge. Some of the participants interviewed for this study feared that a focus on cost reduction could overshadow patients' wellbeing. Consultations through video conferences may increasingly replace, whenever possible, face-to-face medical consultations without being better than an in-person mental or physical health assessment. Moreover, electronic medical journals and online health services and systems have been altered and disrupted in other cities and countries [59]. For Tromsø and Rovaniemi, this may call for clear cybersecurity protocols or alternative systems to be run in case of disruptions or cyberattacks.

It is also important to develop mechanisms or action plans that could mitigate some effects of increased social and economic inequality and the digital divides that may arise from smartening of a city. As scholars such as Hollands [60] noticed, a focus on economic efficiency or development may deem social issues as secondary. Those who own the new digital or smart technology or services, those who develop them and those who have digital competence have a clear advantage compared to people who lack such knowledge or *cultural capital* [61]. The copious smart city literature shows that this advantage has occurred in other smart cities. Promotion and access to affordable IT courses and skills can thus be important. Cities have become more unequal through ICT [62] and globalisation. If policies aiming to spare resources to the government and civil society are supposed to improve people's lives, it is precisely the city inhabitants who should have a saying on their needs and opinions on how IT development and progress happens. Tromsø inhabitants of varied backgrounds, authorities and people from the private sector interviewed for this study agreed that to date, there were few arenas or spaces for these discussions.

Other challenges to be addressed include threats to the privacy of the citizens and the fact that many of the digitalisation of services happens as an absolute process where citizens can do little or nothing but accept the terms. The implementation of smart electricity meters represents a good example of the issues that arise with the smartening of services. Thousands of citizens have already argued that exposure to the radiation stemming from these meters may bring numerous health issues. Additionally, concern has been expressed that the information provided by smart meters may constitute a violation of privacy, as the smart meters send data about when a person is home or not. Similarly, the use of smartphones and other electronic devices, such as sensors of human activity in the city, enable the dissemination of personal data. In theory, authorities, companies, organisations, and individuals should follow the data protection legislation [63]. The Norwegian Data Protection Authority is in charge of supervising that companies follow this legislation. Nonetheless, this still implies that citizens must, regardless of their preferences, accept that companies store their information and rely on it to keep it safe [64].

The power supply may be exposed to cyberattacks and, for Tromsø as well as for Rovaniemi, this could mean power outages, which would be detrimental especially in winter when citizens are most vulnerable due to harsh climatological conditions of the Arctic region. Cybersecurity protocols to protect smart electricity meters are thus essential to prevent malicious attacks and to tackle potential risk situations. The 2018 threat

assessment report issued by PST, the Norwegian Police Security Service, highlighted the cybersecurity vulnerabilities Norway faces. The report stresses that it is expected that Norway will be targeted in diverse digital arenas [65]. Such attacks would affect companies in the defence and emergency response sector, the government and the critical infrastructure of the country. Similarly, Inge Kampenes, the major general at the Norwegian Cyber Defence Force, has previously stated that Norway's capacity to resist a cyber-attack is rather marginal [66]. The numerous cyberattacks, exposed vulnerabilities and incidents that occurred in Norway in 2018 and 2019 appear to corroborate this claim [67]. Such events show that Tromsø is also vulnerable and in need of preparedness and response contingency plans to protect –whenever possible – its ‘smartness’, expressed in digital infrastructure and systems. Similarly, data ethnographies can illustrate the paradox of having connected things and socially disconnected citizens. In an affluent city like Tromsø, where most services have been or will be digitalised, where some jobs or institutions or financial entities no longer require a physical location, face-to-face interaction may be less frequent than before IT solutions were present. Most services can be paid or delivered online. Overall, at the core of smartening the city, policies to be implemented should have the wellbeing of its citizens and the territory they inhabit as a top priority. If real ‘smartness’ is to take place, hearing the opinions or input of its inhabitants (individuals, families, and public and private sector actors) on the ongoing technological development is essential.

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