Digitalization of Municipalities Through Ecosystem Collaboration

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Abstract

Emerging technologies combined with new ways of doing business provides a series of new possibilities, but also significant challenges. In this paper, we study how municipalities can realize value from digitalization through ecosystem collaboration. We analyze 26 digitalization strategies representing 58 municipalities in Norway to get an overlook of the current landscape. In addition in-depth interviews are done in 5 municipalities to discover cross-case similarities and patterns. Our findings highlight important strategic measures related to different types of value for the majority of municipal digitalization approaches. We find experimental Internet of Things pilots, ecosystem collaboration and innovative approaches among the municipalities that are further ahead other municipalities in the digitalization process. The results are analyzed and discussed towards recent literature and similar international research on comparable municipalities.

1 Introduction

In today's modern society, digitalization is relevant in all sectors and industries. There is an exponential growth of available data, with an embedded value potential that could be commercialized or monetized [1]. Meanwhile, the public sector is becoming aware that factors such as urbanization, aging populations, and a more demanding climate are more relevant than ever [2]. With a limited amount of resources, municipalities need to take action to not be left behind by the digital revolution. It is estimated that the digitalization of Norwegian municipalities have a total benefit realization of over 100 BNOK the next ten years [3]. However, they must prioritize and act quickly in order to realize these opportunities.

Over the last decade, the Internet of Things (IoT) has been in a continuous state of evolution. IoT is often defined as the interconnection of physical objects by equipping them with sensors, actuators and means to connect them to the Internet [4]. IoT technology is a key driver of the digital transformation that will enable businesses to reinvent products, services, internal operations and business models [5]. The combined markets of the IoT are forecasted to grow to about $520 billion in 2021, more than double the $235 billion spent in 2017 [6]. The application of the technology is vast and has the potential to drive the next steps of the digitization of our society and economy. Firms have already begun to embrace the IoT and the public sector is following the trend.

Digitalization enables new types of solutions that are more flexible and effective. In the context of municipalities, the use of IoT technologies is often linked to the development of smarter cities. The public sector as a whole is playing a major role in the IoT market around smart city initiatives, and drives the demand for IoT-solutions [7]. Examples of initiatives taken are smarter utilization and deployment of public resources such as lights, roads and parking, better efficiency of services like waste management and public transportation, and better quality of life such as measurement of pollution [8]. The public sector influences the overall IoT ecosystem by providing continuous stimulus, financial resources and raising the awareness of the IoT [7].

In 2015, the Norwegian government published a white paper called Digital *Agenda Norway*. It highlights five areas that should be prioritized in Norwegian ICT-politics: the user is focused, ICT is important for innovation and productivity, digital competences and participation should be

strengthened, effective digitalization of the public sector, good privacy and information security [9]. A conceptualization of municipal digitalization is the development of smart cities, which can be defined in the following manner: *A smart city uses digital technology to make the cities better places to live and work. It aims to improve public services and the life quality of the residents, optimally utilize common resources, increase productivity, and reduce climate and environmental issues in the city* [9].

Although the terms digitalization and smart city development is often used interchangeably in public, smart city development can be seen as a branch of the digitalization of the municipality. Some municipalities have smart city programs, while other does not. It is found that smart cities can generate value by liming the internal spending within municipalities [10]. Although not compulsory, smart city development is often a substantial part of a municipality's digitalization process. Many municipalities seem to undertake projects inspired by smart cities, without specifically calling it a smart city initiative [11].

The global issues we are facing as a society are large and extensive, and cannot be solved without cooperation across all sectors of our community [2]. Emerging technologies with relation to connectivity, use of sensors and collection of data also make digitalization stretch across municipal boundaries. Different resources and competences from several fields are needed, which makes the process of value creation move from the perspective of a single firm to the perspective of an ecosystem consisting of many [12]. Research on ecosystems will therefore be used to understand how municipalities cooperate with other actors in order to create value from digitalization.

Municipalities rarely use the term business models when discussing strategies and plans. However, the term *benefit realization management* is commonly used. It has numerous different interpretations, but is often comparable to business opportunity [13]. With the emergence of IoT and digital technologies, managers should turn their focus from business models to ecosystems [14]. It is through a business model that is depending on a network of complementary and collaborative partners that organizations can generate greater opportunities for improved service delivery and distribution of risks [15].

Although smart products may beat the core of digital solutions, in most cases the full applications require complementary innovations such as cloud and mobile computing, digital social networks and data analytics.

New business models with combination of different technologies drive the IoT development and creates the possibility of data-driven *services* and *processes*. Pflaum and Golzer [16] presents two strategies from the private sector where the first is to embed IoT-technology in a physical product and turn it into a smart service, while the second is to implement IoT-solutions to increase efficiency of production processes.

As the data generated from IoT-solutions can be value added and commercialized, this leads to several questions: How can public data be monetized, who owns the data and how can one differentiate between data and services when the data is available for everyone? Financial value is not necessarily the only type of benefit realization that is desirable for municipalities, and we would therefore like to investigate what they propose as the main goal value of digitalization. This leads us to the following research question: How can municipalities realize value from digitalization through ecosystem cooperation?

We will collect empirical material on Norwegian municipalities in order to research this topic. Through a pool of ongoing digitalization strategies together with a selection of in-depth case studies by municipalities we aim to present the current practices, and important challenges. The findings will be based on how the municipalities cooperate with the actors in their ecosystem, with regards to different types of realized value. A common topic in business development literature from the ecosystem perspective is value co-creation and cooperation. We will also investigate which type of value is the most emphasized by the municipalities, and what quantitative and qualitative benefits are mentioned frequently. The main contribution of this paper is a mapping of the current practices regarding the digitalization of municipalities. A broad basis of digitalization strategies will allow us to investigate current practices, while five case studies allow us to go in depth.

The rest of the paper is organized as follows: the theoretical background is presented in the next section, followed by the research design method including the data collection, selection of case studies, and the data analysis process. Then, the findings from a basis of digitalization strategies, followed by an in-depth presentation of five case studies will be presented. This is used as a basis for an analysis of the findings, including cross-case comparison of the case studies. It will then be thoroughly discussed with regards to the theoretical basis and other research done in the field of digitalization in municipalities. The last section will present the conclusions, limitations, and managerial implications of this research.

2 Literature Review

In recent literature, there have been various papers discussing the business model and development aspects of digital solutions [14, 15, 17, 18]. Business models are the framework often used to analyze how to exploit business opportunities and describe how to do business [13]. The common notion in the emerging literature of business models related to IoT is the focus on ecosystem and environment. As digital ecosystems often span over multiple industries, businesses are required to cooperate [18]. A single IoT-solution provide little value, but when combined into complex digital innovations with many building blocks, the full value is realized [19]. Therefore, the implementation of IoT relies heavily on the ecosystems across different industries [20]. A single actor is less likely able to deliver complete IoT-solutions, and resources and competencies from different fields are required [21]. Traditionally, innovation has often happened in closed context in businesses. The older frameworks are often focused on the firm-level and typically observe the network through the firm's perspective [21]. Westerlund, Leminen and Rajahonka [14] describe the IoT ecosystems as unstructured where actors are struggling to identify the roles of themselves and other actors.

Mora, Deakin and Reid [22] identify five diverging development paths for smart cities, that they use to derive four dichotomies that challenges smart city development: (1) technology-led or holistic strategy, (2) helix model of collaboration, (3) top-down or bottom-up approach, and (4) mono-dimensional or integrated intervention logic. The first is whether cities should focus on technology development to facilitate the smart city development or if they should approach holistically and try to align the technology to the human, social, cultural, economic and environmental factors [23]. Appio, Lima and Paroutis [24] identify several arguments for the idea that smart cities should move towards a holistic strategy. Westerlund, Leminen and Rajahonka [14] present the concept of value networks as a model to emphasize the holistic focus on value creation rather than individual firms delivering isolated solutions. Value nodes and value exchanges describe the actors and activities that link to others, and the exchange of value such as knowledge and information. Several scholars agree that smart city development takes place in a collaborative ecosystem where the interactions and feedback between the actors facilitate development [25–27].

The cooperation between actors is often, in the context of digitalization and smart city development, described using the helix framework. There are various versions of this framework, depending on the number of different
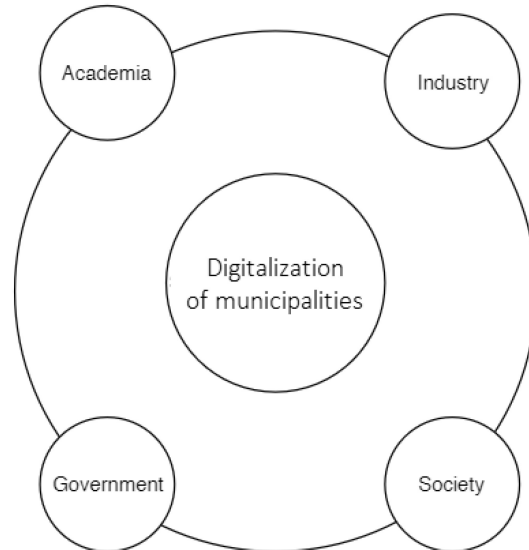
Figure 1 Theoretical framework – quadruple helix model with digitalization of municipalities in center.

actor categories focused on. The triple helix model focuses on the interaction of the state, academia, and industry [28]. *The public* or *the society* can be introduced to obtain a quadruple helix model. This fourth helix associates with media, creative industries, culture, values, and life styles. A quadruple helix model with digitalization of municipalities in center is shown in Figure 1. Lastly, the quintuple helix is where the *environment* or the *natural environments* represent the fifth helix [28]. The idea behind the quintuple helix model is that the implementation of thought and action in sustainability will have a positive impact on society as a whole.

Regarding the third dichotomy by Mora, Deakin and Reid [22], the top-down approach has been criticized by Shin [29], arguing that this approach fails to look after the civilian needs. Capdevila and Zarlenga [30] claim that top-down and bottom-up approaches do not necessarily work against each-other, but can benefit from each other. By combining the two approaches, municipalities can for example create IoT-solutions with a bottom-up approach to address identified and local needs, while the government develop open innovation platforms to combine and facilitate the bottom-up solutions [21]. Furthermore, to support bottom-up development, many smart cities have been promoting open data [31]. However, the current IoT ecosystem is highly fragmented with many similar solutions that uses

different infrastructures that might hinder collaboration [12]. The fourth and last dichotomy by Mora, Deakin and Reid [22] says that when developing goals, actors can choose between mono-dimensional (narrow) or integrated (broad) intervention logic.

Pflaum and Golzer [16] identifies two different strategies for monetization of IoT. The first is to embed smart solutions into physical products, while the second strategy is to use smart solutions to optimize their own processes. The amount of data that can be collected with IoT-solutions can be analyzed to identify new business opportunities and new business models [32]. Pflaum and Golzer [16] propose a new, data-driven business model that focuses on collecting, analyzing and selling value added data aggregated from IoT devices. However, Okwechime, Duncan and Edgar [31] argue that big data loses its value if the organizations lack the competencies to embed the knowledge. Furthermore, scholars argue that there are incentives for the industry to buy and have access to the big data. Examples of opportunities that big data provides for companies are that it can be used to determine market demand, reduce costs, identify new business opportunities and business models [33].

Monetizing is not frequently mentioned in digitalization research on municipalities, smart cities and public sector, because cities most often tend to focus on qualitative, non-monetized values [34]. As there have been changes in technology, the business models may have to change to accommodate the opportunities. Examples of extended or alternative new revenue models are mobile payment, pay-per-use, subscription fees, cross selling, freemium, third party revenue model, razor-blade models and targeted internet advertisements [15, 35–37]. However, IoT-ecosystems has taken it further and moved away from the traditional one-off payment approach to the as-a-service [16]. An example of a data-driven business model is Google who is known for handling big data. An example is their revenue model for Google Maps. Developers are given a $200 credit card every month to be used for developing, thus giving developers access to the APIs without charge. After the credit card has been emptied, the developers have to pay for further usage [38]. Data can also be held in platforms and made available within and across firms [39]. Leminen, Rajahonka, Westerlund and Wendelin [18] identify the platform business model where a dominant actors provides a platform to provide services from other actors, thus taking the role as a service integrator.

Two perspectives were used in the literature review, the public and the private sector. The research question focuses on municipalities and will be regarded as a part of the public sector. The literature did not show extensive application of business models on digitalization and smart city development

in the public sector. Furthermore, little information was identified regarding how the public sector relates to the development in business models in the private sector. Both perspectives show a development from the traditional business model thinking to an ecosystem thinking as digitalization has moved towards the level of IoT implementation. The nature of IoT makes actors lean towards the ecosystem thinking. Furthermore, in the development of smart cities, municipalities should take in account four dichotomies regarding smart city development: (1) technology-led or holistic strategy, (2) helix model of collaboration, (3) top-down or bottom-up approach, and (4) mono-dimensional or integrated intervention logic. However, identifying monetizing strategies for the public sector or municipalities has been deemed difficult as most municipalities focus on qualitative and non-monetizing values. From the private sector, the data-driven business model has been presented. Following the trend, new revenue models are emerging.

3 Methodology

Data Collection

In order to explore the existing theoretical basis on digitalization, value and cooperation in an ecosystem, we conducted a systematic literature search. The aim was to understand conceptual categories and their properties, developed from the empirical evidence of comparative studies [40]. This primary round of data collection was carried out before refining the research question, and provided us with the broad theoretical basis for this paper. The aim was to enhance the legitimacy and authority of the resultant evidence, to provide a reliable basis to formulate decisions and take action [41]. Afterwards, this basis was supplemented with relevant research cited by the selected authors, as well as separate searches for specific concepts. The empirical material is composed of a combination of primary and secondary data, found in Table 1.

The selected digitalization strategies need to be ongoing and current, thus outdated strategies are not chosen. Certain municipalities cooperate with others in the digitalization process, so the total number of involved municipalities is higher than the number of strategies. The chosen strategies are independent with a main focus on digitalization. We did not consider municipalities that only include sections about digitalization incorporated in other municipal plans, in order for the strategies to be as comparable as possible. In order to discuss and compare the findings to recent research on the digitalization of small municipalities in Sweden, we chose digitalization strategies

Table 1   Overview over empirical data sources

Data Source	Description	Informants and Authors
Digitalization strategies	26 strategies representing 58 municipalities	Municipal council IT-department Council man County council
	2 steering documents including guidelines on digitalization	Municipal council IT-department
Interviews	5 interviews with 15 informants from 5 municipalities	Council man, Innovation- and smart city department leaders IT-department advisors and leaders
Documents	Industry level reports on the dynamics of the industry	International smart city organizations National industry leaders
	Reports from the national and regional authorities	Norwegian government Norwegian association of local and regional authorities
	Status reports from digital consultancy firms	Technological consultancy firms Economic consultancy firms
Statistical data	Statistical data on municipalities	Statistics Norway (www.ssb.no)

with the intended representation of a majority of small- and medium sized municipalities in mind.

Case Study Selection

Our approach is a multiple-case design research, with a basis of five real-life cases. The aim is that these cases can provide a great deal of largely qualitative data, which can offer insights into the nature of the phenomena [42]. Each of the case studies describes how the municipality and its network of actors strategize in order to digitalize, with regards to different dimensions that will be explained in data analysis section.

The five case municipalities are chosen because they are considered relatively far ahead in the process of digitalization compared to other municipalities, a form of purposive theoretical sampling [42]. This evaluation was done by having all case studies fulfill three chosen demands: (1) The municipality needs an adopted plan or strategic paper regarding digitalization or smart city development, (2) there needs to be ongoing or finished

digitalization projects, and (3) There needs to be some formal or informal cooperation with other municipalities.

The background for demand (1) resonates with the municipalities being dedicated to digitalization, and the awareness that the terms digitalization and smart city development are often used interchangeably by the public. Although smart city initiatives are only a subsection of the overall digitalization, an active smart city initiative is most often a good indication on the efforts dedicated to digitalization [43]. Given that only 30–50 of the over 400 municipalities in Norway have active smart city initiatives [11] it is logical to consider these municipalities relatively far ahead compared to the national average. Demand (2) allows us to get practical insights into the measures carried out to digitalize, and the possible results. Lastly (3) is crucial in order to understand the ecosystem perspective and the cooperation between actors.

In addition, the case studies have been purposely chosen to reflect different sized municipalities of several geographic areas, in order to more accurately represent the data [44]. In this case, no more than two municipalities from the same county were chosen, given the focus of independently analyzing actors in their ecosystem. In this way, the case studies can be seen as comparable to each other but also previous research. Some structural similarities may occur due to this purposive theoretical sampling of municipalities. However, the implementations of the digitalization measures differ in practice, and thus we choose to go in depth on this topic. The case studies will be anonymous, as we address information such as challenges and classified information.

The fifth and last case study (Epsilon) somewhat differs from the other four. It is not an individual municipality, but a region consisting of six small municipalities that cooperate with regards to digitalization. The reason we were interested in this particular case study is to gain insight on how a formal cooperation works in practice. The municipalities in this region are also significantly smaller than the other four case study municipalities, and we are curious whether this has an impact on any of the factors. As a whole, the region also fulfills the above mentioned three demands.

Data Analysis

The objective of the data analysis is to find how municipalities can realize value from digitalization, with respect to solutions that include ecosystem cooperation.

Digitalization strategies. We have chosen content analysis, which is usually appropriate when existing theory or research literature on a phenomenon is limited [44]. Initially we made observations that lead us to a preliminary data organization and data analysis. We have used NVivo to organize and group data into meaningful codes, in order to obtain a series of smaller categories to base the findings around [44]. This was done by using open and selective coding. We analyzed the digitalization strategies independently, following identical steps. Firstly, open coding was conducted by analyzing every sentence of the digitalization reports line-by-line. With regards to the research question and the nature of the digitalization strategies, we defined conceptual content as data that fits our five clusters: Ecosystem actors, development focus area, core strategic topic, and perceived value. In the first step, all conceptual content was marked important. Secondly we used focused coding to synthesize the content into conceptual labels (NVivo codes) as close to the transcript as possible. Lastly, we saw that certain conceptual codes were subcategories under a common topic, thus these were merged together and categorized under a new parent code. This reduced the total number of codes and made the findings more usable and readable [44]. An example of the full open coding process can be found in Appendix A2.

Case studies. Five case studies were analyzed with respect to the focus areas and relevant technologies for the digitalization within municipalities, as well as how the network of actors within the ecosystem is built up and whether there is cooperation towards a common goal. The case municipalities were interviewed using the same procedure and documented to ensure reproducibility. The interview guide is based on the guide developed by Andersson et al. (2019) and Claesson et al. (2019) studying small municipalities in Sweden. The guide used in Norway can be found in Appendix A1. The chosen approach starts with within-case analysis, which involves detailed case study write-ups for each site. These write-ups are simply pure descriptions, but they are central to the generation of insight [45]. The aim is to discover the unique patterns of each case, before generalizing patterns across cases. Thus, the next step is searching for cross-case patterns, to force investigators to go beyond initial impressions, especially through the use of structured and diverse lenses on the data [45]. Our chosen approach is to select four dimensions, and then look for within-group similarities coupled with intergroup differences. The dimensions are: General description of focus areas, current projects, actors within the ecosystem, and challenges. Together, they should create a basis to

analyze the current state of the digitalization process within each of the case studies.

4 Findings

In this section, we first present the findings from 26 digitalization strategies by the 58 Norwegian municipalities. Central patterns within the municipalities' development focus areas, core strategic topics and different conceptualizations of value are found and categorized. The ecosystem actors in which the municipality operates are also presented. Secondly, we present five case studies where we go in-depth with each municipality in center. Every case description is divided into four parts: a general description, a summary of current digitalization projects, actors within the ecosystem, and challenges related to this process. These findings will be summarized and together serve as a basis for the following analysis and cross-case comparison.

Findings from Digitalization Strategies

Table 2 summarizes the most frequent categorizations within each cluster. Naturally, the municipality itself was the most heavily mentioned public actor in the ecosystem, but public instances on a county- and national basis were also found. Many municipalities have user-centered approaches, and thus society is coded numerous times. Residents, especially elderly and children is highlighted. Governmental actors such as national and international jurisdiction, guidelines and legislation are moderately mentioned, as well as industry in the form of service providers, partners and suppliers. Lastly, academia is only mentioned in three of the digitalization strategies, which is significantly lower than the other ecosystem actors.

In this case, the most frequent development focus areas are both in the form of traditional sectors such as health care and education, and challenge areas such as security and privacy together with information and communication technology (ICT) infrastructure. Information security and privacy are the most common conceptualizations, next to architecture, platforms and network infrastructure. There were also more traditional municipal focus areas such as hospital technologies, retirement facilities and patient interactions. In the educational sector, digital learning tools and cloud solutions were heavily mentioned. In the other end of the scale, there was single digit number of instances covering house and buildings as well as greener environment.

Table 2 Summarized findings from digitalization strategies on the most common categorizations

Ecosystem Actors	Development Focus Area	Core Strategic Topic Within Focus Area		Value
– Public actors – Society – Government – Industry – Academia	– Security and privacy – ICT-infrastructure – Healthcare – Education – Welfare technology – Communication and information – Administration – Area and mobility – Greener environment – House and buildings	– Cooperation, sharing and involvement – Automated processes – Leadership and competencies – Self-service and usability – Evaluation and revision – Change and innovation – Holistic solutions	Qualitative Quantitativee	– Service quality – Usability – Reliability – User satisfaction – Municipal attractiveness – Productivity – Resource management – Cost savings – Automated processes

The core strategic topics can be seen as the measures that are needed to be implemented when digitalizing the development focus areas. Cooperation, sharing and involvement together with automated processes were heavily mentioned, but the first category has a large number of conceptualizations and is coded almost twice as many times as the second. Sharing technology, open data, cooperation between municipalities and resident involvement are currently the hottest topics, and many municipalities believe they have crucial roles in successful digitalization. Leadership and competencies is also a noticeably large factor, where leader training and organizational development are the most common conceptualizations.

Lastly, most municipalities mention both qualitative and quantitative values as goals in the respective digitalization strategies. However, the number of different conceptualizations and instances found are measurably higher for qualitative value. The quantitative goals are mainly based around increase in productivity and efficiency, resource management, cost savings and automated processes. The qualitative value spans wider and reaches from service quality, sustainability, user satisfaction, innovation, and usability, to municipal attractiveness. The full list of conceptualizations can be found in Appendix A3.

Findings from Case Studies

This section will summarize the main takeaways from each of the five case studies. The first four case studies are municipalities that can be seen as further ahead than the country average with regards to digitalization. The fifth case study, Epsilon, is cooperation between six small municipalities towards the digitalization of the region. The complete findings from the case studies can be found in Appendix A4.

Alpha has a high number of implemented projects, and has achieved international recognition for their digitalization efforts. They also collaborate with international partners, as well as academia, enterprise partners and other municipalities. They have a smart city program where the goal is to facilitate development, research and innovation for sustainable community development. The municipality holds workshops and meetings for a series of different actors to initiate interest, innovation and idea-creation in the region. They also participate in county- and nationwide projects to facilitate digital solutions for the residents. Involvement of the public is highlighted in their strategy paper, and Alpha has focus on open data so that anyone is able to create new services. Alpha is also a part of an international network for creating and shaping smart city data. The main challenges for the ongoing digitalization are economy, operations and providing services. The IT-office further argues that it is difficult to buy modular solutions, and that the current solutions contribute to a lock-in effect given lack of will to cooperate. They are also challenged externally by the merging of several neighboring municipalities into a new region, with all the administrative changes it will entail.

Beta sees the main goal of digitalization as the increase in efficiency, and highlights that a 10% increase will result in a benefit realization of millions of NOK. They also present qualitative value goals, such as the municipality being a better place to live, where self-service solutions are especially valuable. The infrastructure itself will not provide measurable value; it is the future services that are based on the infrastructure that will realize value. However, they mention a series of obstacles such as limited resources, unwillingness to change, and lacking competencies. Meanwhile, administration and scaling of large systems with many sensors represent data issues and legal challenges. The municipality cooperates with other municipalities regarding projects related to welfare technology. They are also involved with research facilities such as universities and health innovation centers. Within the municipality, they have multiple ongoing IoT sensor-related projects, collect and utilize data, and experiment with low range wide area network (LoRaWAN) wireless communication network. They have

focus on engaging the residents, and provide a public information system about their digitalization projects in the city center, and provide open WiFi.

Gamma aims to be the most innovative municipality in Norway, and their digitalization program is focused towards cost reduction, providing services and improving the environment. Meanwhile, they highlight the importance of facilitating innovation and creating workplaces. The aim is to achieve this by providing services and data to potential start-up firms. There are several projects, where most are focused on collecting real-time data to increase efficiency of services. The ICT-department is small, thus Gamma is looking to buy rather than develop in-house to attain competence and services. There is communication with other municipalities, but often without a formal structure and many decisions are based on coincidences. Although learning from other municipalities, there is no formal structure or procedures regarding cooperating on digitalization. There are challenges related to data formats not being standardized, and that they have no internal programming competences.

Delta aims to improve the environment, increase inflow of citizens, facilitate academia and research, and be attractive for the industry. They cooperate with four other municipalities with regards to ICT and digitalization, but do experience some problems related to communicating with each other. A lack of common infrastructure leads to different definitions and terminology, and data is deleted after 30 days. There are also issues related to sensitive information and network coverage. They have a smart city program, which is said to have a socio-economic value perspective rather than a quantitative. The success criteria are related to making the region a better place to live. This focus can be observed through the ongoing digitalization projects, which can be said to have a welfare focus. The municipality takes part in innovational partnerships financed by Innovation Norway, the national bank for innovation and development, and wishes to cooperate with suppliers, residents and the private sector. Currently, a pilot project is underway where possible future partnerships and business models will be evaluated.

Epsilon highlights that the cooperation regarding digitalization has been positive for the overall digitalization in each of the municipalities. However, there are challenges related to all of the municipalities not being as involved or timely focused regarding common plans and goals for the digitalization of the region. There is different emphasis on what collaboration entails and how it should be carried out, and some municipalities show less initiative. The goal is to provide new digital solutions to the residents and achieve an increased level of efficiency. However, there are no explicit quantitative goals regarding economic benefits. Cooperates with academia, political organizations and is

involved with Innovation Norway. Epsilon does not cooperate directly with the private sector regarding innovation but uses private actors as suppliers for applications and other services. Main challenges are related to limited financial resources and decline in the population.

To further illustrate the value municipalities are currently realizing from digitalization, two concrete project examples from the case studies will now be presented. The first example is related to an ICT-project aimed to help users medically. Users are reminded of taking their medicine, turn of stoves, lock doors or find their home. With new sensors, user deviations can be identified earlier and notified to relevant recipients [46]. Realized qualitative value include increased dignity and safety for patients and dependents. Furthermore, the project can save money for the municipalities by helping patients in their own home instead of building more nursing homes. The continuous increasing aging population can be seen as a main driver for this project.

Another example to consider is the implementation of smart water solutions. All four case study municipalities are involved in versions of this project, which utilizes sensors to monitor leaks at strategically important places in the water supply. In this way, a majority of all leaks can be detected by the municipality's technical department before any damage to nature and buildings occur, according to Beta. This solution provides value not only for the end user who are less bound to encounter damage to their environment, but is also a quantitative, cost-effective alternative for the municipality. The qualitative value also includes a shift in allocation for operational resources to more time efficient tasks in need of human judgement.

5   Analysis and Cross-Case Comparison

Digitalization Strategies

Regarding cooperation in the ecosystem, it is difficult to classify the most common helix without going in-depth on each of the municipalities. Generalizing is also associated with risk, as there may be significant differences between each municipality. However, we note that only four out of the 26 digitalization strategies mention the environment or sustainability, which implies that no more than 15% utilize the quintuple helix. We do note that society is frequently mentioned, although often in terms of being the end users as opposed to being involved in the development or innovation process. Media and culture-based approaches are rarely mentioned, thus it is logical to

assume the majority of municipalities utilize a triple helix model. However, it must not be excluded that certain municipalities could utilize the quadruple helix.

The findings from the digitalization strategies show a broad focus that span over various areas. Digitalization needs to be shaped with the socio-economic and cultural background in mind, and the selection of applications depends on the local context factors [47]. Many of these factors include urban challenges which are not always related to the singular development focus area. The relatively even distribution of codes is presented in Appendix A3. We also note that in addition to the traditional sectors, several technological challenges are pointed out as focus areas within the digitalization strategies. Indicating that security, privacy and infrastructure are the most urgent focus areas to address, it implies that the majority of the municipalities seem to be technology-led. This is because strategies seem to be based on a massive input of technological solutions in the urban environment. However, we also find that many municipalities have a focus on creating a common infrastructure, as well as competencies, revision and change. It is thus likely that certain municipalities tend towards a holistic strategy, rather than solely implementing ICT solutions for the sake of it.

Most municipalities have a measurable focus on realizing qualitative value, although quantitative value is also represented. The economic values are focused on effective resource management, cost savings and better utilization of resources, but the strategies rarely provide guidelines for monetizing the solutions. Given that cooperation, sharing and involvement is the most heavily mentioned core strategic topic, it is likely that many municipalities wish to pursue a bottom-up approach, which is seen as the preferable alternative in smart city development [22]. However, this approach is normally found among those who have come further in the digitalization process. Therefore, it is likely to assume that there are both top-down and bottom-up approaches among the 58 municipalities, although many are likely to strive for a bottom-up approach.

Cross-case Comparison

In this section, a cross-case comparison and analysis of the case study findings is provided. Presented in Table 3 the main findings from each case are classified and separated. Four relevant aspects are grouped and analyzed in greater detail through the following subsections: (1) the cooperation with different ecosystem actors, (2) areas where digital systems are used for

Table 3   Cross case analysis comparison

	Alpha	Beta	Gamma	Delta	Epsilon
Cooperates with the following ecosystem actor(s):					
Industry	x	x	x	x	x
Academia	x	x	x*	x	–
Other municipalities	x	x	x	x	x
International partners	x	–	–	–	–
Use digital systems for operations and/or monitoring**:					
Health care	x	x	x	x	x
Welfare	x	x	x	x	x
Education	x	x	x*	x	–
Water and draining	x	x	x	x*	–
Renovation	x	x	x	–	–
Road/street lights	x	x	–	x	–
Parking	x	x	–	x	–
Environmental services	x	–	x*	–	–
Has program/project related to the following concepts:					
Smart city	x	x	x	x	–
Open data	x	x	x*	x	–
Data/radio networks for experimental use	x	x	–	–	–
Seeks to realize the following type(s) of value:					
Increase process efficiency	x	x	–	x	x
New or improved services/business opportunities	x	x	x	x	x
Increase municipal attractiveness/better place to live	x	x	x	x	x
Cost savings	x	x	x	x	x
Greener environment	x	–	x	x	–

*Exploring the idea/pilot project;

**Epsilon: Region involved in providing common digital solutions.

operations or monitoring, (3) smart city development, open data platforms and experimental networks, and (4) different types of value to be realized.

Ecosystem Actors

From Table 3, we see that all of the case study municipalities besides Epsilon are involved with academia, industry and other municipalities. The noticeable cooperation with academia is one of the largest differences from the most

common practices discovered in the digitalization strategies analyzed in Section 5.1. Delta does not currently have a formal agreement with any academic instances, but is exploring the possibilities in a pilot project together with a local university. The case studies show that the areas where academia is currently the most involved are health care, environmental services and infrastructure. Furthermore, all of the case studies claim to cooperate with industry, mostly in the form of private firms that offer technological solutions. Three municipalities expect that digitization will bring changes entailing the purchase of external services. Alpha and Epsilon, however, highlight the focus on solutions run by internal resources. Moreover, Alpha takes an active role to facilitate the exchange of ideas and competences by hosting hackathons, ideation's and innovation labs. They are the only case municipality to involve the local industry in such a manner, and claim to have positive results.

It is found that all case studies cooperate with other municipalities. Both Alpha and Delta take part in regions with adopted, common plans for the overall digitalization of the municipalities. As previously mentioned, Epsilon represents this form of cooperative region, but the region itself also cooperates with external municipalities. Beta and Gamma share ICT development strategies with other municipalities, as well as common digitalization projects. However, these cooperative agreements are not formalized with a joint strategy for the overall digitalization of the part taking municipalities. Furthermore, society in the form of residents living in the municipality is also heavily discussed. All of the case municipalities mention qualitative goals related to the quality for the inhabitants. Alpha and Gamma have projects where society gets to take an active role to facilitate innovation. Thus, society may be regarded as an important part of the ecosystem.

Norwegian municipalities and counties are independent administrative levels, and not part of the hierarchically structured state administration. The municipalities are thus responsible for carrying out good digitization and development measures in their areas of responsibility [9]. However, there are certain requirements regarding competencies and documentation which are imposed by the government. Thus, the government is considered as part of the ecosystem with digitalization of the municipalities in center. Most of the municipalities in the case study do not argue that the demands proposed by the government pose any substantial issues or challenges. However, Epsilon raises concerns regarding small municipalities' inability to meet certain national requirements given a limited amount of financial resources.

The presence of both industry, academia, society, government and other public actors indicates that the case study municipalities utilize the quadruple

or quintuple helix. Even though the involvement of academia is sparse for Delta and Epsilon, both are invested in involving society in the digitalization process which activates the fourth helix. For instance, both municipalities highlight the importance of realizing value in the form of making the municipality a better place to live for their residents. Table 3 shows that Alpha, Gamma and Delta emphasize environmental aspects in their overall digitalization strategy, utilizing the fifth helix, while Beta and Epsilon can be classified by the quadruple helix. The case study municipalities thus seem to represent ecosystems with a higher degree of cooperation, compared to the findings from the digitalization strategies. As described in the digitalization strategies section, the majority of these municipalities mainly utilized the triple helix models.

Areas Where Digital Systems are Used

The findings show that the case studies use digital systems for operations or monitoring in all of the traditional sectors such as health care, education and welfare. There are also numerous solutions related to more specific areas such as street lights, parking and environmental services, although not all of these areas are digitalized in every case study. However, several areas where analogue solutions are currently used, the municipalities have already started exploring the possibility of digitalization. Much like the findings from the digitalization strategies, it illustrates that most municipalities focus on solutions for both traditional sectors, as well as more specific challenge areas. The wide focus indicates that the case study municipalities have integrated intervention logic, similar to the municipalities in the digitalization strategies study. Epsilon diverges from the other case studies, as we only have information on which projects the region have initiated, and not the total amount for each of the six municipalities within the region. Therefore, the number of areas is naturally smaller compared to the other four case studies.

Smart City Development, Open Data Platforms and Experimental Networks

Four out of five case studies have launched smart city programs with corresponding projects. Epsilon has projects with digital elements in the form of shared platforms and technologies, although not specifically calling it smart city development. Alpha and Beta are the only case studies that have their own data or radio networks for experimental or commercial use, both in the

form of LoRaWAN. Meanwhile, Delta is open to investigate these opportunities in the nearest future. Furthermore, the case studies indicate that the municipalities have an understanding of issues limiting their technological advancements to be deployed.

The majority of municipalities that have a profound opinion on the usage of data are tending towards providing open data. This is a topic that is less discussed in the digitization strategies than in the case studies. Alpha, Beta and Delta are focusing on making data as accessible as possible, while maintaining privacy. The main arguments suggest that providing open data is a key driver in order to facilitate development of new services. These three municipalities can be seen to facilitate a bottom-up approach, where actors outside of the municipality are encouraged to part take in innovative measures which contribute to the overall digitalization. Gamma and Epsilon are seen to follow the more traditional top-down approach, which is often characterized by limited opportunity for residents to become engaged in the development process [22].

Value

Similar to the findings from the study of the municipality digitalization strategies, the case study municipalities are also seeking to realize both quantitative and qualitative value. Although a mild amount of variation in the specific conceptualizations, all case studies highlight at least one of each category as a goal. Alpha, Delta and Epsilon emphasize that the desired result is not the digital solutions by themselves, but the value they will create in the form of new and improved services for the residents. These benefits are also highlighted by Beta and Gamma, where technological development is aligned with human, social, economic and environmental factors. This points toward a holistic vision being applied for all of the case studies.

6 Discussion

The research presented in this paper aims to investigate how municipalities can realize value from digitalization through ecosystem cooperation. In this section, we consider our analysis of the empirical material from multiple digitalization strategies and five in-depth case studies. We seek to discuss our results with regards to relevant literature, and compare the findings to research from comparable Swedish municipalities. For the past year, Björn Laumert and Jan Markendahl have undertaken the SAMIR project on coordinated

infrastructure for smart and sustainable small cities in Sweden. They aim to explore needs for and limitations in small municipalities using digitalization and smart solutions for coordinated infrastructure (Claesson et al., 2019; Andersson et al., 2019). Given that 41 out of 58 municipalities represented in our researched collection of digitalization strategies are small- to medium sized, we find the comparison between our results and the Swedish study very relevant.

A key takeaway from the SAMIR study is that most problems and obstacles regarding digitalization are not primarily technical, but stem from inadequate organization, coordination and the lack of communication between different municipal activities and administrations [48]. This is in line with our findings from the five case studies, where the main challenges were the lack of a common infrastructure, reluctance to part take in innovative, holistic solutions, and dispersed settlement (see Table A3). None of the case studies mentioned issues where they lacked a specific technology, but instead emphasized factors such as lack of competencies or that they choose to not implement solutions without knowing the specific benefit realization compared to the cost. Our first case study, Alpha, problematize that one of their technical providers does not provide application programming interfaces (API's) that fulfill all the needs of the municipality, but wishes to sell complete solutions. This makes it difficult to buy modular solutions, and the unwillingness to cooperate seems to contribute to a lock-in effect. These findings are also in line with business development research published in 2017, where Ghanbari, Laya, Alonso-Zarate and Markendahl [21] argue that the ICT sector must be more involved in the development of services and understand how it can be profitable for other industries, in order to support the creation of IoT solutions. Thus, several factors from our findings together with research of Swedish municipalities indicate that the technologies are available, but cooperation and organization is not always optimal.

Our findings from the digitalization strategies have certain similarities and differences compared to the case studies composed of municipalities that are further ahead in the digitalization process. Whether this is a direct result of the maturity of the digitalization process is not possible to assert with certainty, but scholars argue that optimal approaches that utilize advantages from bottom-up and top-down perspectives develop over time as the digitalization process matures [16]. In order to bring together different actors and facilitate citizen participation in co-creation of technological advancements, measures of engagement is important [22]. Involving the residents is one of the most prominent common core strategic topics across the pool of digitalization

strategies presented in Table 2. In addition to this categorization being the most heavily mentioned among the digitalization strategies, engaging the residents is also mentioned in four out of five case studies. Whether this is because the municipalities themselves have experienced positive results or trust previous research on this topic is unknown. As initially mentioned, the government has defined a long-term vision for the digitalization of the public sector, where the first priority is that users, such as citizens, public and private organizations should be focused [9]. Meanwhile, similar wording and goals throughout the researched digitalization strategies leads us to question whether numerous municipalities are leaning towards using pre-existing, national frameworks. Further research on project plans and other initiation processes could be useful to discover whether municipalities follow up the aspects from the digitalization strategies in practice.

Swedish research shows that diversity of different systems and system types, as well as lack of integration require both broader competence and more time to process and operate [49]. This could explain why ICT-infrastructure is the second most common development focus area among the 58 municipalities represented by the digitalization strategies. This could be an important factor in why it is necessary to see the digitalization process of municipalities in an ecosystem context. Westerlund, Leminen and Rajahonka [14] also emphasize the holistic focus on value creation rather than individual firms delivering isolated solutions. Furthermore, lack of knowledge of both existing and future systems and IT competence prevents municipalities from acting [49]. This is also found in our case studies, where certain municipalities are looking to buy rather than develop in-house, as there are no internal programming competences. However, two of the case study municipalities highlight the focus on solutions run by internal resources, which minimizes the risk of becoming dependent on suppliers. Lastly, Swedish research shows that problems are often related to difficulties in changing working methods and activities [49]. A prominent core strategic topic among our researched digitalization strategies is leadership and competencies. This could be a factor indicating that the issue is relevant in Norway as well, as organizational development and leader training is found important in order to solve challenges.

Value is a central concept in our research question, and it shows that the goals among the common practices of the municipalities represented by the digitalization strategies does not differ far from the case study municipalities that have come further along than the average. Both qualitative and quantitative value types are heavily described, which diverges from Swedish research

on the digitalization of infrastructure where the minimization of costs has a prominent focus [48]. We previously presented literature which claims that data driven enterprises are changing the traditional business models to providing services and monetizing data rather than selling traditional physical items [50]. Our case studies show that three out of five municipalities already have projects related to open data, and the fourth is planning to do so in the nearest future. The prominent focus on qualitative value in the form of service quality, user satisfaction and attractive municipalities leads us to consider the fact that the focus may have shifted from the strict fixation on monetization of products and services, to a holistic approach where qualitative goals are valued as concrete benefits to be realized. All of the case study municipalities seem to have a holistic vision, whereas the majority of municipalities researched through the case studies were technology-led. This resonates with the literature published by McNeill [51] and Schiavone, Paolone and Mancini [10] where the holistic visions can be seen as a sign of digitalization maturity.

One of the main differences between the municipalities researched through the digitalization strategies and the case studies are that all case studies are measurably experimenting with emerging technologies. Experimental or commercial radio and data networks, sensor technology and open data are just some examples of digital solutions that are applied and tested. This type of experimentation is not only useful for the municipality itself, but is likely to influence the overall IoT ecosystem, raising awareness for the IoT in society [7]. Lastly, we note that the number of helices is generally higher among the case municipalities that have come further in the digitalization process, compared to the municipalities represented by the digitalization strategies. Three case studies emphasize the environmental factors, indicating the presence of a quintuple helix. According to Carayannis [28], this will have a positive impact on society as a whole.

7 Conclusion and Further Research

The emergence of value networks highlights the importance of co-creating value together with involved entities in the network [21]. We have found that cooperation, sharing and involvement are among the most crucial strategic measures to realize value from digitalization in the researched municipalities. Municipalities rarely stand utterly alone in the digitalization process, and there are both opportunities and challenges linked to the cooperation with different actors. Similarly to findings from Swedish research, our findings suggest that few of the main issues are directly related to technological

solutions, but cooperation, organization and coordination. The empirical material highlights the challenge of cooperating actors wanting to provide holistic solutions to maintain profitability, while the municipality seeks modular solutions given limited resources. Open data is also a severely discussed area, as it can be seen to facilitate growth [22]. However, this includes known issues concerning security and the handling of sensitive data.

Moreover, the results show many similarities between the widespread selection of municipalities, the case studies and the current situation among Swedish municipalities. The digitalization ecosystem around the municipality consists of a series of actors that are responsible to realize value from the different development focus areas. Most case study municipalities utilizes a quadruple or quintuple helix model, commonly endorsed by international leaders of the public sector [22]. While less digitalized municipalities often can be technology-led with top-down approaches, the majority of the further digitalized case studies tend towards holistic strategies, with a mixed approach of top-down and bottom-up approaches. The majority of municipalities in this research seem to apply integrated intervention logics.

Managers should utilize these results to make conscious decisions regarding the cooperation with other actors. As the aim for qualitative value is prominent among most municipalities, the focus cannot solely revolve around the monetizing of data and services. Instead, managers need to investigate how new digital tools can be utilized to manage and operate services and infrastructures in order to create value for the residents. Although municipalities often claim to learn from other in similar situations, one of our case studies explains that many decisions are still made based on coincidences. A structured approach could be useful in order to gain beneficial synergies for multiple municipalities. Furthermore, we suggest that managers should establish a standpoint on which type of value is prioritized, as well as concrete milestones in order to be able to evaluate the performance of the implemented measures. The municipalities need to set the long-term vision and control over the development to ensure a sustainable smart city development while developing the needed infrastructure to develop digital solutions. Digitalization thus needs to be viewed as the collection of human, social, cultural, economic and environmental factors.

As in any scientific paper, there are a few limitations. One of the case study municipalities was also represented in the pool of digitalization strategies, a decision that could have mild impact on the connection we found between the two distinct parts of our research method. Further research on the topic is both useful and necessary given the emergence of new technologies

combined with ecosystem thinking. Most published research concerns value realization for firms through research models, while the public sector still needs guidelines and comparable results. We suggest there should be conducted research on how the different conceptualizations of qualitative and quantitative value can be realized in practice, and what the concrete roles of the different actors could entail from a platform perspective. Also, the emergence of co-opetitive relationships with non-distinct roles of competitors or cooperators could be introduced in this context to discover potential pitfalls. As suggested by Hakanen and Rajala [52], existing research mostly focuses on the technological requirements, rather than the reason why actors should participate in collaborative value creation. This paper contributes to the theoretical knowledge base by providing a closer look at how municipalities realize value from digitalization through cooperation in their ecosystem.

Appendix

A1. Smart municipalities – Interview guide (The guide is translated from Norwegian).

A. Introduction

1. Briefly about Telenor Research, the work on 5G/IoT use cases, business modes and ecosystem – how to cooperate with partners for innovation

   - Smart municipalities as a use case: We are interested in similarities and differences between municipalities with regards to challenges, needs and solutions

2. Regarding physical infrastructure, we wish to reach an understanding of the current situation, challenges and future plans of the municipality.
3. General information:

   - Number of employees and organization within the municipality

B. The Digitalization of Infrastructure

1. In what types of municipal infrastructure and services are digital solutions utilized for operations and monitoring?

   a. Construction, water, drainage, renovation, energy, road, light, transport, parking, health, education, etc
   b. Does the municipality have its own data and radio networks for experimental or commercial use (eg, LoRAWAN, NB-IoT)?

2. In which types of municipal infrastructure are digital systems NOT used for operations and monitoring today?
3. Are there plans for new digital systems for municipal infrastructure and services?

C. Challenges, Utility and Obstacles

1. What challenges does the municipality have today, regarding different types of infrastructure and services?
2. What types of problems does the municipality think can be solved by digitalization?
3. Which obstacles does the municipality see for the implementation of digitalization?

D. City/County Perspective

1. Are there any general and special challenges in this municipality regarding geography, socio-economic composition, population density, etc.?
2. How can ownership of infrastructure and management in the municipality affect the choice of ICT and IoT for the municipality's infrastructure and services?

E. Cooperation Between and Within Municipalities

1. How does the municipality handle financing, development and operation of various infrastructures today?

   a. Is there any form of coordination/cooperation with other municipalities?
   b. Is there coordination/collaboration between different agencies with regard to the choice of solutions?

2. What cooperation opportunities can you see within the municipality for common ICT- and IoT strategies for different infrastructures, in order to achieve eg. critical mass and scale advantages?
3. What cooperation opportunities can you see between municipalities for a common strategy, for example when it comes to technology development, operation and organization of service offerings?

F. Digitization from a Municipality/County/National Perspective

1. Are there any other challenges you see within the municipality and its various business areas? (There may be other issues that can be solved with digitization that we haven't thought of)
2. Are there investigations, plans and development of infrastructure that affects the municipality, but where responsibility lies with other authorities, such as rail, highway, airport, ports?

G. Innovation and Ecosystem

1. Which actors does the municipality see as relevant partners for innovation and digitalization?
2. What obstacles does the municipality see for development cooperation?
3. Does the municipality expect that digitization will bring changes such as the purchase of external services rather than solutions run by internal resources?

H. Value Realization

1. What does the municipality see as the most important value and success criteria with digitalization? (rationalization, streamlining, better services, new business areas, etc)

A2. Open coding example (focus on perceived value)

Data from Digitalization Strategy	Line-by-Line Coding	Conceptualization	Categorization
Digitization will lead to efficient use of the municipality's resources and labor	Efficient use of resources and labor	Effective resource management	Quantitative/ financial
Standardized solutions provide fewer systems, which in turn provide less costly operations, training, and licenses	Less operational costs, less training costs, fewer licenses	Cost savings	Quantitative/ financial

Continued

Data from Digitalization Strategy	Line-by-Line Coding	Conceptualization	Categorization
Welfare technology and digital services will be used to offer quality and dignity	Service quality and dignity for users	Service quality, User satisfaction	Qualitative/ socio economic
It is all about developing new and better services that are simple and reliable	New and better services, simple and reliable services	Service quality, Innovation, Usability, Reliability	Qualitative/socio economic
Digital tools shall contribute to higher productivity and more efficient use of resources	Higher productivity, efficient use of resources	Increase in productivity, Effective resource management	Quantitative/ financial
Qualitative benefits: Better services, increased sustainability, higher user satisfaction	Better services, increased sustainability, higher user satisfaction	Service quality, Sustainability, User satisfaction	Qualitative/socio economic

A3. Clusters, categorizations and conceptualizations: NVivo coding of digitalization strategies

Cluster	Category	Nr. of Strategies	Total Codes	Conceptualizations
Actor	Academia	3	3	Universities, Technological research facilities, Innovation labs
	Government	17	29	National authorities, International jurisdiction, Guidelines and legislation
	Industry	15	22	Service providers, Partners, Suppliers, Customers
	Public actors	26	50	Municipalites, County councils, State

(*Continued*)

		Continued		
Cluster	Category	Nr. of Strategies	Total Codes	Conceptualizations
	Society	18	34	Residents, Children, Elderly
Development focus	Administration	9	9	Documentation, Casework, Internal management, Archiving
	Area and mobility	8	13	Planning, Construction, Geodata, Parking, Technical Services, Traffic
	Communication and information	11	12	Interaction with residents, Access to information, Social media, Mail
	Education	13	17	Digital learning tools, Pre-school technology, E-learning cloud solutions, Office 365, Digital skills
	Greener environment	4	8	Sustainability, Environmental services, Green solutions, Renewable energy
	Health care	15	19	Hospitals, Retirement facilities, Caretaking techn., Patient interaction, Patient administration systems, Home care
	House and buildings	3	5	Smart buildings, Private property, Municipal buildings
	ICT-infrastructure	16	24	Architecture, Techn. infrastructure, Platforms, ICT-operations, Mobile networks, App. integration, Standardization

Continued

Cluster	Category	Nr. of Strategies	Total Codes	Conceptualizations
	Security and privacy	17	26	Information security, Privacy, GDPR, Security threats, Sensitive data
	Welfare technology	13	24	Welfare technology, Citizen services, Life management, User centric services and products
Core strategic topic	Automated processes	20	33	Free resources, Reduce manual labor, Change employment structure, Reduce operation costs, Standardization
	Change and innovation	5	9	Originality, Innovation culture, Pioneer, Solve societal challenges, Change management
	Cooperation, sharing and involvement	20	63	Sharing technology, Open data, Municipal cooperation, Resident involvement, Private coordination, Co-creation, Loyalty, Common solutions, KS Learning, Availability
	Evaluation and revision	9	11	Continous improvement, Project prioritization, Cost evaluation, Value measurement, Follow-up, User need assessment
	Leadership and competencies	17	25	Leader training, Specific expertise, Organizational development, Human resources, Capabilities, Leader responsibilities, Education of employees

(*Continued*)

		Nr. of	Total	
Cluster	Category	Strategies	Codes	Conceptualizations
	Self-service and usability	14	22	Self-service solutions, Proactive services, Custom language, 24-hour management, Usability, Universal design
	Holistic solutions	3	6	Digitalization teams, Common measures, Smart city, Integration, Solid data platform, Connecting actors
Perceived Value	Quantitative/ financial	17	29	Increase in productivity, Effective resource management, Cost savings, Automated processes, Economic value, Efficient processing, Greater implementation capabilities, Process optimization, Greater purchasing power, Better utilization of competencies
	Qualitative/ Socio-economic	21	47	Service quality, Sustainability, User satisfaction, Innovation, Usability, Reliability, Democratic participation, Better work environment, Legal protection, Improved resident-municipality interactions, Privacy, Attractive municipalities

Continued

A4. Findings from case studies

Topic	Alpha	Beta	Gamma	Delta	Epsilon
General description	Vision: to be the leading smart city in Norway with the most sensors per capita, and the most preferred city for startups, industry and academia. High population growth rate. There will be administrative changes when the municipality is part of the merging of a new region in the near future. Does not have a digitalization strategy but a smart city program and a digitalization section in the municipal plan. Strong ICT environment.	Goal: the first and current goal of Beta's digitalization process is to create an infrastructure that will serve as a basis for new ways to work. Then it will be used to develop services and applications for the residents. There is no growth in population, and the municipal operating income is currently negative. Full broadband coverage is also a goa, and LoRaWAN to be deployed for experimental use.	Vision: to be the most innovative municipality in Norway. Launched a smart city program. Main goal is to facilitate innovation, development and research. Focuses digitalization towards cost reduction, provide services and improve the environment. Want to facilitate innovation and create workplaces through providing services and data to potential start-up firms.	Cooperates with four other regions with regards to ICT and digitalization. As a result, they have launched a common digitalization program. The goal is to improve the environment, increase inflow of citizens, facilitate academia and research, and be attractive for the industry. The smart city development is said to have a socio-economic perspective, where the success criteria are related to making the region a better place to live.	A region composed of six small municipalities, which manages the municipalities' ICT solutions and has a server park. There are five employees, who distribute applications in the region. The individual municipalities have their own hubs towards institutions and departments, but everything is linked within a common and public network. Aims to provide the residents new digital services, so called 24-hour municipalities.

(Continued)

Continued

Topic	Alpha	Beta	Gamma	Delta	Epsilon
Current projects	– Smart water and sewage solutions – Road lighting management system – IoT broker system for decoding, exchange, dissemination and virtualization of data – Smart city labs and ideations – Visualization of energy consumption – Self-driving minibus – LoRaWan – Circular economy measures – Smart solutions regarding health, buildings, governance, mobility and fleet mapping – Open data platform	– LoRaWan – Parking sensors – Smart street lights – Smart water solutions – Environment and climate data – Open WiFi – Digital forms – Municipal chat robot – Booking system for services – Public information system for digitalization projects	– Virtual short-term division for patients – Digital communication platform – Network for pumping stations – Smart waste management – Sensors measuring real time smart city environmental data – Intune-controlled devices – Smart water meters in households – Electric carpark for employees – Public electric bikes – A "smart" gathering space	– Control systems for municipal buildings – Household water measurement – Smart lamp posts with fiber and sensors – Classroom robots – Health care voice and alarm functions – Testing LoRaWan – Smart parking solutions	Common regional projects: – Distribution of applications – ICT operations – Firewall and security – Common projects with actors outside the region: – Welfare technology platform – Security alarms – Regional response center

Actors within the ecosystem	Alpha lists a series of stakeholders, suppliers and service providers. Different responsibilities for the digitalization process are dispersed between internal and external actors. The relationships between the actors in the ecosystem are viewed as a quadruple helix where the four cores are the public sector, industry, academia and society. A part of an international network for creating and shaping smart city data. Involvement of the public is highlighted as an important activity.	Common ICT solution with 10 other municipalities, which has operational and economical economies of scale. Has a health innovation center with a common, regional response center for welfare technology. Inter-municipal fire department, child care services, and educational psychology services. Several suppliers and service providers, also with regard to cloud solutions. Have guided other municipalities, and hosts an organization for inter-governmental co-operation within the Nordics. Also cooperates with research facilities such as universities and health innovation centers	Without a big ICT-department, the operation of an own network is difficult. Thus, Gamma is looking to buy rather than develop in-house to attain competence and services. Several network providers that are in competition have done distinct parts of the fiber rollout. There is communication with other municipalities, but often without a formal structure and many decisions are based on coincidences. Gamma is a member of Smart Innovation Norway and a county-wide smart city initiative. They are also seeking to attain financial support from Innovation Norway and The Research Council of Norway.	The municipality has an ICT-department consisting of 16 employees while the cooperating regional municipalities in total have 38 employees. Delta does not aim to host smart city technology for other municipalities, but want to cooperate with suppliers, citizens, businesses and academia. They follow a policy of only buying off-the-shelf items, but participate in innovational partnerships financed by Innovation Norway. The municipality has bought everything related to communication to external buildings and has rolled out their own fiber network to these facilities. They use an external provider of technical infrastructure for communication in the health care.	Cooperates with academia, in the form of universities in the region. The collaborating municipalities in the region are also involved with political organizations regarding sub-elements like welfare technology. Innovation Norway is present in the current establishment phase to provide new competences. Epsilon does not cooperate directly with the private sector regarding innovation, but uses private actors as suppliers for applications and other services. Also cooperates with municipalities outside the region, where most of the ongoing projects are initiated by the external municipalities.

(Continued)

Continued

Topic	Alpha	Beta	Gamma	Delta	Epsilon
Challenges	The municipality lacks a digitalization strategy, and is fragmented with various offices. Operational services and reporting goes at the expense of reorganization and error correction. Economic challenges are often prioritized before climate and environment, and few use public transportation. It also seems that there is a mismatch in interests between their technical infrastructure provider and the municipality. The provider does not provide APIs that fulfill all the needs, but wishes to sell complete solutions. The IT-office argues that it is difficult to buy modular solutions and the unwillingness to cooperate makes the current solution contribute to a lock-in effect. Meanwhile, they are externally challenged by the merging of counties into a new region.	Opposing forces within the municipality can be seen as a general barrier for change. Projects are mainly run by organizational implementation demands mobilization of the employees. Changes are done through small, incremental steps, and there is reluctance to step away from tried and trusted solutions in favor of innovative measures. Public procurement rules can make standardization problematic. Need to develop own competencies in favor of expensive consultancy solutions. Administration and scaling of large systems with many sensors represent data issues and legal challenges.	A principal challenge for Gamma is the dispersed settlement, leading to poor fiber coverage and quality. Private network providers will not improve current offering because it is not profitable. Meanwhile, Gamma is seen as a low income municipality. Majority of inhabitants commute to larger municipalities. There are challenges related to data formats within the municipality not being standardized, and that they minor programming competence. Gamma may be merged with other municipalities in the nearest future. Although learning from other municipalities, there is no common structure or procedures regarding cooperating on digitalization.	Delta is experiencing challenges related to singular systems or industry solutions not being able to communicate with each other. The data-sets are not coordinated, some are hard to interpret, and has different definitions and terminology. The region also struggles with network coverage. Another challenge is the storing of data as the data is deleted after 30 days. The data is also difficult and slow to access as the portals are slow to open. Delta is not on the ROBEK* list, but are struggling with infrastructure and transportation. There are issues regarding utilizing large amounts of data in which parts contain sensitive information. *ROBEK list constitutes of municipalities being set under administration by the state due to major financial problems.	Epsilon sees digitalization as 80% organizational development, meaning that a key task is to manage human resources. None of the municipalities have redundant administrative resources, and the financial resources are generally limited. There is a decline in the population, and the settlement is dispersed. There is also a need to free up capacity, and streamline work processes. There are issues related to establishing high-speed broad band, as well as challenges in developing the municipality's digital processes within areas such as welfare technology. All the region municipalities are taking part in the collaboration needs to be invested.

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