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Nordic Digital Municipality Index 2020

How large, medium-sized and small municipalities facilitate a digital future in Norway, Sweden, Denmark and Finland

September 2020

A note from Jukka Leinonen

Dear reader,

The COVID-19 situation has demonstrated clearly the importance of a well-functioning digital society. Telecom networks have played a key role in enabling online business and remote working in addition to keeping people connected with family and friends. The crisis has also prompted us to re-think and re-evaluate how we work, communicate and do business. It has opened our eyes to new opportunities ahead that depend on reliable, secure and undisturbed mobile and fixed networks. Good connectivity enhances all aspects of society. This could be well-designed healthcare with remote counselling and diagnostics, flexible education combining e-learning tools with classroom education, or improved safety and smooth logistics in congested cities. In short, the opportunities are many.

Even in these difficult times, we at Telenor Group to continue to focus on ways to better serve our customers and societies. We expect the new generation of mobile technology, 5G, to be a key enabler of a more advanced digital society. Beyond higher speeds, better security and faster network response times (known as low latency), a key feature of 5G is that the same physical network can support numerous use cases with different requirements simultaneously. By design, 5G will be more open than previous generations of technology, which increases the opportunity for innovation.

Telenor Group is launching 5G in all our four Nordic markets, supporting the political ambition set by the Nordic Prime Ministers in May 2018 to “lead the world in developing and rolling out 5G”. This is an important directional political statement and, as Telenor Group, we are ready to do our part.

A prerequisite for reaching the goal set by the Nordic Prime Ministers is a future-proof regulatory framework that eschews red tape and incentivises investments in both networks and services. This study gives insight into some of the requirements necessary to rollout 5G in a timely and efficient manner, as well as presenting some of the services and opportunities already available to our customers at a municipal level. The addition of DNA in Finland to the Telenor family during 2019 has afforded us a unique opportunity to compare all our four Nordic markets across a wide range of different factors using data from about 60 municipalities.

This report visualises the differences and the advancements of four Nordic countries in the deployment of broadband networks, strategies for smart cities and availability of digital services at the municipal level. While the score varies between municipalities and between countries, the Nordic region stands out in an international context as a digital frontrunner. We should be proud of the level of maturity many of our municipalities have reached.

Ultimately, this represents a valuable opportunity to learn from each other across the Nordic countries. We hope this report will be useful for both local and central governments, but also for industry players with digital ambitions.

Jukka Leinonen
EVP Head of Nordics and CEO of DNA, Finland

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Executive Summary

Background and methodology

Nordic governments have developed strategies, agendas and plans for digitalisation towards a future often referred to as the Gigabit Society. Progress in these areas is shown by several studies that indicate that the Nordic countries have the most advanced digital economies in Europe.

However, we have only just embarked on the very extensive process of digital transformation of the society. In the coming years, 5G roll-outs and IoT developments will contribute to the next phase of this digital transformation process. Nordic countries are well prepared for an ever more digitalised future, but it is important to maintain frameworks that ensure digitally driven innovations are developed, disseminated and used.

In addition to commercial providers of network infrastructure, services and content, there is an important role for central, regional and local governments in contributing to the ambitious political goals for digitalisation, and ultimately a Nordic Gigabit Society.

The study has mapped, analysed and compared how 60 selected municipalities in Norway, Sweden, Denmark and Finland are facilitating a digital future. Five large, five medium-sized and five small municipalities have been selected from each of the four Nordic countries.

Based on the methodology used in this study, the 60 municipalities are given scores within three sections:

1. Facilitation of mobile network deployment
2. Municipalities' digital service offerings
3. Planning, organising, facilitating and developing smart municipality ecosystems and services

These three section scores are then aggregated into a total score for each of the municipalities. Each section represent 1/3 of the total score.

Total ranking of the municipalities

The table below shows the total ranking of the 60 selected municipalities in this study[1].

#	Municipality	Final Score[1]	Country	Size
1	Aalborg	8.3	DK	Large
2	Bærum	7.7	NO	Large
3	Halden	7.4	NO	Medium
4	Göteborg	7.1	SE	Large
5	København	7.1	DK	Large
6	Trondheim	7.0	NO	Large
7	Stavanger	7.0	NO	Large
8	Stockholm	6.9	SE	Large
9	Grimstad	6.9	NO	Medium
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45	Naantali	4.1	FI	Small
46	Sjöbo	4.1	SE	Small
47	Dragør	4.0	DK	Small
48	Ærø	4.0	DK	Small
49	Lycksele	3.9	SE	Small
50	Heinola	3.9	FI	Small
51	Hanko	3.8	FI	Small
52	Jyväskylä	3.7	FI	Large
53	Vimmerby	3.6	SE	Small
54	Rauma	3.5	FI	Medium
55	Raahe	3.5	FI	Medium
56	Valkeakoski	3.4	FI	Medium
57	Allerød	3.4	DK	Medium
58	Munkedal	3.4	SE	Small
59	Hämeenkyrö	3.2	FI	Small
60	Teuva	2.7	FI	Small

[1] The ranking is based on the final score, which in turn is based on the individual performances of each municipality in the three different sections. Each of the 60 municipalities has a unique final score, and therefore a unique place in the final ranking.

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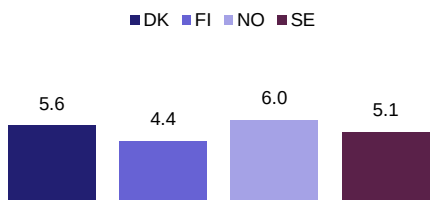
Executive Summary

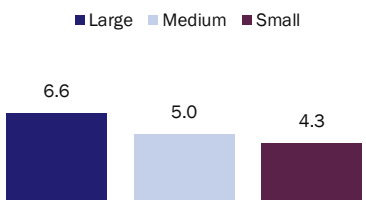
TOTAL RANKING AND SCORING OF COUNTRIES AND MUNICIPALITY SIZES

- All capitals in the Nordic countries are among the top 20 municipalities in this study. However, while København and Stockholm are placed fifth and eighth in the overall ranking, the scores for Oslo and Helsinki put the Norwegian and Finnish capitals in 18th and 20th position respectively.
- Total scores in the ranking show a significant gap between the municipalities with the highest and the lowest scores in the study. While the top 10 municipalities achieved scores between 6.9 and 8.3, the total scores for the bottom 10 municipalities ranged between 2.7 and 3.9.
- Small municipalities have challenges to keep up with larger municipalities, especially in Smart Municipality initiatives.

AVERAGE FINAL SCORES - COUNTRY LEVEL



AVERAGE FINAL SCORES – SIZE LEVEL



COMMONALITIES FOR HIGH-SCORING MUNICIPALITIES

1 RESOURCES FOR SMART MUNICIPALITY FACILITATION

The eight highest scoring municipalities all receive top score regarding their Smart Municipality facilitation efforts, which are established initiatives in different domains to gain/share knowledge or stimulate innovation.

2 FAR AHEAD IN SMART MUNICIPALITY PLANNING

When it comes to scope and maturity of their Smart Municipality plans, as well as how they organise the corresponding efforts, high-scoring municipalities have well-established plans and corresponding assigned responsibility.

3 STRONG WELFARE TECHNOLOGY USE

High-scoring municipalities have come a far way implementing operational services in the health and welfare sector (e.g. patient monitoring, remote communications, etc.).

COMMONALITIES FOR THE NORDIC CAPITALS

1 IMPROVEMENT POTENTIAL FOR ACCESS TO MUNICIPAL SITES

All capitals have difficulties accommodating mobile sites on municipal grounds. This is especially evident for Oslo, Helsinki and København.

2 STRONG DIGITAL SERVICES OFFERINGS

All capitals have a strong digital services offering. They receive high scores on five out of nine services and receive full score on the remaining four services, reaching a total section score of between 7.8 to 8.9.

3 STRONG SMART MUNICIPALITY INITIATIVES

The four capitals are far ahead in the planning, organizational and facilitation aspect of Smart Municipalities. In addition, Oslo, Helsinki and København all receive full scores in the Traffic & Mobility and Health & Welfare services sections.

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Executive Summary

Key Findings from Section 1 – Mobile Network Deployment

- Denmark and Norway are the country winners in the Mobile Network Deployment section. They each have five municipalities in the top 10 ranking in this section.
- Denmark scores the highest among the four countries, mainly due to more efficient communication between operators and municipalities regarding site planning.
- For large municipalities, Norway and Sweden experience more cumbersome processes with municipalities than is the case in Denmark and Finland.
- Out of the top 20 municipalities, only four are large municipalities. 60% of the large municipalities (including the four country capitals) place themselves in the bottom 15. The main reason for this is related to difficulties with the process of placing sites in the large municipalities.

Key Findings from Section 2 – Digital Services

- Larger municipalities tend to achieve higher scores in the Digital Services section, but only one of the four surveyed capitals is ranked among the highest scoring municipalities.
- National programmes appear to be effective tools to improve broad digitalisation among all sizes of municipalities.
- Nearly all of the benchmarked municipalities have launched a baseline of digital services, showing that digitalisation of municipal services is well under way across the Nordic region.
- Smaller municipalities, on average, score less well in regards to welfare technology use and digital learning platforms (both of which are particularly important for rural communities).
- A group of smaller municipalities is punching above their weight and reaching scores typically achieved by much larger municipalities.

Key Findings from Section 3 – Smart Municipalities

- The large municipalities dominate in all Smart Municipality categories. This is especially true for the Planning & Organisation and Facilitation parameters.
- The highest-scoring small municipalities, are situated in a greater capital area and benefit from regional initiatives spinning out of the capital city.
- The 11 highest ranking medium-sized municipalities host institutions of higher education or are situated within 20 minutes driving distance from one of the largest cities in their country.
- Based on the selection of municipalities in this study, open data initiatives are solely a large municipality effort as of now.
- With reference to welfare technology services in Norway and Denmark, regional or state initiatives may help raise the national level of adaptation, especially benefitting small or rural municipalities.

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Executive Summary

LESSONS AND RECOMMENDATIONS

MOBILE NETWORK DEPLOYMENT

Lesson: Win-win relationship in the area of site planning
Recommendation: Reduce the lead time in the complete site planning process

Lesson: Lack of municipal mobile coverage plans for municipal buildings
Recommendation: Create plan to consider mobile coverage with new buildings

DIGITAL SERVICES

Lesson: Limited communication to inhabitants regarding digital offerings
Recommendation: Communicate digital offerings on a national/regional/local level

Lesson: Gap between rural and urban municipalities in welfare technology use
Recommendation: Secure participation of small municipalities in regional or national projects/programmes

SMART MUNICIPALITIES

Lesson: Small municipalities fall behind in the smart municipality area
Recommendation: Establish a link between small and large municipalities' plans

Lesson: Potential causality between national initiatives and adoption rate
Recommendation: Develop cost-benefit of national smart municipality initiatives

ADDITIONAL INFORMATION: SUMMARY OF LESSONS AND RECOMMENDATIONS

All lessons and recommendations described on this page are summarized on a high level, and thus, several important aspects are omitted. It is advised to read chapter 7 – Lessons and Recommendations to fully understand the reasoning behind all lessons and recommendations.

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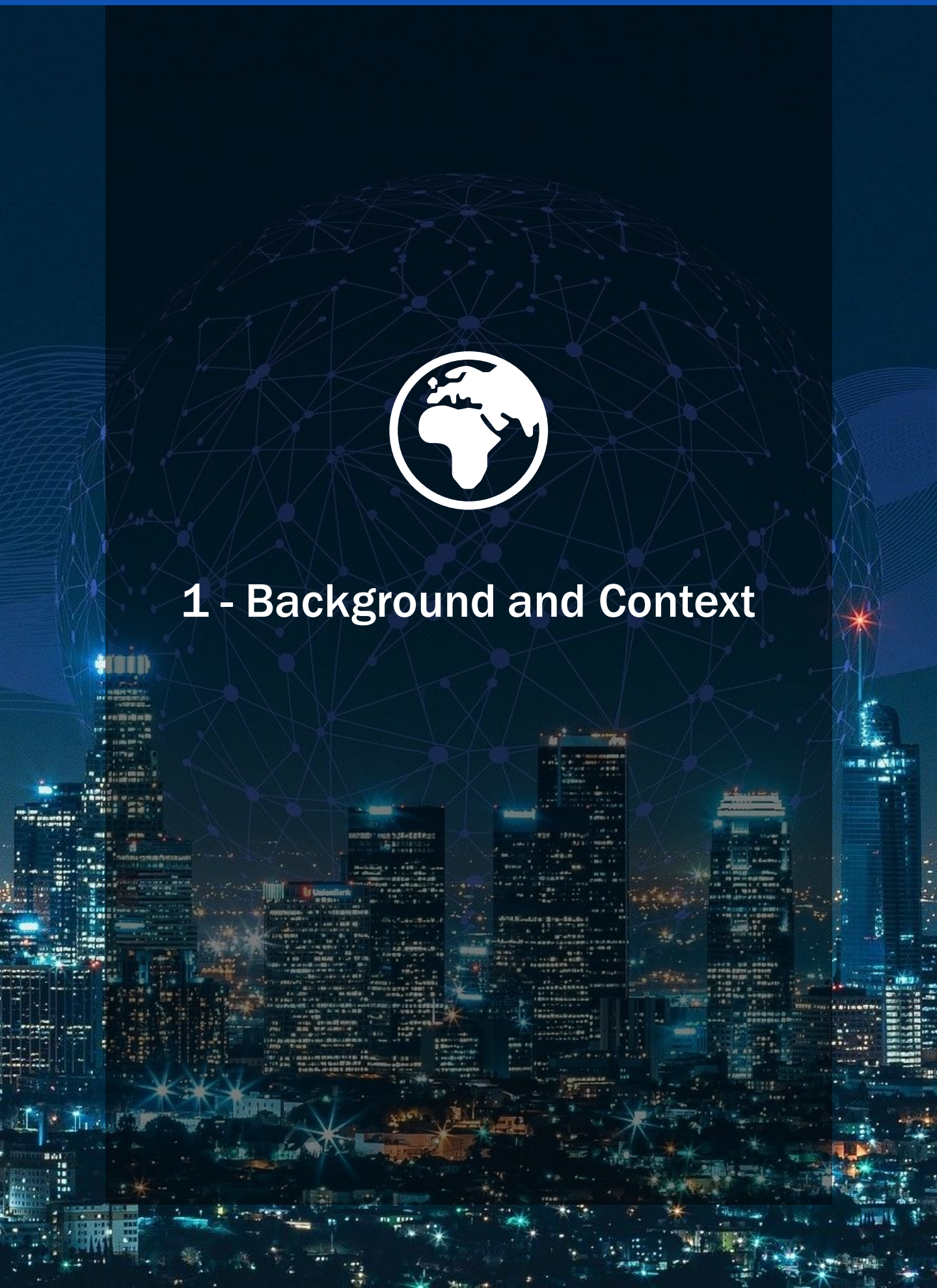


1 - Background and Context

How Large, medium-sized and Small Municipalities Facilitate a Digital Future in Norway, Sweden, Denmark and Finland

Nordic governments have developed strategies, agendas and plans for digitalisation towards a future often referred to as the Gigabit Society. Progress in these areas is shown by several studies that indicate that the Nordic countries have the most advanced digital economies in Europe. In addition, Denmark, Finland, Norway and Sweden have all designated a particular digitalization responsibility to part of their governments, thus signalling their focus on various digitalisation efforts currently underway, as well as the focus on future initiatives[1].

However, we have only just embarked on the very extensive process of digital transformation of the society. In the coming years, 5G roll-outs and IoT developments will contribute to the next phase of this digital transformation process. Nordic countries are well prepared for an ever more digitalised future, but it is important to maintain frameworks that ensure digitally driven innovations are developed, disseminated and used.

In addition to commercial providers of network infrastructure, services and content, there is an important role for central, regional and local governments in contributing to the ambitious political goals for digitalisation, and ultimately a Nordic Gigabit Society. The study has mapped, analysed and compared how 60 selected municipalities in Norway, Sweden, Denmark and Finland are facilitating deployment of mobile infrastructure, how developed the municipalities' digital service offerings to its inhabitants are and how the municipalities are planning, organising, facilitating and developing smart municipality ecosystems and services.

This Nordic Digital Municipality Index 2020 (NDMI 2020) has been prepared on behalf of Telenor in the period from December 2019 to May 2020. The work is based on previous studies from 2012, 2014 and 2016, called Nordic Broadband City Index (NBCI), but with a number of differences. The NBCI studies included two to three Nordic countries, whereas the NDMI 2020 has encompassed four countries. The NBCI studies focused on the largest cities in each country, while NDMI 2020 looks at large, medium-sized and small municipalities. Finally, there is an additional area in the NDMI 2020 focusing on smart municipalities.

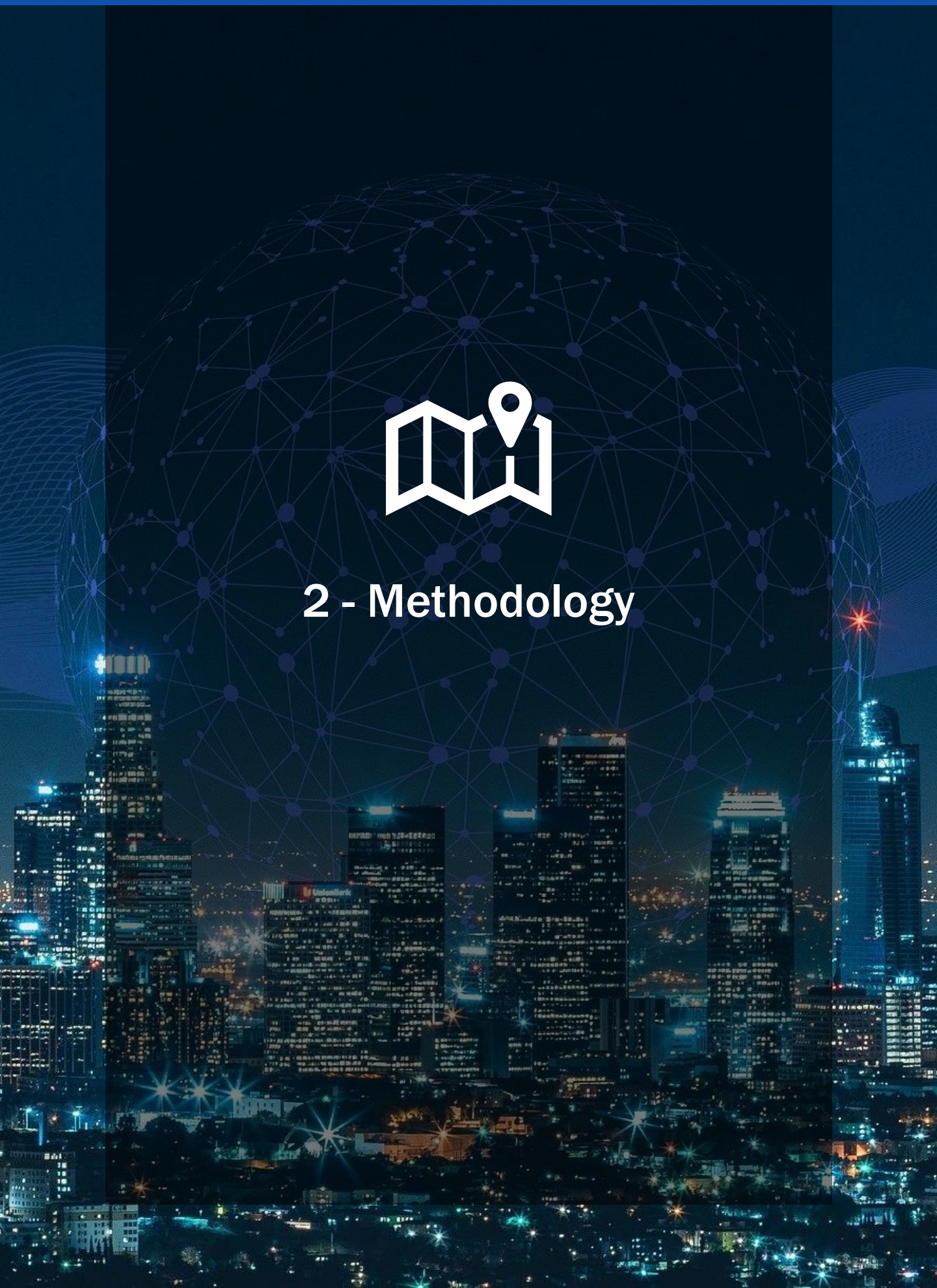
For each of the 60 selected Nordic municipalities, we have mapped and analysed several variables related to how the municipalities facilitate a digital future, and we have given the municipalities scores based on the information we have collected and analysed for each variable. In total, NDMI 2020 consists of 27 variables across these three sections:

1. Facilitation of mobile network deployment
2. Municipalities' digital service offerings
3. Planning, organising, facilitating and developing smart municipality ecosystems and services

In addition to scores and ranking of the 60 selected municipalities, this report describes differences between the Nordic countries and differences between large, medium-sized and small municipalities across the four countries. For each the three sections of this study, we also highlight key findings.

[1] Denmark has established "Digitaliseringsstyrelsen", an independent authority reporting to the Ministry of Finance. In a similar manner, Finland has established a Public Sector ICT Department which is part of the Ministry of Finance. Norway has a Minister of Regional Development and Digitalisation in the Ministry of Local Government and Modernisation and Sweden has an Energy and Digitalisation Minister in the Department of Infrastructure.

Holistically, these governmental structures aids to put a strong focus on the countries digitalization efforts by actively taking part in work performed globally, investigating best practice methods, adapting local solutions, etc.



2 - Methodology

Methodology of the Study

2.1 Selection of municipalities

NDMI 2020 is a benchmarking study of 60 municipalities in Norway, Sweden, Denmark and Finland.

Three groups of large, medium-sized and small municipalities were created based on the following criteria:

- Large municipalities: Five largest municipalities in each of the four countries.
- Medium-sized municipalities: Five municipalities in each of the four countries with a population between 20 000 and 50 000 inhabitants. The number of municipalities to select from in this category was as following:
  - Norway: 43
  - Sweden: 75
  - Finland: 35
  - Denmark: 50
- Small municipalities: Five municipalities in each of the four counties with less than 20 000 inhabitants. The number of municipalities to select from in this category was as following:
  - Norway: 142
  - Sweden: 151
  - Finland: 119
  - Denmark: 5[1]

A set of five randomly selected municipalities were then picked from each group. If the set contained municipalities situated too close to each other, a new set was picked in order to decrease geographical dependencies. The final municipalities for each country were the following:

Norway

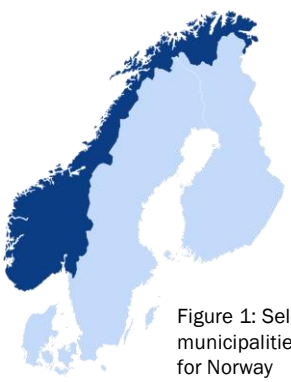


Figure 1: Selected municipalities for Norway

- Trysil
- Tynset
- Froland
- Odda - Ullensvang
- Sortland
- Halden
- Lillehammer
- Grimstad
- Molde
- Askøy
- Oslo
- Bergen
- Trondheim
- Stavanger
- Bærum

Sweden

Figure 2: Selected municipalities for Sweden

- Sjöbo
- Munkedal
- Vimmerby
- Lycksele
- Berg
- Eslöv
- Falköping
- Oskarshamn
- Piteå
- Hudiksvall
- Stockholm
- Göteborg
- Malmö
- Uppsala
- Linköping

Finland

Figure 3: Selected municipalities for Finland

- Hanko
- Heinola
- Hämeenkyrö
- Naantali
- Teuva
- Salo
- Raahe
- Riihimäki
- Rauma
- Valkeakoski
- Helsinki
- Oulu
- Tampere
- Jyväskylä
- Vantaa

Denmark

Figure 4: Selected municipalities for Denmark

- Dragør
- Vallensbæk
- Langeland
- Ærø
- Lemvig
- Allerød
- Kalundborg
- Vordingborg
- Billund
- Rebild
- København
- Aarhus
- Aalborg
- Odense
- Esbjerg

[1] As an outcome of the municipal reform ("Strukturreformen") in Denmark in 2007, 270 municipalities were merged or continued as 98 new municipalities. According to the parties behind the reform the ideal municipality in Denmark should have at least 30 000 inhabitants. Today, there are only five municipalities left with less than 20 000 inhabitants.

Methodology of the Study

2.2 Data collection, analysis and scores

NDMI 2020 comprises three main sections. Key questions for each of these sections have been:

- How do municipalities facilitate mobile network deployment?
- How developed are the municipalities' digital service offerings to its inhabitants?
- How do municipalities plan, organise, facilitate and develop smart municipality ecosystems and services?

The data collection and analysis in Section 1 are based on the same methodology used in the three previous NBCI studies for Telenor. Data in this section are collected through interviews with, and written input from, key resources within network roll-out and site acquisition teams in Telenor's local Nordic operational units and network contractors that Telenor uses and cooperates with when deploying mobile infrastructure in the municipalities included in the study. This means that scores in Section 1 reflect Telenor's and different network contractors' experiences and perceptions from deployment of mobile infrastructure in the respective municipalities.

Sections 2 and 3 are completed as desktop studies, where we have used municipal websites and additional web search as data sources. This means that scores in Sections 2 and 3 reflect the municipalities' public information about digital service offerings and how municipalities' websites present planning, organisation, facilitation processes, along with plans for developing ecosystems and services necessary to become a smart municipality.

Based on our analysis of the collected data, the selected 60 municipalities have been given scores for each of the three sections of this study. These section scores are then aggregated into a total score for each of the municipalities.

2.3 Variables and weighting of the study

Below are listed the variables and the weighting of each variable behind the scores in this study.

Section 1: How do municipalities facilitate mobile network deployment?

In Section 1, the municipalities are scored against the following variables and weightings:

Section 1 Variables	Weight
Access to Municipal Sites	40%
Lease Cost (Municipal and Private)	10%
Lease Cost (Real Estate-Adjusted)	20%
Effectiveness	10%
Application Approval	10%
Mobile Masterplan	10%

Table 1: Variables for Section 1

Section 2: How developed are the municipalities' digital service offerings to its inhabitants?

In Section 2, the municipalities are scored against the following variables and weightings:

Section 2 Variables	Weight
Digital Learning Platforms	11%
Online Daycare	11%
Online Build-Permit	11%
Fix-My-Street	11%
Secure Communication	11%
Availability of Communication Channels	11%
Welfare Technology Use	11%
Digital Learning Platforms - Advanced	11%
Municipal Warning System	11%

Table 2: Variables for Section 2

Section 3: How do municipalities plan, organise, facilitate and develop smart municipality ecosystems and services?

In Section 3, the municipalities are scored against the following variables and weightings:

Section 3 Variables	Weight
Planning - Scope	10%
Planning - Maturity	10%
Organisation - Scope	10%
Facilitation - Open Data - Scope	13%
Facilitation - Cooperation - Scope	13%
Facilitation - Working Facilities, Etc. - Scope	13%
Services - Traffic & Mobility - Scope	5%
Services - Traffic & mobility - Maturity	5%
Services - Health & Welfare -Scope	5%
Services - Health & Welfare - Maturity	5%
Services - Infrastructure - Scope	5%
Services - Infrastructure - Maturity	5%

Table 3: Variables for Section 3

Methodology of the Study

Total ranking and scores: How do Nordic municipalities facilitate a digital future?

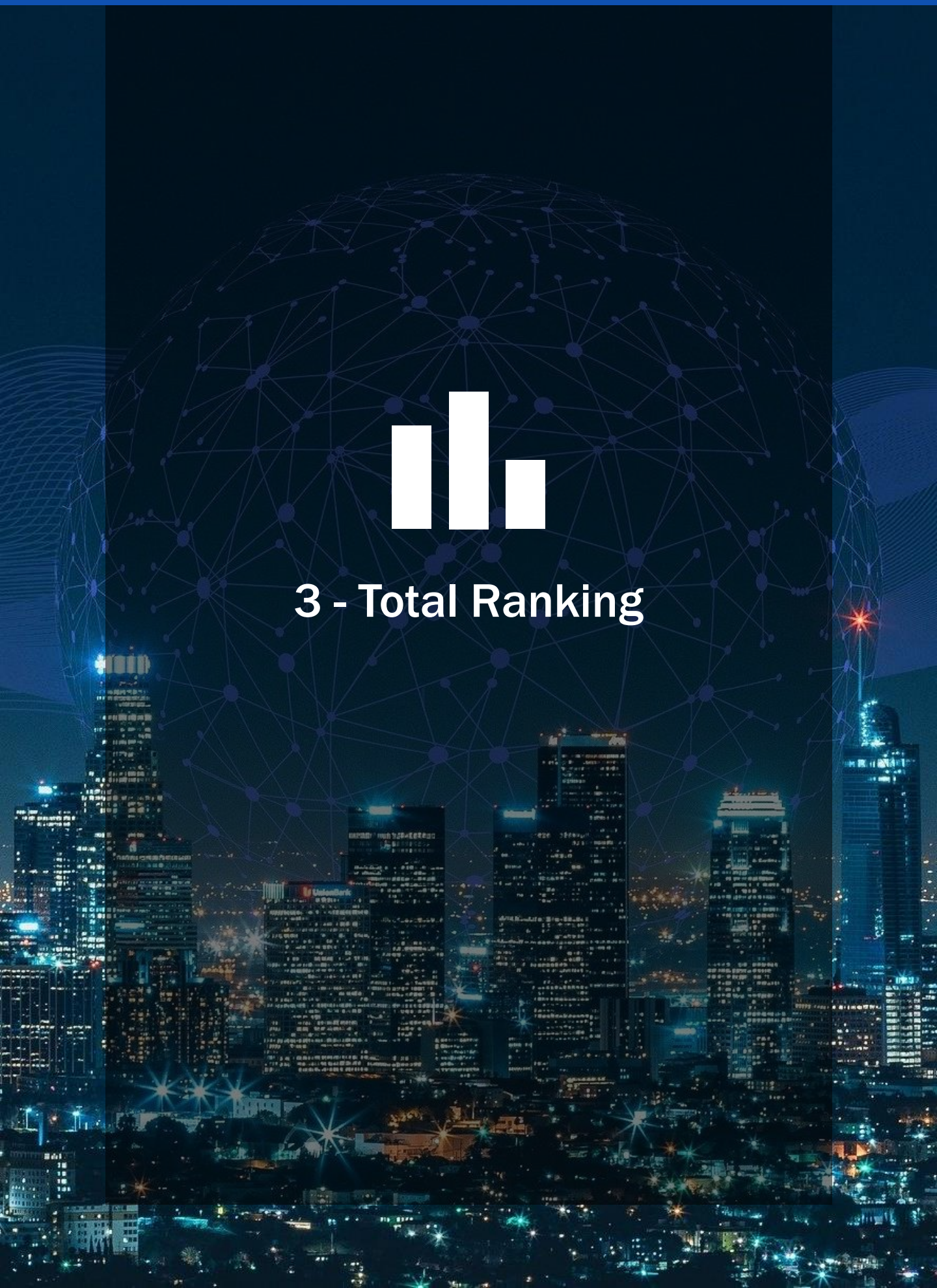
The overall ranking of how well the 60 selected Nordic municipalities facilitate a digital future is based on the following weighting of the scores from each of the three sections:

Total Ranking	Weight
Section 1	33%
Section 2	33%
Section 3	33%

Table 4: Final weights per section

2.4 Limitations

- Section 1
  - Some scores are based on qualitative data from a limited range of interviewees. Furthermore, some information was aggregated from dual-source information from both Telenor and contractors.
- Section 2 and 3
  - Scores are based on information which was mainly gathered through selected municipal communication channels (e.g. the official municipality website). This does not necessarily reflect the actual service offering, and this should be taken into account when reading this study.
  - Smart municipality, ICT, and digitalisation are concepts that are not mutually exclusive. Some municipalities have strategically avoided using certain nomenclature for various reasons. As a consequence, the study has determined the municipality's technological initiatives based on the municipality's chosen nomenclature.



3 - Total Ranking

Total Ranking

3.1 Introduction

Total scores and total ranking in this Nordic benchmarking study (Table 5) express how the 60 selected municipalities have performed in relation to the assessment criteria we have defined for the three selected sections in this study: 1) Mobile Network Deployment, 2) Digital Services and 3) Smart Municipality.

The total score for each municipality is based on the scores the municipality has got in the three sections, and the scores in each section represent 1/3 of the total score. In order to better understand the underlying reasons for the municipalities' total scores we recommend reading the comments and observations described for each of the three sections in Chapters 4, 5 and 6 below.

3.2 Overall ranking of municipalities

- Aalborg in Denmark achieved the highest total score of the 60 selected Nordic municipalities in this study. Aalborg is ranked fifth in the Mobile Network Deployment section and fourth in the Smart Municipality section. In the Digital Services section Aalborg has got the second highest score (together with five other municipalities).
- The Norwegian municipalities Bærum and Halden join Aalborg on the podium in this study. Halden is one of only two medium-sized municipalities among the top 15 municipalities in this study. The rest of the top 15 are large municipalities.
- All capitals in the Nordic countries are among the top 20 municipalities in this study. However, while København and Stockholm are placed fifth and eighth in the overall ranking, the scores for Oslo and Helsinki put the Norwegian and Finnish capitals in 18th and 20th position respectively.
- Total scores in the table below show a significant gap between the municipalities with the highest and the lowest scores in the study. While the top 10 municipalities achieved scores between 6.9 and 8.3, the total scores for the bottom 10 municipalities ranged between 2.7 and 3.8.

NDMI 2020 Ranking

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47	Dragør	4.0	DK	Small
48	Ærø	4.0	DK	Small
49	Lycksele	3.9	SE	Small
50	Heinola	3.9	FI	Small
51	Hanko	3.8	FI	Small
52	Jyväskylä	3.7	FI	Large
53	Vimmerby	3.6	SE	Small
54	Rauma	3.5	FI	Medium
55	Raahe	3.5	FI	Medium
56	Valkeakoski	3.4	FI	Medium
57	Allerød	3.4	DK	Medium
58	Munkedal	3.4	SE	Small
59	Hämeenkyrö	3.2	FI	Small
60	Teuva	2.7	FI	Small

Table 5: The NDMI 2020 ranking

[1] The ranking is based on the final score, which in turn is based on the individual performances of each municipality in the three different sections. Each of the 60 municipalities has a unique final score, and therefore a unique place in the final ranking.

Furthermore, there are several municipalities that score low due to the lack of information on their websites about digital service offerings (no matter if it is local or national services that exist). It is noteworthy that the study only scores how well the municipalities communicate their offerings on their websites, not what actual services that are available to the inhabitants. The latter could be different due to national services that exist but not communicated or collaborations between municipalities that result in regional services that exist but not communicated.

Total Ranking

3.3 Country-level differences

Norway comes out on top in the country ranking, as seen in Figure 5. On average, Norwegian municipalities in this study received an average total score of 6.0. Close behind are the Danish municipalities with an average total score of 5.6. Sweden follows as the third country in this ranking with an average total score of 5.1, while the Finnish municipalities obtain an average total score of 4.4.

With average total scores on country level between 4.4 and 6.0, there exists potential for improvement for all four countries in this study. Finland has the biggest potential for improvement, with 7 out of 15 municipalities in the bottom 10 of the total ranking.

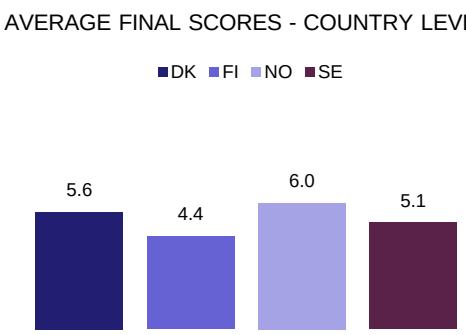


Figure 5: Average final score per country

Table 6 shows that Norwegian municipalities in general score much higher in the Digital Services section than municipalities in other Nordic countries. The average score for the Norwegian municipalities in this section is 7.8, while the average scores for the other three countries in this section are between 6.0 and 6.9.

In the other two sections in this study, the country level differences are less obvious. In the Mobile Network Deployment section, the country-level averages were all between 4.1 and 5.3, and in the Smart Municipality section the range was between 3.9 and 5.2.

	Mobile Network Deployment	Digital Services	Smart Municipality	Final Score Total
DK	5.3	6.4	5.1	5.6
FI	4.1	6.0	3.2	4.4
NO	5.1	7.8	5.2	6.0
SE	4.6	6.9	3.9	5.1

Table 6: Final score per section of the NDMI 2020 study

Total Ranking

Figure 6 shows how each of the four countries score in relation to Mobile Network Deployment, Digital Services and Smart Municipalities/Cities.

For Mobile Network Deployment, the range of scores shows little consistency. In Sweden, all municipalities are judged to fall within a relatively small range, from 3.1 and 5.9. In Norway, by contrast, the scores vary much more significantly (between 1.4 and 8.5).

For Digital Services, the range of scores is somewhat smaller, especially among Norwegian municipalities, with scores between 6.1 and 8.9. Finnish municipalities, the most variable of the four, score between 3.3 and 7.8.

For Smart Cities, all four countries show significant variation between the best performing municipalities and the ones with the highest improvement potential. Scores from Norway are ranged between 1.8 and 9.8, those from Denmark vary between 1.4 and 9.8, those from Sweden vary between 0.6 and 8.8 and those from Finland vary between 0.1 and 8.5.

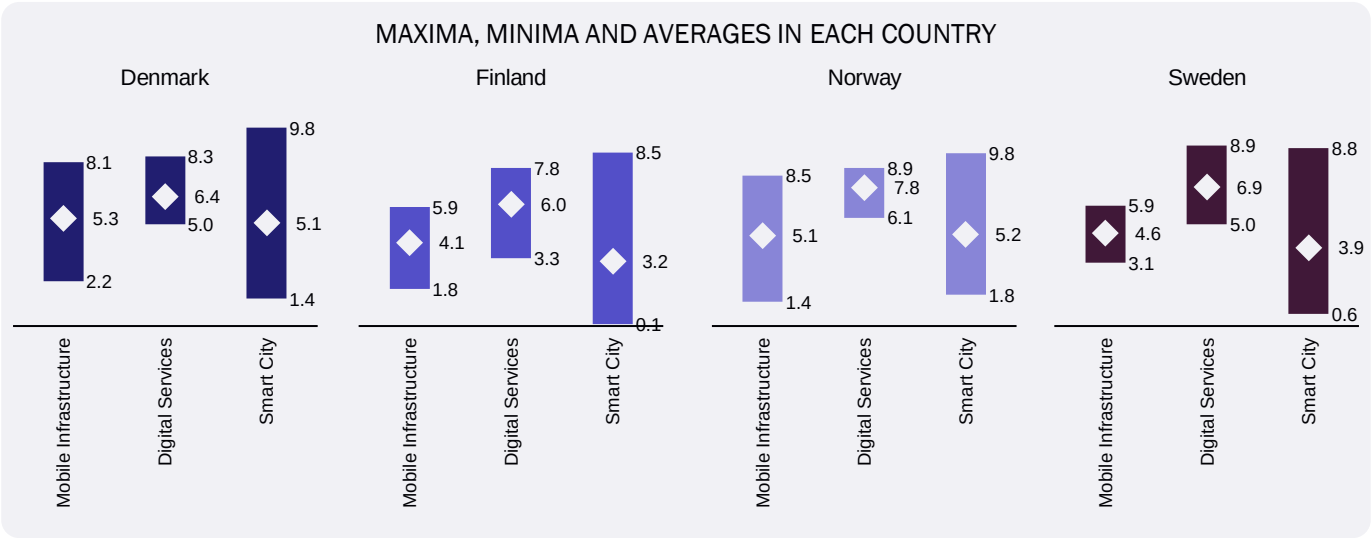


Figure 6: Maxima, minima and averages for each section and country

3.4 Differences between small, medium-sized and large municipalities

- Large municipalities
  - overall average: 6.6
  - 13 out of the top 15 municipalities in the total ranking
  - accounted for 95% of the top 30 municipalities.
- Medium-sized municipalities
  - overall average: 5.0
  - 9 municipalities in the top 30 municipalities
  - 11 municipalities in the bottom 30 municipalities.
  - more scattered in the total ranking than large and small municipalities.
- Small municipalities
  - overall average: 4.3.
  - 2 municipalities in the top 30
  - 90% are in the bottom 30 municipalities

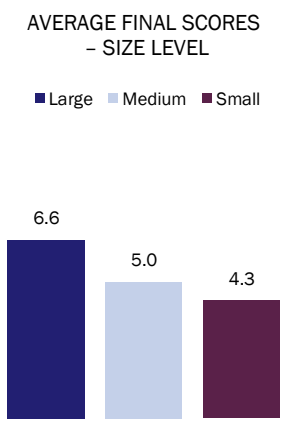


Figure 7: Average final score per size category of municipalities

Total Ranking

Table 7 gives an overall summary of the scores for each size category of the municipalities.

It can be seen that large municipalities in general gain much higher scores in the Smart Municipality section than small and medium-sized municipalities. The average score for large municipalities in this section is 7.8, while the average scores for small and medium-sized municipalities are 2.0 and 3.2 respectively. This is the main reason why large municipalities come out on top of the total ranking in this study.

In the other two sections the differences between the three municipality sizes are less pronounced. Indeed, it is interesting to notice that in the Mobile Network Deployment section, the average score for small (5.1) and medium-sized (5.2) municipalities are higher than for the large ones (4.1).

	Mobile Network Deployment	Digital Services	Smart Municipality	Final Score Total
Large	4.1	7.8	7.8	6.6
Medium	5.2	6.7	3.2	5.0
Small	5.1	5.8	2.0	4.3

Table 7: Final score per section and size category

Figure 8 shows that in the Digital Services section, the scores tend to be somewhat higher, and with a typically smaller range than in the other sections. The large municipality with the highest improvement potential scores 6.1 for Digital Services, compared to the one with the highest improvement potential in the small municipalities at 3.3.

Several of the municipalities in this study, regardless of size, have big improvement potentials in the Smart Municipality section. This is especially evident among the medium-sized and small municipalities where the ones with the most improvement potential score 0.1.

Furthermore, the distribution of scores among large, medium-sized and small municipalities in the Mobile Network Deployment section shows that the municipalities with the highest improvement potential are large municipalities. It is interesting to notice that two Nordic capitals (Oslo and Helsinki) are among bottom three in the Mobile Network Deployment section.

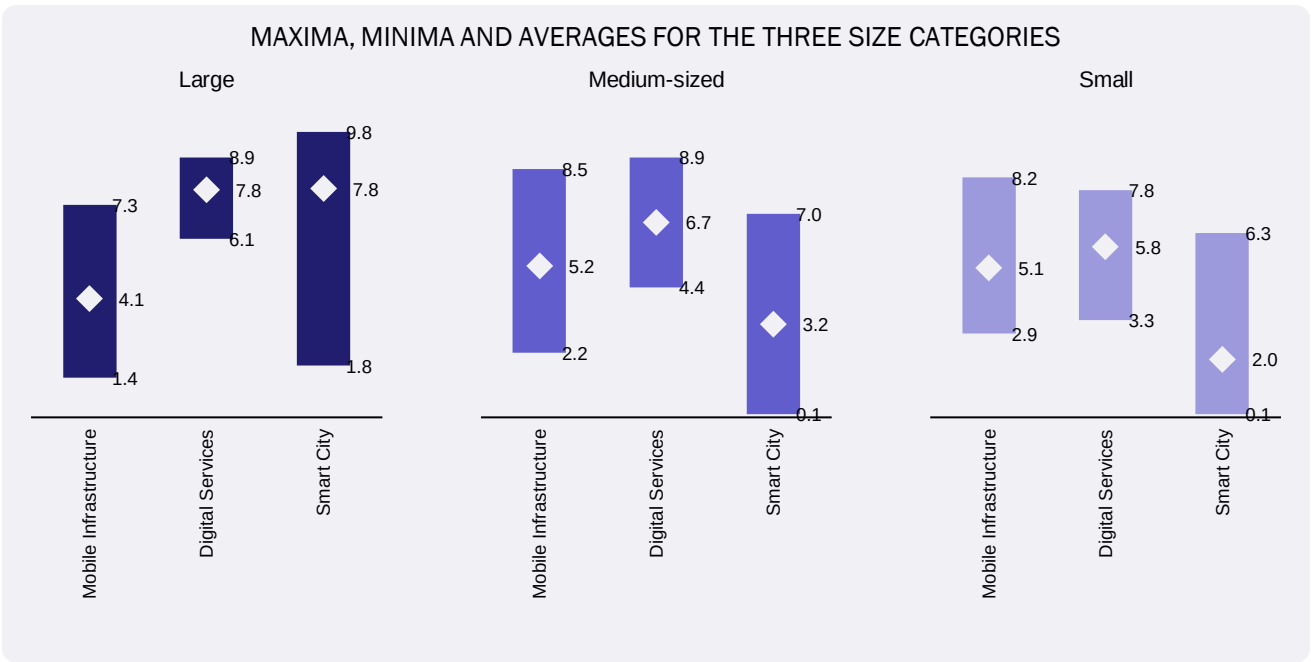
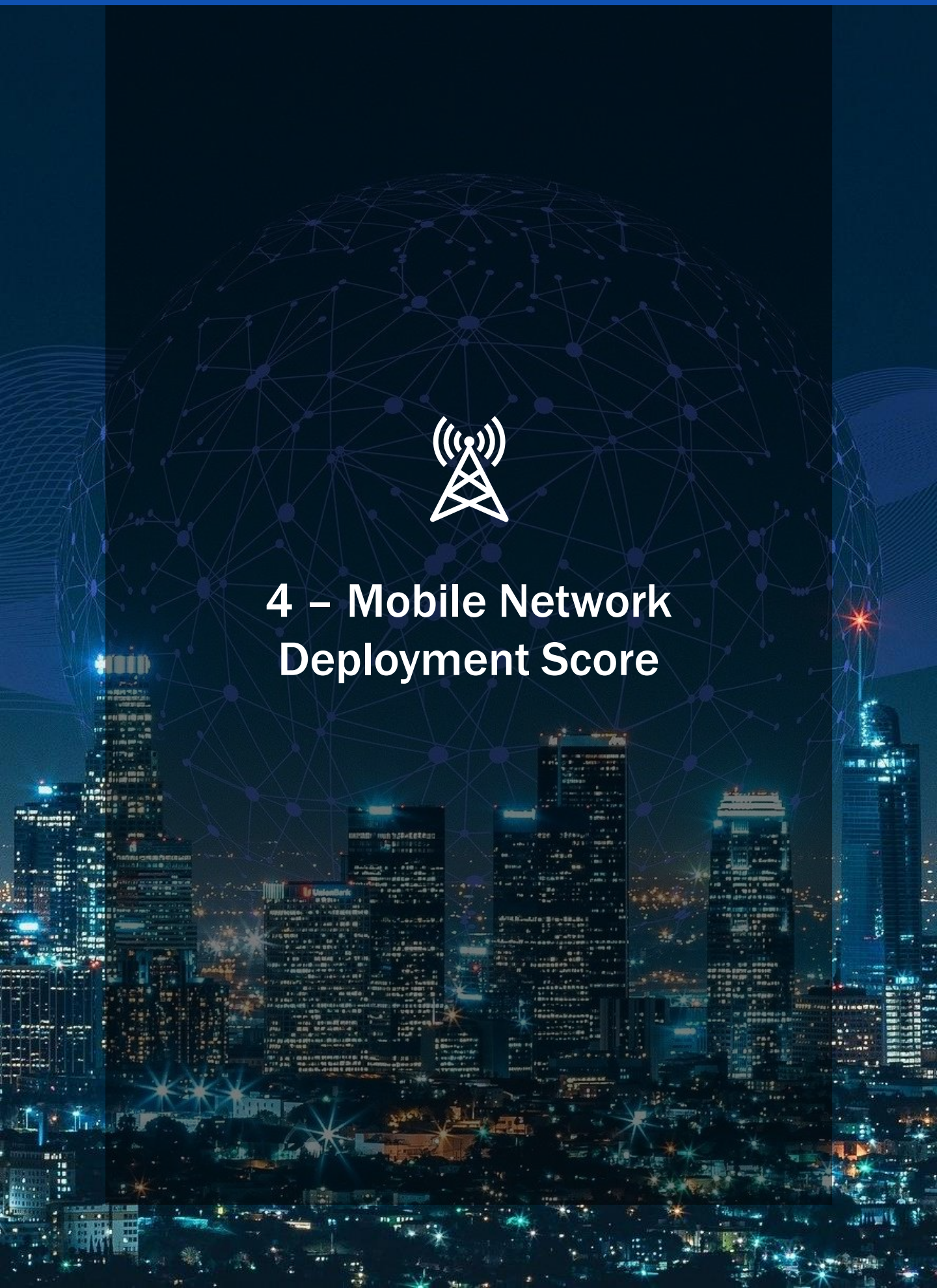


Figure 8: Maxima, minima and averages for each section and size category



4 – Mobile Network Deployment Score

Section 1

Key Findings

Mobile Network Deployment

1

Denmark and Norway are the country winners in the Mobile Network Deployment section. They each have five municipalities in the top 10 ranking in this section.

2

Denmark scores the highest among the four countries, mainly due to more efficient communication between operators and municipalities regarding site planning.

3

For large municipalities, Norway and Sweden experience more cumbersome processes with municipalities than is the case in Denmark and Finland.

4

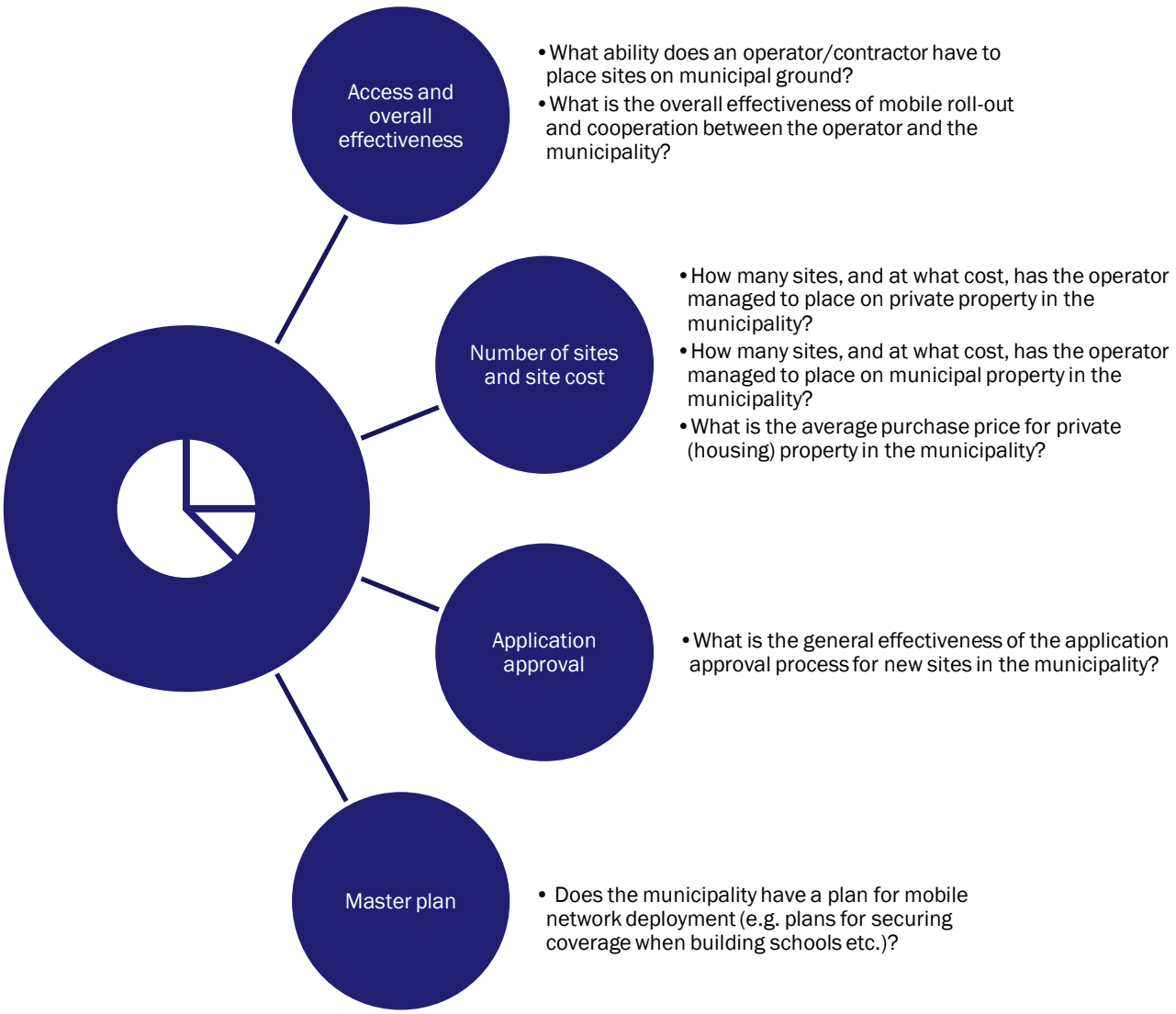
Out of the top 20 municipalities, only four are large municipalities. 60% of the large municipalities (including the four country capitals) place themselves in the bottom 15. The main reason for this is related to difficulties with the process of placing sites in the large municipalities.

Mobile Network Deployment Score

4.1 Introduction

Reliable and high-capacity mobile network infrastructure is one of the prerequisites for digitalisation in societies. Roll-out of the fifth generation (5G) mobile networks will in many cases require further densification of mobile sites to ensure coverage with the use of higher frequency ranges. To ensure efficient roll-out of mobile networks, efficient cooperation with municipalities is key.

The Mobile Network Deployment section of this analysis is designed to estimate how efficiently such mobile network rollouts can be performed in different municipalities. The underlying parameters behind the score each municipality achieves in this section are:



Mobile Network Deployment Score

4.2 Ranking

- Denmark and Norway are the country winners in the Mobile Network Deployment section. They each had five municipalities within the top 10 ranked municipalities, as illustrated in Table 8.
- Large municipalities are struggling in this category, accounting for only 30% of municipalities in the top half of the ranking. By contrast 60% of medium-sized and small municipalities were in the top half of the ranking.
- All capitals of the Nordic countries in this study have great potential for improvement, placing themselves at 45th, 48th, 58th and 60th out of the 60 places in the ranking.

Mobile network deployment ranking

#	Municipality	Score	Country	Size
1	Grimstad	8.5	NO	Medium
2	Froland	8.2	NO	Small
3	Rebild	8.1	DK	Medium
4	Langeland	7.4	DK	Small
5	Aalborg	7.3	DK	Large
6	Lemvig	7.1	DK	Small
7	Vordingborg	6.9	DK	Medium
8	Bærum	6.8	NO	Large
9	Sortland	6.5	NO	Small
10	Halden	6.3	NO	Medium
11	Kalundborg	6.2	DK	Medium
12	Trysil	6.2	NO	Small
13	Odda - Ullensvang	6.1	NO	Small
14	Billund	6.0	DK	Medium
15	Esbjerg	6.0	DK	Large
16	Falköping	5.9	SE	Medium
17	Piteå	5.9	SE	Medium
18	Vantaa	5.9	FI	Large
19	Molde	5.9	NO	Medium
20	Lycksele	5.6	SE	Small
21	Naantali	5.4	FI	Small
22	Hudiksvall	5.4	SE	Medium
23	Valkeakoski	5.2	FI	Medium
24	Tampere	5.2	FI	Large
25	Tynset	5.1	NO	Small
26	Ærø	5.1	DK	Small
27	Rauma	4.8	FI	Medium
28	Teuva	4.7	FI	Small
28	Vimmerby	4.7	SE	Small
30	Oulu	4.6	FI	Large
31	Riihimäki	4.6	FI	Medium
32	Odense	4.6	DK	Large
33	Malmö	4.5	SE	Large
34	Berg	4.4	SE	Small
35	Uppsala	4.4	SE	Large
36	Askøy	4.3	NO	Medium
37	Göteborg	4.2	SE	Large
38	Eslövs	4.2	SE	Medium
38	Hanko	4.2	FI	Small
38	Hämeenkyrö	4.2	FI	Small
38	Munkedal	4.2	SE	Small
38	Sjöbo	4.2	SE	Small
38	Oskarshamn	4.2	SE	Medium
44	Linköping	4.0	SE	Large
45	København	3.9	DK	Large
46	Trondheim	3.5	NO	Large
47	Lillehammer	3.3	NO	Medium
48	Stockholm	3.1	SE	Large
49	Dragør	3.1	DK	Small
50	Stavanger	3.0	NO	Large
51	Vallensbæk	3.0	DK	Small
52	Aarhus	3.0	DK	Large
53	Raahe	2.9	FI	Medium
54	Heinola	2.9	FI	Small
55	Jyväskylä	2.7	FI	Large
56	Salo	2.6	FI	Medium
57	Allerød	2.2	DK	Medium
58	Helsinki	1.8	FI	Large
59	Bergen	1.5	NO	Large
60	Oslo	1.4	NO	Large

Table 8: Section score for the Mobile Network Deployment section

Mobile Network Deployment Score

4.3 Country-level differences

Generally, the four countries achieve - on average - quite similar scores, as illustrated in Figure 9. However, there exist some minor differences in the underlying parameters. Denmark scores the highest of the four countries, mainly due to more efficient communication and planning between operators and municipalities regarding site planning. There exists great potential for all countries to improve in this area, potentially by further nurturing the cooperation between the municipality, the operator and the contractors.

In Figure 10, the average score for the application approval process for new sites on municipal ground in the countries is shown. The higher scores may be a consequence of a low case-burden and less complex considerations to take into account (e.g. infrastructural considerations). This becomes especially evident for smaller municipalities which tend to have faster lead times for its approval processes. However, a high application approval score does not necessarily mean a high share of sites on municipal property (see Figure 11) since there are numerous other considerations to take into account when planning locations for sites (geography, cost, private leasing conditions, etc.).

The general dialogue and effectiveness (between operators/contractors and municipalities) among the countries are very similar for medium-sized and small municipalities. However, for large municipalities, both Norway and Sweden experience more cumbersome processes with the large municipalities than Denmark and Finland, which is illustrated with the Effectiveness parameter in Table 9.

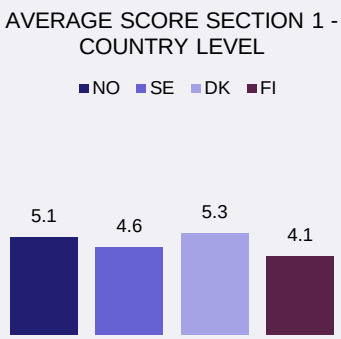


Figure 9: Average country score for the Mobile Network Deployment Section

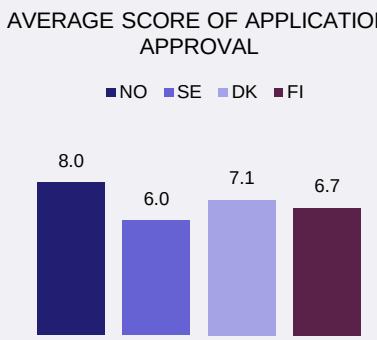


Figure 10: Average score of the application approval process parameter

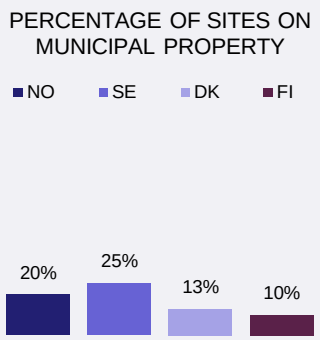


Figure 11: Percentage of sites on municipal property per country

	Large	Medium	Small
DK	8.0	7.2	7.6
FI	7.2	6.8	6.0
NO	4.8	8.0	8.0
SE	4.0	6.4	6.8

Table 9: The score for the Effectiveness parameter per size category and country

Mobile Network Deployment Score

4.4 Differences between small, medium-sized and large municipalities

- Scoring between the different size categories is broadly similar for small and medium-sized municipalities, with large municipalities scoring less (see Figure 12). Large municipalities tend to have several areas where economy of scale works at its advantage. Unfortunately, there exists an inverse relationship in relation to how easy it is to accommodate for mobile sites. Large municipalities tend to have more cumbersome processes of placing sites on municipal property in combination with a more time-consuming application approval process in the larger municipalities. This does not inherently mean that all approval processes for large municipalities are more inefficient than the processes for smaller municipalities, since many cases of slower processing times can be attributed to the sheer amount of cases large municipalities have to process.
- Only four large municipalities place themselves in the top 20. Furthermore, 60% of the large municipalities (including the four capitals in the Nordic countries) place themselves in the bottom 15. The main reason for this is related to difficulties with the process of placing sites in large municipalities.

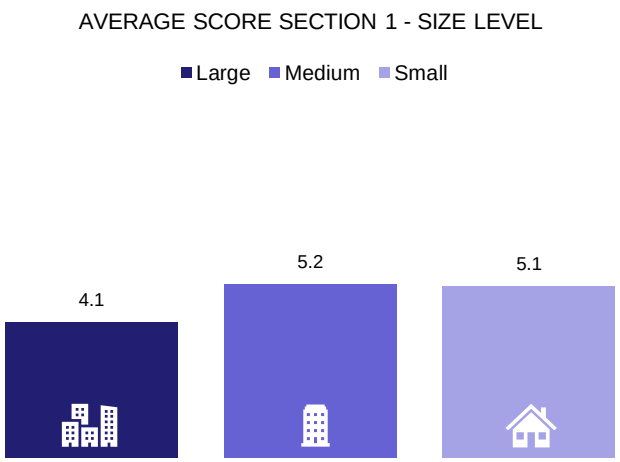
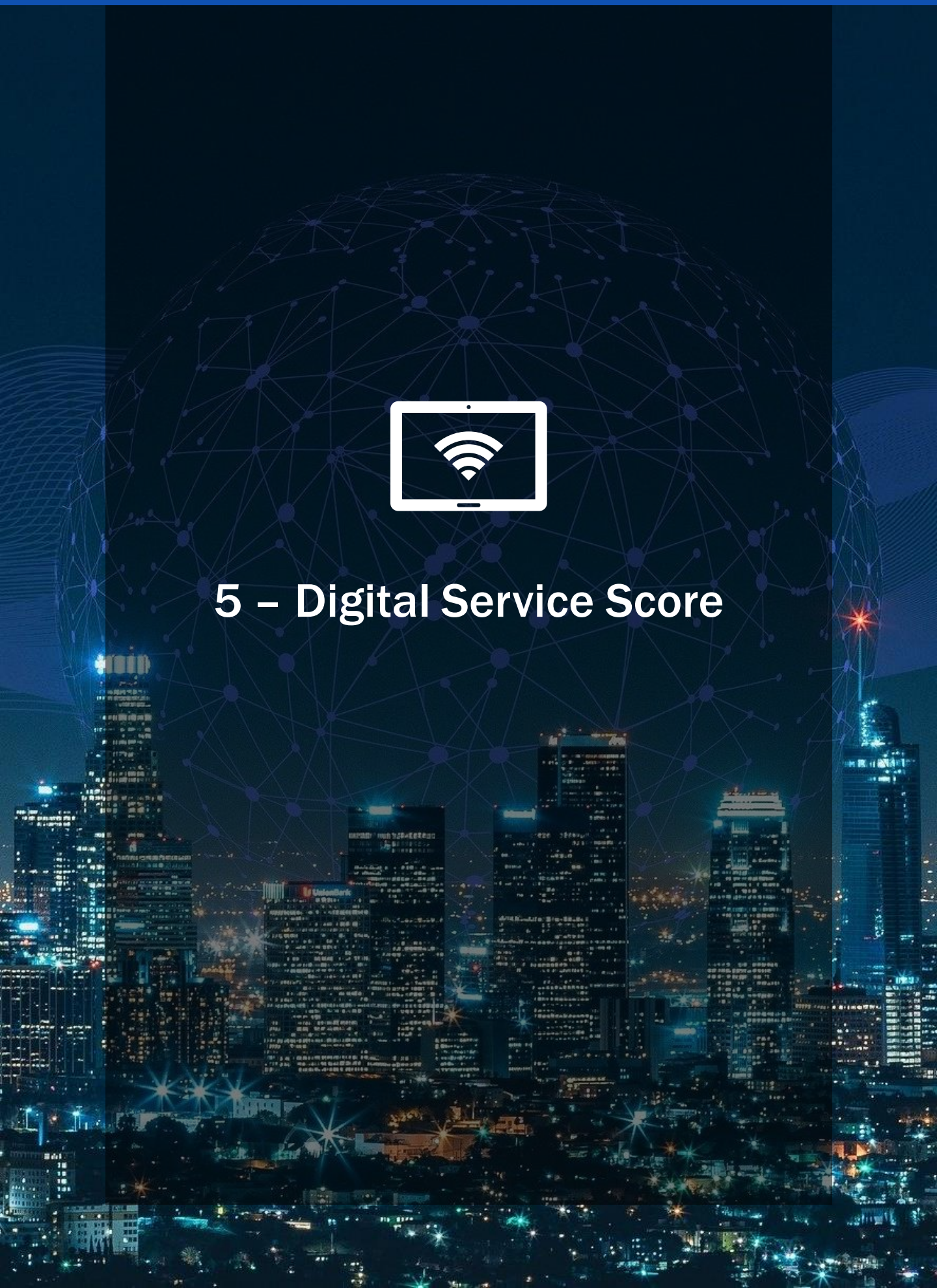


Figure 12: Average score per size category for the Mobile Network Deployment Section



5 – Digital Service Score

Section 2

Key Findings

Digital Services

1

Larger municipalities tend to achieve higher scores in the Digital Services section, but only one of the four surveyed capitals is ranked among the highest scoring municipalities.

2

National programmes appear to be effective tools to improve broad digitalisation among all sizes of municipalities.

3

Nearly all of the benchmarked municipalities have launched a baseline of digital services, showing that digitalisation of municipal services is well under way across the Nordic region.

4

Smaller municipalities, on average, score less well in regards to welfare technology use and digital learning platforms (both of which are particularly important for rural communities).

5

A group of smaller municipalities is punching above their weight and reaching scores typically achieved by much larger municipalities.

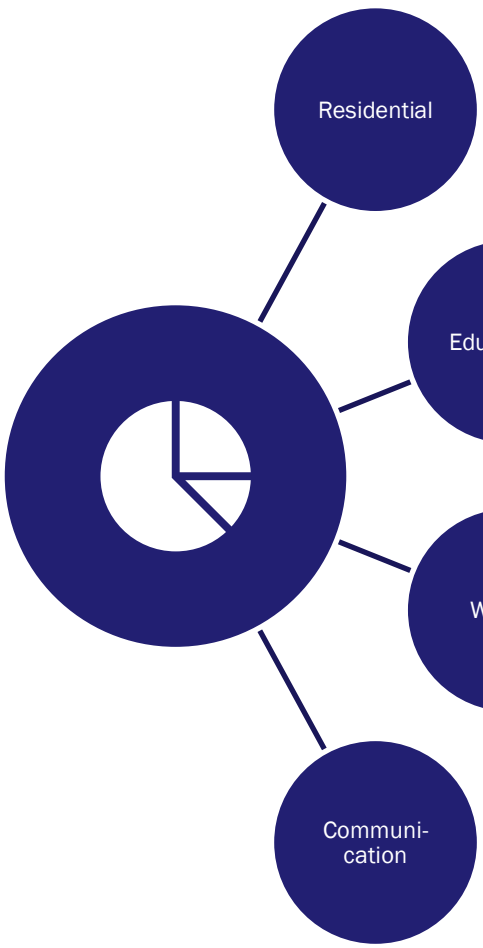
Digital Service Score

5.1 Introduction

In this section, the digital services offered by municipalities to their inhabitants are benchmarked and compared. Grading takes into account not only the mere existence of services, but also the functionality, scope, promotion, and (where available) usage of the services.

It is worth noting that several municipalities can be modest when it comes to communication of digital services on their websites. One contributing factor is if there are established national services in place, and therefore some municipalities do not feel the need to inform of such services. In those cases, the municipalities receive a low score and they show improvement potential to inform their citizens about such services. To summarize, the score in this section takes the temperature on the municipalities' abilities to clearly enlighten its inhabitants about what services are available to them, whether they are produced at a municipal or national level.

The underlying parameters behind the score each municipality achieves in this section are:



- Can building permits be applied for online?
- Is there a convenient way for residents to inform the municipalities, and be informed themselves, of malfunctioning or improvable parts of the basic municipal services such as road works, broken streetlights or similar?

- Can guardians apply for daycare online?
- Can guardians follow schoolwork online and communicate with teachers and faculty members?
- Are digital tools an integral part of the curricula, where students and teachers work and collaborate?

- Which welfare technology categories and services are offered by municipalities?

- How active is the municipality on social media?
- Which communication options does it offer its inhabitants?
- Can inhabitants anonymously, and securely, communicate sensitive matters to the municipality?
- Has the municipality a secure and reliable way to communicate critical information to inhabitants and visitors in the area?

Digital Service Score

5.2 Ranking and scores

- Top scoring municipalities, in the context of digital services, are dominated by large and medium-sized Norwegian municipalities, along with the two largest Swedish municipalities. All these municipalities reach a score of 8.9 in the benchmark, which is illustrated in Table 10.
- Out of the top 20 municipalities in this benchmark, Sortland is the only municipality from the small category.
- Only one of the capital cities (Stockholm) is found in the highest scoring group.
- There are several municipalities that score low (e.g. Teuva that places itself on the 60th place in the ranking) due to the lack of information on their websites about digital service offerings (no matter if it is local or national services that exist). It is noteworthy that the study only scores how well the municipalities communicate their offerings on their websites, not what actual services that are available to the inhabitants. The latter could be different due to national services that exist but not communicated or collaborations between municipalities that result in regional services that exist but not communicated.

Digital service ranking

#	Municipality	Score	Country	Size
1	Stockholm	8.9	SE	Large
1	Bærum	8.9	NO	Large
1	Halden	8.9	NO	Medium
1	Trondheim	8.9	NO	Large
1	Göteborg	8.9	SE	Large
1	Grimstad	8.9	NO	Medium
7	Aalborg	8.3	DK	Large
7	Stavanger	8.3	NO	Large
7	Oslo	8.3	NO	Large
7	Falköping	8.3	SE	Medium
7	Bergen	8.3	NO	Large
7	Uppsala	8.3	SE	Large
13	Sortland	7.8	NO	Small
13	Helsinki	7.8	FI	Large
13	Molde	7.8	NO	Medium
13	Aarhus	7.8	DK	Large
13	København	7.8	DK	Large
13	Askøy	7.8	NO	Medium
13	Malmö	7.8	SE	Large
20	Oulu	7.2	FI	Large
20	Berg	7.2	SE	Small
20	Tynset	7.2	NO	Small
20	Tampere	7.2	FI	Large
20	Hudiksvall	7.2	SE	Medium
20	Salo	7.2	FI	Medium
26	Esbjerg	6.7	DK	Large
26	Trysil	6.7	NO	Small
26	Langeland	6.7	DK	Small
26	Vantaa	6.7	FI	Large
26	Raahe	6.7	FI	Medium
26	Lillehammer	6.7	NO	Medium
26	Odense	6.7	DK	Large
26	Piteå	6.7	SE	Medium
26	Froland	6.7	NO	Small
26	Jyväskylä	6.7	FI	Large
36	Odda - Ullensvang	6.1	NO	Small
36	Oskarshamn	6.1	SE	Medium
36	Sjöbo	6.1	SE	Small
36	Riihimäki	6.1	FI	Medium
36	Allerød	6.1	DK	Medium
36	Vordingborg	6.1	DK	Medium
36	Rebild	6.1	DK	Medium
36	Lemvig	6.1	DK	Small
36	Kalundborg	6.1	DK	Medium
36	Linköping	6.1	SE	Large
46	Hanko	5.6	FI	Small
46	Heinola	5.6	FI	Small
46	Eslöv	5.6	SE	Medium
46	Rauma	5.6	FI	Medium
46	Dragør	5.6	DK	Small
46	Vallensbæk	5.6	DK	Small
46	Lycksele	5.6	SE	Small
53	Billund	5.0	DK	Medium
53	Munkedal	5.0	SE	Small
53	Ærø	5.0	DK	Small
53	Naantali	5.0	FI	Small
53	Vimmerby	5.0	SE	Small
53	Hämeenkyrö	5.0	FI	Small
59	Valkeakoski	4.4	FI	Medium
60	Teuva	3.3	FI	Small

Table 10: Section score for the Digital Services section

Digital Service Score

5.3 Country-level differences

1

Norway scores highest among the countries with a top score of 7.8, 30% higher than Finland

Norway's leading position (see Figure 13) primarily comes from progress in digitalisation of the welfare system and the adoption of digital ways of working in education.

2

Denmark has the most uniform scoring among its municipalities (Fig. 14), whereas Sweden and Finland have larger deviations between its municipalities

Denmark has implemented national platforms and policies to a higher degree than its Nordic neighbours. The fundamental platforms Denmark uses in the digitalisation of childcare and education are both implemented at national levels which is unique in our study. Furthermore, we found more references to national policy in municipal communications, for example the mandate on all municipalities to implement a digital learning platform in addition to the state-provided basic services.

3

National programmes appear to be effective tools to improve broad digitalisation among all sizes of municipalities

Examples from Denmark and Norway show that tools (such as Aula in Denmark) and mandates (such as those published by Direktoratet for e-helse in Norway) are key to drive development on national levels.

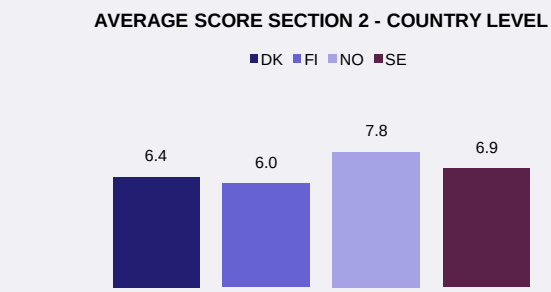


Figure 13: Average score per country for the Digital Services section

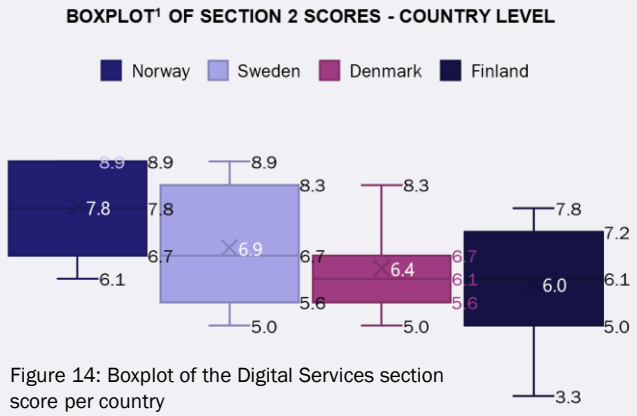
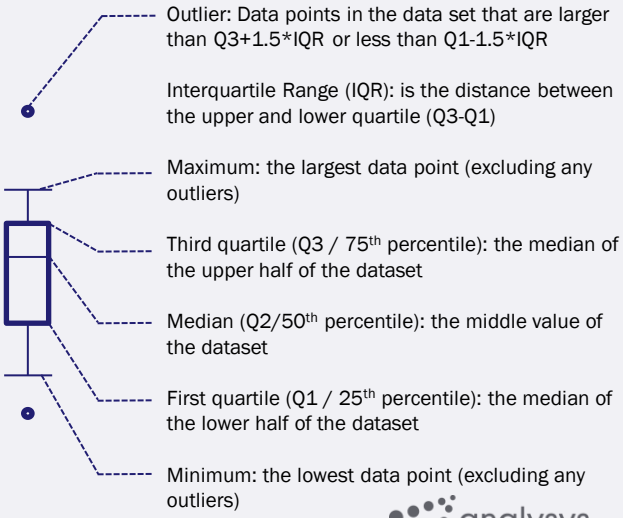


Figure 14: Boxplot of the Digital Services section score per country

[1] HOW TO READ BOXPLOTS

Boxplots are a helpful tool to visualise the distribution of numerical data. It provides information on the range of scores, how scattered the data is, etc. Q1-Q3 are the quartiles in the data set. If Q1 is 5.0, that means that 25% of the data is below 5.0, and 75% is above 5.2. If Q3=7.2, that means that 25% of the data is higher than 7.2. The max and min markers show the max and min of the data set after filtering out potential outliners.



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Digital Service Score

4

All four countries have high and similar scores for learning platforms and online daycare

Except for a few outliers, all Nordic municipalities in this study have implemented digital platforms for daycare application forms and basic information sharing with guardians and students in education.

5

Digitalisation of public alert systems acts as a catalyst for national differences

Neither Denmark nor Finland has implemented any digital public warning systems, hence their low score in Table 11. In Norway, all investigated municipalities have implemented systems on their own or joined a larger regional initiative, and in Sweden, a national solution has been put in place by the civil contingencies agency (MSB). Denmark and Finland have made available smartphone apps, which nationals can download if they wish, in addition to auditory and public service broadcasting channels (TV and radio), but no mention of telecoms-powered public warning systems has been found.

	Digital learning platforms	Online daycare	Online build-permit	Fix-my-street	Secure comm.	Availability of comm. Channels	Welfare technology use	Digital learning platforms - advanced	Municipal warning system[1]
DK	10.0	10.0	10.0	8.3	4.7	4.3	5.3	4.7	
FI	10.0	10.0	8.3	7.3	4.7	6.3	3.0	4.3	
NO	10.0	9.7	8.3	8.7	5.0	5.0	7.7	6.0	10.0
SE	10.0	10.0	6.7	5.7	5.7	6.0	3.0	4.7	10.0

Table 11: Parameter score per country in the Digital Services section

[1] MUNICIPAL WARNING SYSTEMS

Municipal warning systems is a broad term and tends to include both different types of technologies, as well as different types of methods to inform something or someone about impeding challenges or danger. In order to ensure that municipalities are benchmarked fairly and consistent, a clear and well-defined description of what type of municipal warning system the study ought to look for was needed. As a consequence, the study concluded that municipalities' websites should be investigated for any information on an SMS-based public warning system. This is a well-established technology available in all countries, and thus, does not favour any of the investigated municipalities. Furthermore, several countries have chosen to implement SMS-based municipal warning systems on a national level. Thus, rendering incentives for municipalities to implement their own as non-existent. In such cases, municipalities have been awarded scores according to whether the national systems are in the planning stage, or have been implemented and is currently in working condition.

However, by choosing a well-defined parameter that is suitable for benchmarking, an apparent disadvantage emerges. Several municipalities (and countries) are looking into other aspects and methods of warnings its inhabitants. This is especially evident for Finland and Denmark.

In Denmark, there has historically not existed a common SMS-based warning system. Instead, public warnings have traditionally been taken care of by public service radio and TV, as well as the national network of sirens covering the entire country. However, a number of municipalities are offering SMS-based solutions in order to communicate with their citizens. The solutions range from reminders on trash pick-up, medical appointments, etc. to SMS-based warning solutions aimed primarily at people who are blind or weak of hearing. A large number of municipalities also communicate warning messages to the citizens via social media and there also exists a national application, which warns its uses of accidents and catastrophes.

Going forward for Denmark, they will (as the rest of the EU) be obligated by 21st of June 2022 to introduce a public warning system. This is an obligation introduced in the new Telecom Codex (EU-Directive 2018/1972 of the European Parliament and of the Council of 11th of December 2018, establishing the European Electronic Communications Code), art. 110 and will (when introduced) function nationwide.

Finland has, just like Denmark, focused public warnings by TV and radio broadcast in combination with outdoor sirens. There also exists legislation (The Information Society Code, section 287) that stipulates "Obligation of a telecommunications operator to transmit a targeted message from the authorities". This has been successfully deployed at least once via SMS during the COVID-19 outbreak. In addition, messaging has been tested with an existing "112" application. Going forward for Finland, there exists work-in-progress legislation which is based on a smartphone application where installation is voluntary.

To summarize, municipal warnings systems is a broad field with several technologies, vast number of warning methods, as well as different legislations on a national and European level that regulate both current and future plans. Going forward, it might be of more interest to benchmark European-based legislation efforts once such regulation harmonizes the numerous initiatives.

Digital Service Score

5.4 Differences between small, medium-sized and large municipalities

1) Larger municipalities achieve higher scores than smaller ones, with medium-sized municipalities in between

- There is an approximate 16% improvement in scoring comparing small to medium-sized and medium-sized to large municipalities. This is illustrated in Figure 15 with a gradually increasing score between the size categories.

2) Among larger municipalities, the gap between the lowest scoring municipality and the category average is smaller than is the case among small and medium-sized categories

- Looking at the dynamic of each group in Figure 16, the large category shows the most conformity, with a 45% difference between the top and lowest scores, compared to 102% and 136% for medium-sized and small categories, respectively.

3) Scoring dynamics within each group suggests different levels in development for large municipalities and opportunity for smaller municipalities to learn from larger neighbours

- Top performers in the medium-sized group reach the same levels as the top performers in the large group (see top bars in Figure 16); the difference between the groups come from the higher number of 'laggards' in the medium-sized group. The significant conformity in development of the largest municipalities suggests that the there is a hurdle to get to the next step of digitalisation of municipal services.

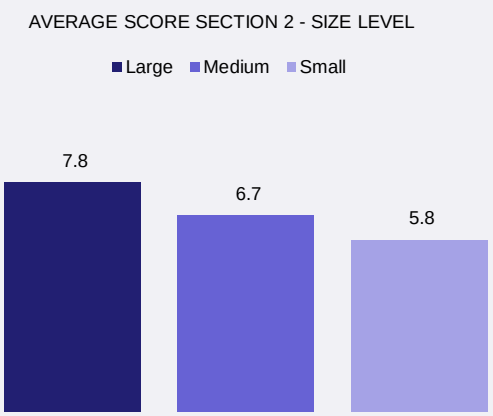


Figure 15: Average score per size category for the Digital Services section

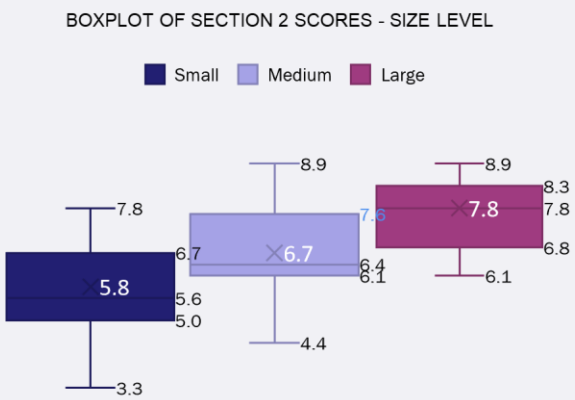


Figure 16: Boxplot of the Digital Services section score per size category

Digital Service Score

5.4 Differences between small, medium-sized and large municipalities (continued)

4) Smaller municipalities, on average, score lower in regards to welfare technology use and digital learning platforms (see Table 12), both of which are particularly important for rural communities

The study indicates that even for services especially important for smaller municipalities, size is the strongest indicator for digital maturity. Digitalisation in education and welfare can be more important for a smaller municipality, especially for municipalities where citizens are spread over vast geographical areas.

	Digital learning platforms	Online daycare	Online build-permit	Fix-my-street	Secure comm.	Availability of comm. Channels	Welfare technology use	Digital learning platforms - advanced	Municipal warning system
Large	10.0	10.0	9.3	9.8	5.8	7.0	6.5	6.8	5.0
Medium	10.0	10.0	7.5	7.8	5.0	5.0	5.0	4.8	5.0
Small	10.0	9.8	8.3	5.0	4.3	4.3	2.8	3.3	5.0

Table 12: Parameter score per size category in the Digital Services section

5) A group of municipalities is reaching scores typically achieved by much larger municipalities (see Figure 17)

Askøy, Halden, Grimstad, Molde and Sortland in Norway as well as Falköping in Sweden are all municipalities, with a population size of less than 34 000, scoring higher than their peers in areas of digitalisation. For rural municipalities, using technology to bring sparsely populated areas closer together can be especially important. This group is likely an important source for best practices which can be duplicated among their Nordic peers.

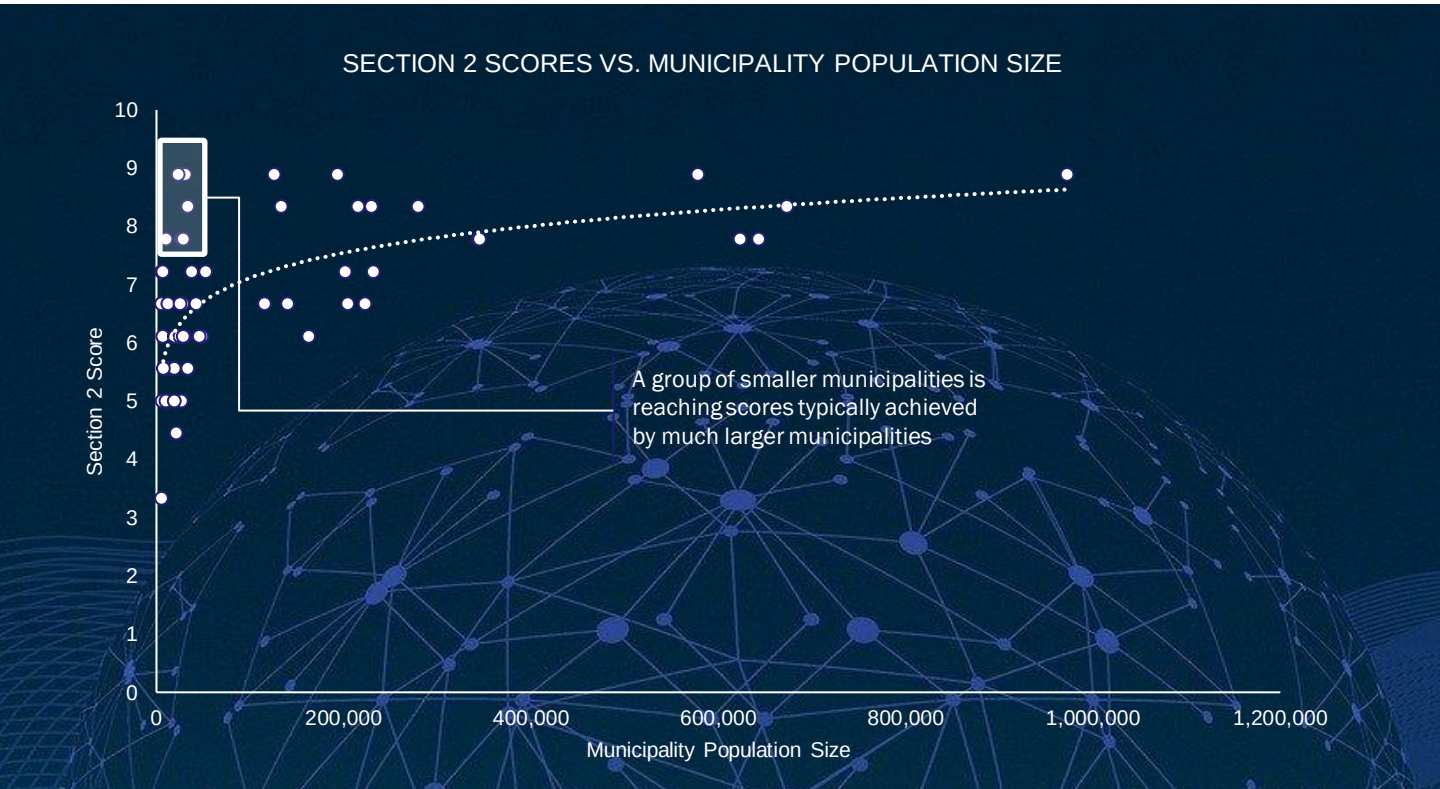


Figure 17: Scatter plot of municipalities' score in the Digital Services section vs. municipalities' population size

6 – Smart Municipality Score

Section 3

Key Findings

Smart Municipalities

1

The large municipalities dominate in all Smart Municipality categories. This is especially true for the Planning & Organisation and Facilitation parameters.

2

The two highest scoring small municipalities, which rank considerably higher than their peers, are situated in a greater capital area and benefit from regional initiatives spinning out of the capital city.

3

The 11 highest ranking medium-sized municipalities host institutions of higher education or are situated within 20 minutes driving distance from one of the largest cities in their country.

4

Based on the selection of municipalities in this study, open data initiatives are solely a large municipality effort as of now.

5

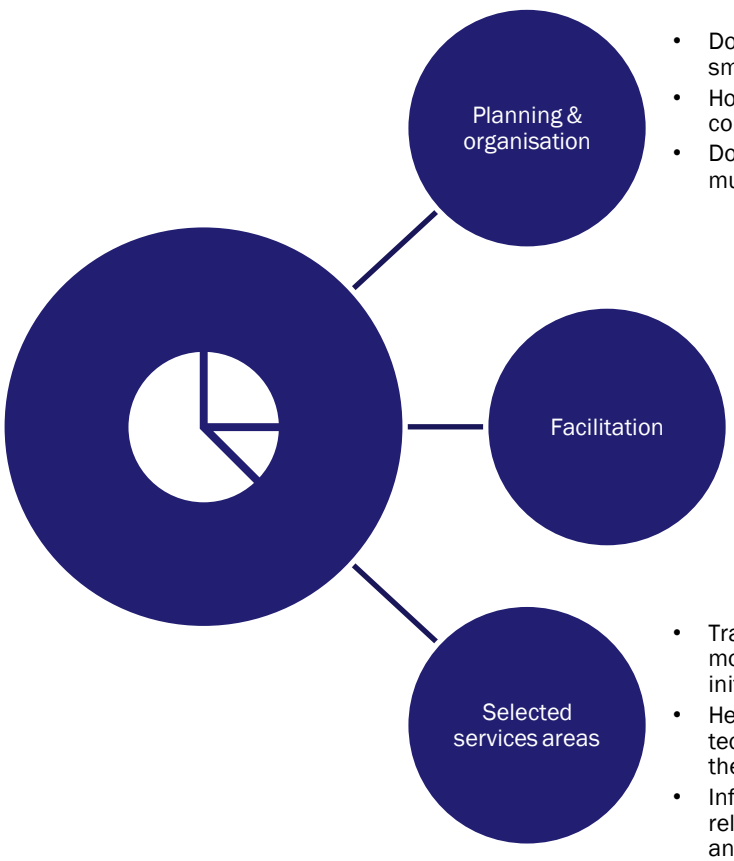
With reference to welfare technology services in Norway and Denmark, regional or state initiatives may help raise the national level of adaptation, especially benefitting small or rural municipalities.

Smart Municipality Score

6.1 Introduction

Due to the breadth of technologies and services that have been implemented under the Smart City / Municipality label, there is no uniform and precise definition of Smart Municipality. In this analysis, we have taken it to represent a collective term for municipalities utilising IoT and ICT technologies to innovate and optimise internal processes or services offered to its inhabitants. In broad terms, the smart municipality efforts are initiated to make municipalities more effective, sustainable and more attractive places to live, work and interact in. The concepts like ICT, digitalisation, innovation and sustainability often overlap and meld into each other, and are also used to describe initiatives which could be classified under the smart municipality label. Some municipalities deliberately avoid using the 'smart' term for describing their ICT and/or IoT enabled initiatives.

The focus for this section's analysis is to evaluate the written digital material provided by municipalities that will give insight into the goals, plans and management, cooperation and facilitation efforts and the presence and maturity of initiatives in some selected service areas. It is worth noting that since the study is looking for published information on the web, a low score does not necessarily mean that a municipality has no initiatives, merely that it is not communicating them. The underlying parameters behind the score each municipality achieves in this section are:



- Do municipalities have goals, strategies or plans for smart municipality efforts?
- How extensive are these goals, strategies or plans communicated or described?
- Do resources or management dedicated to smart municipality efforts exist?

- Open data: Do open data initiatives exist and is municipal data exposed in a uniform way?
- Cooperation and ecosystems: To what degree can there be found examples of cooperation on smart municipality efforts in relation to governmental entities, academia, industry or inhabitants?
- Equipment and infrastructure: To what degree can there be found municipal initiatives facilitating coworking spaces, labs, equipment, network infrastructure or events to encourage innovation and cooperation on smart municipality efforts?

- Traffic and mobility: The number of smart traffic and mobility initiatives and the maturity of these initiatives.
- Health and welfare: The number of welfare technology initiatives offered and the maturity of these initiatives.
- Infrastructure sensors: The number of infrastructure-related initiatives utilising sensors and IoT solutions and the maturity of these.

Smart Municipality Score

6.2 Ranking and scores

- Table 13 illustrates that the top scoring municipalities are København, Aarhus and Stavanger. Furthermore, all four capital cities rank within the top 10.
- Of the top 30 municipalities, 10 are from Denmark, 8 are from Norway, 7 are from Sweden and 5 municipalities are from Finland.
- The 10 lowest ranking municipalities consist of small and medium-sized municipalities from Denmark (1 small), Sweden (4 small) and Finland (3 medium-sized and 2 small).

Smart municipality ranking

#	Municipality	Score[1]	Country	Size
1	Aarhus	9.8	DK	Large
1	Stavanger	9.8	NO	Large
1	København	9.8	DK	Large
4	Aalborg	9.3	DK	Large
5	Oslo	8.9	NO	Large
6	Odense	8.9	DK	Large
7	Trondheim	8.8	NO	Large
8	Stockholm	8.8	SE	Large
9	Helsinki	8.5	FI	Large
10	Göteborg	8.3	SE	Large
11	Oulu	8.2	FI	Large
12	Tampere	8.2	FI	Large
13	Bergen	7.9	NO	Large
14	Linköping	7.6	SE	Large
15	Bærum	7.6	NO	Large
16	Malmö	7.4	SE	Large
17	Uppsala	7.0	SE	Large
18	Halden	7.0	NO	Medium
19	Kalundborg	6.7	DK	Medium
20	Vallensbæk	6.3	DK	Small
21	Esbjerg	5.8	DK	Large
21	Salo	5.8	FI	Medium
23	Molde	5.7	NO	Medium
24	Lillehammer	4.6	NO	Medium
25	Vantaa	4.5	FI	Large
26	Vordingborg	4.1	DK	Medium
27	Piteå	3.8	SE	Medium
28	Rebild	3.6	DK	Medium
29	Dragør	3.4	DK	Small
30	Eslöv	3.4	SE	Medium
31	Grimstad	3.4	NO	Medium
32	Heinola	3.3	FI	Small
33	Froland	2.8	NO	Small
33	Sortland	2.8	NO	Small
35	Tynset	2.5	NO	Small
36	Riihimäki	2.4	FI	Medium
37	Askøy	2.3	NO	Medium
38	Trysil	2.0	NO	Small
38	Oskarshamn	2.0	SE	Medium
38	Hudiksvall	2.0	SE	Medium
41	Sjöbo	1.9	SE	Small
41	Billund	1.9	DK	Medium
43	Falköping	1.9	SE	Medium
43	Naantali	1.9	FI	Small
43	Lemvig	1.9	DK	Small
46	Allerød	1.8	DK	Medium
46	Ærø	1.8	DK	Small
46	Jyväskylä	1.8	FI	Large
46	Odda - Ullensvang	1.8	NO	Small
50	Hanko	1.6	FI	Small
51	Langeland	1.4	DK	Small
51	Bergs	1.4	SE	Small
53	Vimmerby	1.1	SE	Small
54	Raahe	0.9	FI	Medium
54	Munkedals	0.9	SE	Small
56	Valkeakoski	0.6	FI	Medium
56	Lycksele	0.6	SE	Small
58	Hämeenkyrö	0.5	FI	Small
59	Rauma	0.1	FI	Medium
59	Teuva	0.1	FI	Small

Table 13: Section score for the Smart Municipality section

[1] The scores in the Smart Municipality section are based on 12 parameters. The parameters, along with the definitions for the range of scores, have enabled the study to pinpoint differences between municipalities. However, several definitions may need to be updated in the future to reflect developments in the Smart Municipality areas. As a consequence, top-scoring municipalities in this section, might not necessarily score as high the next time the study is performed.

Smart Municipality Score

6.3 Country-level differences

1

Norway and Denmark on top

2

Wide variation in scores for all countries

As seen in Figure 18 and Table 14, Norway and Denmark come close to a tie for the average total score. Both countries have municipalities with the highest score in this section. Norway's slight lead over Denmark can be largely attributed to its superior performance in the welfare technology area. Denmark and Norway score better than their neighbouring peers in Planning and Organization, Facilitation and Health and Welfare technology services. Sweden ranks in third place, predominantly due to weaker scores on Planning & Organisation and Facilitation. On a country level, Finland scores lowest in 7 out of 12 parameters.

Figure 19 shows that all countries have a wide variation in scores, meaning that there are big differences in scoring between municipalities in all countries. Denmark has the largest variation between the first and third quartile in its distribution, whilst Finland and Denmark have the largest differences between maximum and minimum scoring municipalities.

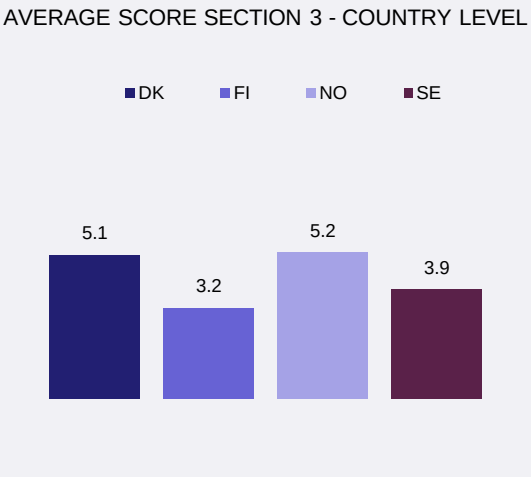


Figure 18: Average score per country for the Smart Municipality section

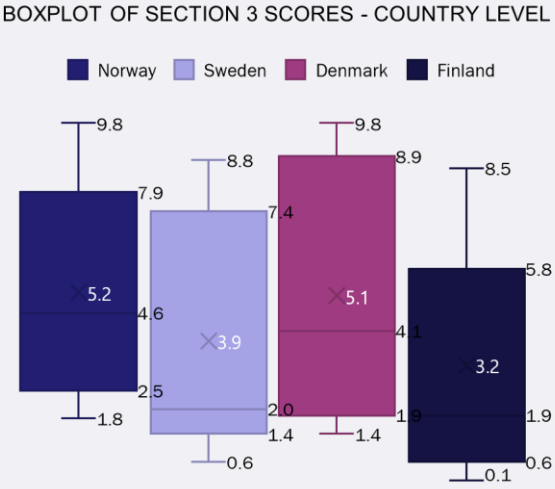
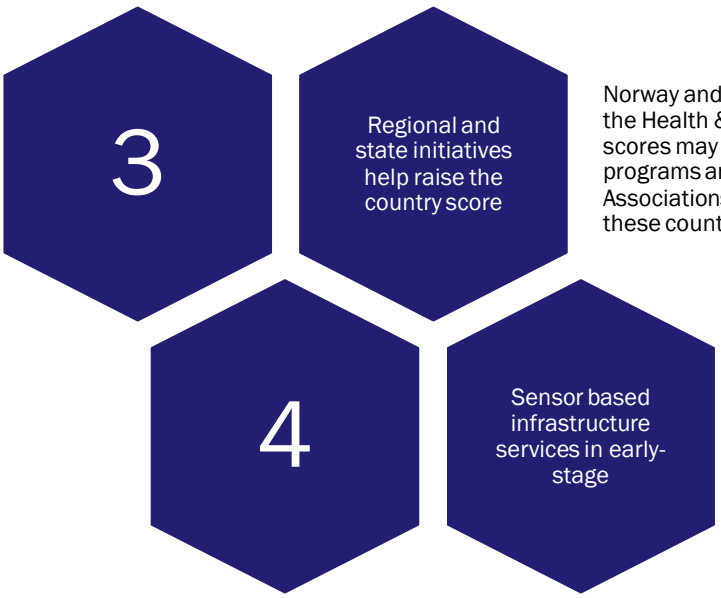


Figure 19: Boxplot of the Smart Municipality section score per country

Smart Municipality Score

6.3 Country-level differences



Norway and Denmark score better than Sweden and Finland in the Health & Welfare services category (see Table 14). The scores may indicate the effect of state-driven welfare technology programs and coordination efforts taken on by the National Associations of Local and Regional Authorities (KS and KL) in these countries.

Table 14 shows that sensor-based infrastructure services is the service category with the most immature services. Meaning that on average, there are more services in this service category in a pilot or limited roll-out stage.

	Planning - scope	Planning - maturity	Org. – scope	Facilitation - open data - scope	Facilitation - coop. - scope	Facilitation - working facilities, etc. - scope	Services - traffic & mobility - scope	Services - traffic & mobility - maturity	Services - health & welfare - scope	Services - health & welfare - maturity	Services – infrastr. - scope	Services – infrastr. - maturity
DK	6.0	5.0	5.3	3.3	7.0	4.7	4.3	4.0	3.7	9.7	4.7	2.7
FI	5.0	3.0	2.3	3.0	3.7	2.1	4.0	5.7	4.0	2.0	3.1	1.7
NO	6.3	6.7	4.7	1.7	7.7	4.0	4.3	4.0	7.7	9.3	3.9	3.3
SE	4.3	3.3	2.7	2.7	4.7	3.7	3.0	8.0	3.3	7.3	3.2	2.1

Table 14: Parameter score per country in the Smart Municipality section

Smart Municipality Score

6.4 Differences between small, medium-sized and large municipalities

Figure 20 and Table 15 show that larger municipalities score substantially higher than both the medium-sized and small municipalities in all categories, and large municipalities account for all of the top 17 places.

The largest positive contribution in favour of large municipalities are Planning & Organisation and Facilitation. This implies a higher number of described instances of dedicated leadership or resources linked to digitalisation and smart municipality efforts and more examples of municipal initiatives to orchestrate and enable cooperation and evolution of innovation ecosystems among the large municipalities than in the others.

The scores show that by means of information provided by the municipalities, smart municipality efforts seem to have more traction in large urban areas. Entry barriers for smaller municipalities could be addressed if a country (as a whole) wants to raise the level of successful smart municipality initiatives.

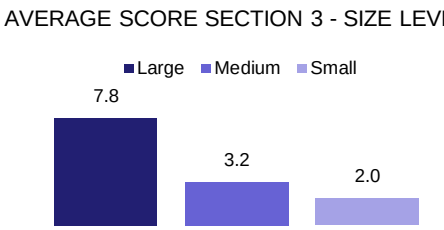


Figure 20: Average score per size category for the Smart Municipality section

Table 15 shows that exposing municipal data through open data initiatives is a parameter exclusively dominated by large municipalities.

The boxplot in Figure 21 shows the variation in scores, indicating the largest spread among the medium-sized municipalities and outliers in the small (Vallensbæk in Denmark) and large category (Vantaa and Jyväskylä in Finland) scoring way below or over the vast majority in their respective categories.

Seven out of the eight highest scoring medium-sized municipalities all host institutions of higher education. As an example the three highest ranking medium-sized municipalities are Halden in Norway, Kalundborg in Denmark and Salo in Finland.

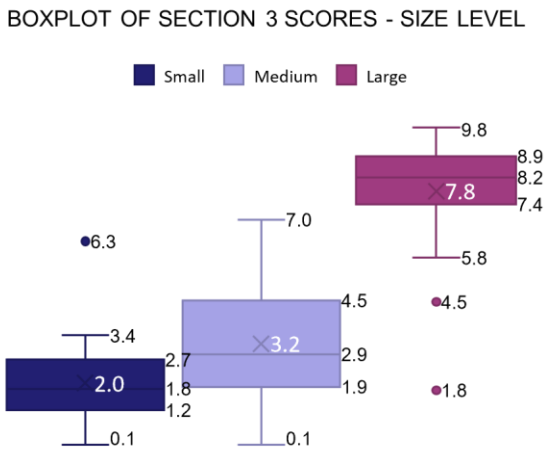


Figure 21: Boxplot of the Smart Municipality section score per size category

All three municipalities lie within 1.5 hours' drive from their capitals and host campuses or university colleges.

Halden and Kalundborg both have University Colleges, whilst Salo has an IoT Campus linked to Turku University of Applied Sciences. Kalundborg municipality has together with local businesses, inhabitants and Alexandra Institute been running an EU-funded Living Lab (URB-Grade) in the village of Svebølle since 2012 to explore the benefits of smart digitisation efforts in smaller societies.

The two highest ranking small municipalities in Table 13 are Vallensbæk and Dragør in Denmark. These two municipalities are both situated in the Greater Copenhagen area and benefit from regional initiatives (clusters, networks, etc.) spinning out of the capital area. One example is the triple helix partnership network Gate 21, which has become the common platform for municipalities, companies and knowledge institutions to address green solutions, green innovation and green growth in Greater Copenhagen[1].

Finally, in Finland we see regional smart city initiatives spinning out of the capital city area which includes as many as 26 surrounding municipalities. An example of regional outcome is the open data portal that enables use of public data for innovation[2].

	Planning - scope	Planning - maturity	Org. – scope	Facilitation - open data - scope	Facilitation - coop. - scope	Facilitation - working facilities, etc. - scope	Services - traffic & mobility - scope	Services - traffic & mobility - maturity	Services - health & welfare - scope	Services - health & welfare - maturity	Services – infrastr. - scope	Services – infrastr. - maturity
Large	9.3	8.0	8.0	7.5	9.0	7.8	8.8	8.8	6.8	7.8	5.3	4.0
Medium	4.3	3.3	2.0	0.5	5.3	2.0	2.0	4.0	4.5	7.5	3.3	2.8
Small	2.8	2.1	1.3	0.0	3.0	1.0	1.0	3.5	2.8	6.0	2.5	0.8

Table 15: Parameter score per size category in the Smart Municipality section

[1] Gate 21, https://www.gate21.dk/, accessed 2020-04-02
[2] Open data service, https://hri.fi/, accessed 2020-04-02

7 – Lessons and Recommendations

Identified Commonalities

A summary of identified commonalities for high-scoring municipalities and Nordic capitals

COMMONALITIES FOR HIGH-SCORING MUNICIPALITIES

1

RESOURCES FOR SMART MUNICIPALITY FACILITATION

The eight highest scoring municipalities all receive top score regarding their Smart Municipality facilitation efforts, which are established initiatives in different domains to gain/share knowledge or stimulate innovation.

2

FAR AHEAD IN SMART MUNICIPALITY PLANNING

When it comes to scope and maturity of their Smart Municipality plans, as well as how they organise the corresponding efforts, high-scoring municipalities have well-established plans and corresponding assigned responsibility.

3

STRONG WELFARE TECHNOLOGY USE

High-scoring municipalities have come a far way communicating operational services in the health and welfare sector (e.g. patient monitoring, remote communications, etc.).

COMMONALITIES FOR THE NORDIC CAPITALS

1

IMPROVEMENT POTENTIAL FOR ACCESS TO MUNICIPAL SITES

All capitals have difficulties accommodating mobile sites on municipal grounds. This is especially evident for Oslo, Helsinki and København.

2

STRONG DIGITAL SERVICES OFFERINGS

All capitals have a strong digital services offering. They receive high scores on five out of nine services and receive full score on the remaining four services, reaching a total section score of between 7.8 to 8.9.

3

STRONG SMART MUNICIPALITY INITIATIVES

The four capitals are far ahead in the planning, organizational and facilitation aspect of Smart Municipalities. In addition, Oslo, Helsinki and København all receive full scores in the Traffic & Mobility and Health & Welfare services sections.

Lessons and Recommendations

A summary of proposed initiatives on the bases of the report's findings

MOBILE NETWORK DEPLOYMENT

1 LESSON: WIN-WIN RELATIONSHIP IN THE AREA OF SITE PLANNING

There exists a win-win relationship for operators and municipalities in terms of efficient site planning. Coverage concerns from inhabitants, industries, etc. can be reduced which benefit both the municipality and the operator (reduced complaints regarding network coverage). The longer lead times are often found in larger municipalities which tend to have more complex dimensions to consider (e.g. more infrastructural concerns, more stakeholders, etc.).

RECOMMENDATION: REDUCE THE LEAD TIME IN THE COMPLETE SITE PLANNING PROCESS

It will be beneficial for both the municipality and the operator to secure more efficient steps in the complete site planning process in order to reduce the overall lead time of the site planning approval process.

2 LESSON: LACK OF MUNICIPAL MOBILE COVERAGE PLANS FOR MUNICIPAL BUILDINGS

Several municipalities do not seem to have a mobile coverage plan established (i.e. a plan that secures that coverage is taken into account when establishing new municipal buildings etc.). In the best of cases, this only slows down the roll-out of mobile coverage. In the worst of cases, this could lead to costs that are difficult to justify from a roll-out perspective.

RECOMMENDATION: CREATE PLAN TO CONSIDER MOBILE COVERAGE WITH NEW BUILDINGS

It is in the interest of both operators and municipalities to establish a plan that secures mobile coverage for municipalities without such coverage plans.

Lessons and Recommendations

A summary of proposed initiatives on the bases of the report's findings

DIGITAL SERVICES

1 LESSON: LIMITED COMMUNICATION TO INHABITANTS REGARDING DIGITAL OFFERINGS

There exists a low-hanging fruit for several municipalities when it comes to communication of digital offerings to their inhabitants. Several municipalities tend not to communicate different digital service offerings on their websites to their inhabitants. Two reasons for this could either be because the municipalities do not consider it their responsibility to announce national/regional programmes, initiatives and services, or because they believe it is established as common knowledge that there exist national/regional services that solve the issue at hand.

RECOMMENDATION: COMMUNICATE DIGITAL OFFERINGS ON A NATIONAL/REGIONAL/LOCAL LEVEL

There exists an apparent need for the municipalities to summarise what everyday digital services that exist on a national/regional/local level and communicate this to their inhabitants so they can more easily understand what digital tools they have at their disposal.

2 LESSON: GAP BETWEEN RURAL AND URBAN MUNICIPALITIES IN WELFARE TECHNOLOGY USE

Several rural municipalities in all countries score less in the area of welfare technology use. This is particularly noteworthy since these municipalities often are the ones that could benefit the most from such services. This gap between rural and urban municipalities could be attributed to the sheer amount of resources (and the subsequent outcome) the urban municipalities often manage. However, there could also potentially exist other contributing factors: e.g. lack of information reaching rural municipalities about when it comes to larger purchasing projects of welfare technologies, lack of understanding of how to participate in larger welfare projects on a national or European level, etc.

RECOMMENDATION: SECURE PARTICIPATION OF SMALL MUNICIPALITIES IN REGIONAL OR NATIONAL PROJECTS/PROGRAMMES

It may be worth to further nurture dialogues on both a national level (i.e. how can the participation of smaller municipalities be accommodated in large welfare projects), as well as a local level (i.e. the establishment of dialogues/projects between smaller municipalities and regional authorities, operators, welfare technology businesses, etc.) in order to decrease the existing welfare technology use gap between the smaller and larger municipalities.

Lessons and Recommendations

A summary of proposed initiatives on the bases of the report's findings

SMART MUNICIPALITIES

1 LESSON: SMALL MUNICIPALITIES FALL BEHIND IN THE SMART MUNICIPALITY AREA

The Smart Municipality section's main areas of investigation are planning and organization, facilitation and deployed services. Smaller municipalities fall repeatedly behind on all three areas. Some of the services are not always as relevant for small municipalities (e.g. different services dealing with traffic and infrastructural challenges). However, there is no reason why small municipalities could not participate in some form on the larger neighbouring municipalities' plans, and thus, securing that the small municipalities are up to date with the fast-moving digital transformations that the Smart Municipality concept will entail. This could also be relevant for the use of open data, where smaller municipalities could piggy-back on initiatives launched by neighbouring large municipalities.

RECOMMENDATION: ESTABLISH A LINK BETWEEN SMALL AND LARGE MUNICIPALITIES' PLANS

Establish a link between larger municipalities' Smart Municipality plans and their neighbouring smaller municipalities. Secure that the smaller municipalities are involved in the oncoming digital city transformations (in the areas that are relevant to them) in order to not increase the digital gap between large and small municipalities. The responsibility for such a link could be placed on large municipalities and be encouraged to establish by operators.

2 LESSON: POTENTIAL CAUSALITY BETWEEN NATIONAL INITIATIVES AND ADOPTION RATE

National Smart Municipality initiatives could have a widespread effect on the adaption of the next generation of digital services, something with seems to be the case in regard to welfare technology services in Norway and Denmark. As such services become a more integrated part of our lives, and a strong contributing factor to the quality of life for people with special needs, it is vital to understand how such services can be efficiently created, distributed and adapted by inhabitants.

RECOMMENDATION: DEVELOP COST-BENEFIT OF NATIONAL SMART MUNICIPALITY INITIATIVES

Develop national Smart Municipalities initiatives (e.g. national policies, frameworks and guidelines for organising, facilitating and executing Smart Municipality initiatives in municipalities) and its corresponding effects. In addition, relevant cost ought to be investigated in order to understand the cost-benefit situation of the deployment of national Smart Municipality initiatives.

APPENDIX

Final Scores and Ranking

A summary of section score and final rank for each municipality

#	Country	Municipality	Mobile Network Deploy.	Digital Services	Smart Municipalities	Final Score
1	DK	Aalborg	7,3	8,3	9,3	**8,3**
2	NO	Bærum	6,8	8,9	7,6	**7,7**
3	NO	Halden	6,3	8,9	7,0	**7,4**
4	SE	Göteborg	4,2	8,9	8,3	**7,1**
5	DK	København	3,9	7,8	9,8	**7,1**
6	NO	Trondheim	3,5	8,9	8,8	**7,0**
7	NO	Stavanger	3,0	8,3	9,8	**7,0**
8	SE	Stockholm	3,1	8,9	8,8	**6,9**
9	NO	Grimstad	8,5	8,9	3,4	**6,9**
10	FI	Tampere	5,2	7,2	8,2	**6,9**
11	DK	Aarhus	3,0	7,8	9,8	**6,8**
12	DK	Odense	4,6	6,7	8,9	**6,7**
13	FI	Oulu	4,6	7,2	8,2	**6,7**
14	SE	Uppsala	4,4	8,3	7,0	**6,6**
15	SE	Malmö	4,5	7,8	7,4	**6,5**
16	NO	Molde	5,9	7,8	5,7	**6,4**
17	DK	Kalundborg	6,2	6,1	6,7	**6,3**
18	NO	Oslo	1,4	8,3	8,9	**6,2**
19	DK	Esbjerg	6,0	6,7	5,8	**6,1**
20	FI	Helsinki	1,8	7,8	8,5	**6,0**
21	DK	Rebild	8,1	6,1	3,6	**5,9**
22	NO	Bergen	1,5	8,3	7,9	**5,9**
23	SE	Linköping	4,0	6,1	7,6	**5,9**
24	NO	Froland	8,2	6,7	2,8	**5,9**
25	DK	Vordingborg	6,9	6,1	4,1	**5,7**
26	NO	Sortland	6,5	7,8	2,8	**5,7**
27	FI	Vantaa	5,9	6,7	4,5	**5,7**
28	SE	Piteå kommun	5,9	6,7	3,8	**5,5**
29	SE	Falköping	5,9	8,3	1,9	**5,4**
30	FI	Salo	2,6	7,2	5,8	**5,2**
31	DK	Langeland	7,4	6,7	1,4	**5,2**
32	DK	Lemvig	7,1	6,1	1,9	**5,0**
33	NO	Trysil	6,2	6,7	2,0	**5,0**
34	NO	Tynset	5,1	7,2	2,5	**5,0**
35	DK	Vallensbæk	3,0	5,6	6,3	**5,0**
36	SE	Hudiksvall	5,4	7,2	2,0	**4,9**
37	NO	Lillehammer	3,3	6,7	4,6	**4,8**
38	NO	Askøy	4,3	7,8	2,3	**4,8**
39	NO	Odda	6,1	6,1	1,8	**4,6**
40	SE	Eslöv	4,2	5,6	3,4	**4,4**
41	FI	Riihimäki	4,6	6,1	2,4	**4,4**
42	SE	Berg	4,4	7,2	1,4	**4,3**
43	DK	Billund	6,0	5,0	1,9	**4,3**
44	SE	Oskarshamn	4,2	6,1	2,0	**4,1**
45	FI	Naantali	5,4	5,0	1,9	**4,1**
46	SE	Sjöbo	4,2	6,1	1,9	**4,1**
47	DK	Dragør	3,1	5,6	3,4	**4,0**
48	DK	Ærø	5,1	5,0	1,8	**4,0**
49	SE	Lycksele	5,6	5,6	0,6	**3,9**
50	FI	Heinola	2,9	5,6	3,3	**3,9**
51	FI	Hanko	4,2	5,6	1,6	**3,8**
52	FI	Jyväskylä	2,7	6,7	1,8	**3,7**
53	SE	Vimmerby	4,7	5,0	1,1	**3,6**
54	FI	Rauma	4,8	5,6	0,1	**3,5**
55	FI	Raahe	2,9	6,7	0,9	**3,5**
56	FI	Valkeakoski	5,2	4,4	0,6	**3,4**
57	DK	Allerød	2,2	6,1	1,8	**3,4**
58	SE	Munkedal	4,2	5,0	0,9	**3,4**
59	FI	Hämeenkyrö	4,2	5,0	0,5	**3,2**
60	FI	Teuva	4,7	3,3	0,1	**2,7**

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