SMARCTIC
Roadmap to Smart Arctic Specialization

Smart Logistics, Transport and Living Environment (WP3)
Summary report
SMARCTIC in a Nutshell

The SMARCTIC project formulates a future vision and a roadmap toward maintaining and further developing the Finnish Arctic expertise. The project will primarily evaluate how the principles of sustainable development and human well-being shall be realized in future natural resource exploitation projects and when taking advantage of new transportation routes. In order to respond to this concern, the project will examine the main research questions and, at the same time, evaluate the capacity for industrial renewal and assess new business potential.

WP 3: Smart Logistics, Transport and Living Environment

The objective of WP3 is to explore the impacts of opening northern frontiers on transport flows, communities and infrastructures, and to identify opportunities for related business concepts and services. The focus areas are accessibility, sustainability and growth. The driving vision is a viable community in the North with adequate logistical conditions enabling accessible services as well as ecologically, socially and economically sustainable living environment. A multidisciplinary study consists of logistical, architectural and geographical views.

The geographical part focuses on arctic geographical accessibility. In two reports the state of accessibility and health care services in the Arctic are being reviewed. For the purposes of researching arctic themes a geographic information system (GIS) network database has been collected. The database includes air and road travel networks with travelling times from area containing Finland and adjacent areas. The database has ability for multimodal analyses for reviewing accessibility of the Arctic in different scales; local, regional, national and supranational.

The second part is a history review of the development of the built environment and construction in the Arctic. With cases from indigenous peoples until the present day it has been identified what kind of construction and vision there have been in the Arctic and what direction the development is going to. By analysing the examples, the key elements of the future arctic construction have been outlined and the possible business potential figured out. The results of the report can be utilized when planning new human activities generated by the construction in the Arctic.

Smart Arctic Logistics – gives three cases to illustrate the development and business opportunities related to arctic transport and logistics. The first case handles arctic road and railroad infrastructure maintenance coping with the arctic conditions. In the second case Smartport concept is used to describe the opportunities of port organizations to serve as intelligent nodes in transport corridors especially in the Arctic Regions. The third case is about logistics being crucial part in producing health care related service in peripheral areas with arctic conditions.

The intersection points of the different viewpoints are being gathered into an interdisciplinary conclusion. The same features both separate the Arctic from other areas and join it as one: long distances, remoteness, isolation, sparse population and difficult climate conditions, as well as cultural differences and traditional lifestyle. These features have a major impact on the accessibility, mobility and functioning of people living there and supplying of services.
Participants and distinct reports in WP3:

University of Oulu, Faculty of Science, Department of Geography: Jarmo Rusanen & Virpi Keränen / Arctic Geographical Accessibility, 66 pages.

University of Oulu, Faculty of Technology, Department of Architecture: Helka-Liisa Hentilä & Anniina Valjus / Urban Development and Construction in the Arctic, 56 pages.

University of Oulu, Oulu Business School, Department of Marketing: Jari Juga, Timo Pohjosenperä & Hanne Kettunen / Smart Arctic Logistics, 59 pages

Cover photos: Virpi Keränen and Anniina Valjus
Arctic geographical accessibility

Focus on the Arctic has been increasing significantly in the past few years, mostly because of the natural resources uncovering from ice and the economic interests of Arctic nations. There are numerous ongoing co-operative projects in the area, but all problems however can’t be avoided. Climate change brings changes to the accessibility of the area, some for better and some for worse. Major changes are occurring especially in sea and road transportation as sea ice melts and soil thaws. Northern sea routes become more accessible as the travelling season keeps getting longer and the building and maintaining of roads, especially the winter ones gets harder as the freezing period shortens. Thawing of soil additionally contributes to negative impacts on building and infrastructure. Climate change brings the natural resources of the area more available than ever before, which attracts new investors to the area. Growth in transportation creates further concerns such as the possibility for oil spills or other emergencies and their prevention, against which there is no preparedness at the moment.

Accessibility in the Arctic

Northern peripheral areas experience severe accessibility issues in different scales, for example continental (distance to main markets in the south) and regional (lack of sufficient population). Arctic’s accessibility is characterized by long distances, sparsely populated areas and the problems caused by geographic and seasonal variations. Of the four possible means of transportation, air, sea, road and railway, in the arctic only few are available. The most remote communities often have no land connections of any kind. For this reason many communities in the arctic are highly dependent on costly travelling options, especially air transportation. Internal connections in the arctic are scarce, and usually connections run only in North-South direction taking resources out of the Arctic and bringing consumer goods into the region. There have been several attempts to open up inter-Arctic connections, but many of them have only lasted for short periods of time because of limited usage and expensive maintaining costs. There have been extensive efforts for compensating these issues, but the costs are constantly rising. As ordinary solutions are often insufficient and unsuitable for Arctic environment, unconventional measures have become more common. At the same time the importance of information and communication technologies have become even more essential for remote communities with poor accessibility. In addition to connecting people with the rest of the world, with communication technologies it’s possible to offer multiple services previously unreachable for them, such as education, health care and different commodities. With proper connections isolated communities can be offered a sufficient level of services and be brought closer to other areas.

Finland has extensive know-how of the Arctic environment and operating in Arctic conditions, so the opening of the Arctic will be beneficial in many ways. Even though Finland is not an Arctic coastal state, we have strong expertise in marine technology and marine transport overall. Another strong field in Finland is the ability to work in cold climates and make a living out of it. These skills can be an asset when working with Arctic coastal states and others who are seeking to make profits from the area. Finland has great expectations for the future development of the Arctic and excellent prospects to be a part of it even outside of Finnish borders.

In order to fully harness the potential of the Arctic, in addition to existing know-how extent
investments are needed for creating a functional transportation network and improving the conditions for business activities. Improvements in the area should be directed to strengthen the existing assets and strategic sectors of expertise of the area.

*Arctic Health Care*

The rapidly changing world of Arctic communities is increasingly associated with diverse health issues. Providing health care services in remote communities is challenging due to the special characteristics in accessibility. In addition to Arctic communities’ high suicide and stress rates, the developing world has brought with it an increase in so-called “lifestyle” health problems, such as obesity and cardiovascular diseases. The indigenous populations of the Arctic must also be taken into consideration when solving problems in the area, since they are more susceptible to rapid changes. The transformation of surrounding world and the questioning of traditional values have also resulted in mental health problems in many communities. There is clearly a need in the Arctic to establish and maintain a health-promoting environment. Human well-being however includes more than just health-related issues, and they need to be recognized when planning health care services. These include issues like ensuring cultural continuity and loss of local control. Locally controlled community services have been noticed to improve the perception and outcomes of health-promoting services. Different areas have unique characteristics so the applied health care service programs and policies need to be flexible.

For improving the remote areas’ health care there have been multiple applications developed in different countries and areas, in some cases with excellent results. Traditions and new technology have been able to be successfully combined in Arctic’s health care solutions. An example for this is the combination of community nurses and telehealth solutions used widely in remote parts of Alaska and Canada. Community nurses are paraprofessionals, trained from the community’s inhabitants in basic clinical skills and health education. Telehealth is used to supplement the nurse’s skills. As needed, a nurse can contact a doctor situated in regional center. Telehealth is also used to transfer health-related information such as test results or X-ray photographs from nurses to doctors, and to give diagnosis and treatment from afar. This combination of tradition and contemporary solutions has brought Arctic communities greater well-being than ever before and connected it with the rest of the world. Cross-border co-operation has also had multiple benefits for the inhabitants of remote communities that are located far from their own country’s services. In Northern parts of Finland, Sweden and Norway it is possible to use the neighboring country’s health care services if they are the closest available.

In different parts of the Arctic have been introduced very different and also very similar health care solutions to decrease the impacts of remoteness and isolation. For developing and improving health care services in the Arctic it would be worthwhile to compare health care practices from different areas. Further, different health care policies and successful solutions should also be placed under comparison. By examining and applying the best of those practices it could be possible to create useful strategies to strengthen the health care services in the entire Arctic area.
GIS network database for the Arctic

It can be concluded, that in many areas the issues in the Arctic are caused by the same reasons: long distances, remoteness, isolation, sparse population and difficult climate conditions. Cultural differences and traditional lifestyle are also an important factor that separates Arctic from the rest of the world. Arctic has distinct characteristics that must be taken into consideration when planning the future of the area. These features must also be noted when conducting Arctic research. The Arctic's regions differ greatly from one another but even so it should be reviewed if not as a separate entity, then at least as distinctive from other areas to recognize its unique features.

For the purposes of researching Arctic themes, ones mentioned above and for multiple others has been collected a geographic information system (GIS) network database. The database includes air and road travel networks with travelling times from area containing Finland, Sweden, Norway, Western Russia (Arkhangelsk, Karelia, Murmansk, St. Petersburg and Leningrad), Estonia, Latvia and Lithuania. The database has ability for multimodal analyses for reviewing accessibility of the Arctic in different scales; local, regional, national and supranational. It's designed mainly for Finland's research purposes to examine how Finland's Arctic areas are connected to other adjacent areas. The database is collected solely from various open sources, which can be freely accessed by anyone. Open sources were used to apply comparable data from different countries for cross-border research purposes. The observations made in reports of accessibility and health care structure in the Arctic support the use of a specific data for research made in the area. As said, to make successful decisions and increase the well-being of Arctic communities consideration of its distinctive features is required. To demonstrate the possibilities of the GIS network database has been made an example of potential accessibility in Northern Europe (Figure 1.). In the figure it can be observed how in addition to Stockholm-Helsinki-Tallinn region's strong accessibility there is a strong significance of northern airports in connecting regions. With the network database it's possible to create different scenarios of the many possibilities of accessibility.
Figure 1. Potential accessibility in Northern Europe
Arctic Urban Development and Construction

From Traditional Villages towards Modern Internationally Networked Communities

This report is a review of arctic urbanism and construction from the indigenous peoples until the present day. With cases from different periods of time it is being identified what kind of urbanism and construction there has been in the Arctic and what direction the development is going to. By analysing the examples it is tried to outline the key elements of the future arctic construction, urbanism and services and to figure the possible business potential in them. The results of the report can be utilized when planning new human activities generated by the construction in the Arctic.

Arctic regions are assumed to meet major changes in the next few years. The increased need for new urban development is based on the assumption of future changes in the world: climate change, population growth, globalization of the economy and demand for resources. (Smith 2011) The Arctic is mostly very sparsely populated. For example, Lapland has a population density of 2 inhabitants /km2 and the northern parts of Canada only 0.03 inhabitants /km2. (Statistics Finland 2012, Statistics Canada 2006) So the scale of urbanization in these areas is likely to be different from anything that has been seen elsewhere. The trend is, however, away from the traditional villages towards denser, internationally connected cities that meet the requirements of modern communities.

The interest in the Arctic is nothing new. From time to time because of the increasing profitability of the exploitation of natural resources or changes in the political interests the urban development in the North has risen to a topic of discussion. The utopian urban visions from the 1950s and 70s (see chapter 3. Colonizing the North in the 1950s and 70s: Arctic Urban Utopias) are examples of the previous construction work done in the Arctic. Designed under an economic growth they contained innovative - though partly utopian - ideas about how to protect oneself from the harsh climate, design self-sufficient communities in remote areas or achieve the sense of community.

Because of their large scale and western building style copied from bigger cities the urban visions were however alien next to the traditional small arctic villages. The design didn't take into account what would happen if the economic growth should wander off. That is why most of the plans fell short of execution or were only partially implemented when the recession stroke. After the operations stopped the buildings were left without use. Besides the abandoned cities the arctic utopias also left behind a wide range of problems among indigenous peoples and other inhabitants.

The Arctic Urban Utopias of the 21st Century?

When talking about the future exploitation of natural resources or inhabiting the North the core question will be how to handle the long distances and maintain the existing communities and infrastructure. The infrastructures are already partly outdated or in a very poor condition. The thawing permafrost caused by global warming will give an extra challenge for the whole design process. It will cause more and more problems with the maintenance of the existing roads and building stock. The question will be how to maintain the old infrastructures in an economic way and on the other hand, build new ones. Designers find themselves in a situation where they need to find new innovative solutions to ensure the accessibility and survival of the old villages.
To exploit off-shore deposits of petroleum and natural gas in the North, the oil industry has come up with ideas of infrastructural urban development in the 2000s. These infrastructural cities (see chapter 4.1 Infrastructural Urbanism) consist of tankers, platforms, ports, and pipe networks. They allow the exploitation, production, processing and transporting of natural resources in the challenging Arctic marine climate. The infrastructural cities contain the idea of temporality which was already waking up in some of the 1960s and 70s utopias, for example DEW line radar stations (see p. 26) or residential areas of Frobisher Bay (see p. 24), such as endless adaptability, expandability, shrinkage, unification or mobility. The engineer solutions for harnessing underwater resources have been designed to serve the needs of the industry. So, the temporality is seen just economically not ecologically. The plans do not take into account the duration of the exploitation of natural resources or what happens to the mega-structures as the industry stops operating. However, the temporal solutions contain further development potential to find the sustainable way to exploit natural resources in the Arctic.

The Future Guidelines for the Arctic Development

The arctic urban utopias from the past and recent infrastructural megaprojects act as warning examples of what kind of consequences an economy-based industry-driven big-scale urban development could cause in the fragile Arctic. The lately drawn visions of urbanism try to take more sustainable direction instead. The plans try to ensure the survival of the existing communities by utilizing the wealth brought by new businesses. This is done by maximizing the utilization of existing urban structures, finding co-operation between different actors, ensuring the traditional livelihoods, preventing the damages caused by global warming, reducing the economical dependency from just one source of livelihood by diversifying the economics of the villages and designing larger regional concepts.

Synergies and Larger Regional Concepts

The case projects highlight that to ensure accessibility and services for everyone the Arctic should be seen as a larger regional entity instead of only one village or one entrepreneur. Solutions could be found by combining supportive activities together. In northern Canada synergies have been found by combining unexpected activities, such as health care services and airport facilities (see p. 47) or winter road reinforcement, fish farming, energy production and tourism (see p. 46). Supportive features for the nature and traditional livelihoods could also be integrated in the new constructions. For example, the underwater parts of infrastructure communities, such as anchors, could provide conditions for the survival of sea ecologies. Also natural gas pipelines on land could act as wildlife feeding stations.

To satisfy the needs of welfare society, tourism and heavy industry new sustainable energy and waste concepts should be invented. Instead of a single one-family house or business the communities could be seen as larger entities where different operators, industry, agriculture, tourism, buildings, transportation, logistics etc., are chained together to form an energy system where energy is transforming from form into another without disappearing and without waste. Such a concept has been already developed by Bjarke Ingels Group for Denmark. The idea seems utopian in its scale, but it could contain potential how to solve the future energy problems in the Arctic.
Building without a Trace

Our economic-growth and welfare-based lifestyle has consumed natural resources and materials rapidly and now we find ourselves in a situation where we have to reduce the use of materials. Before the era of industrial development the constructions of the indigenous people (see chapter 2. Traditional Construction in the Arctic) were made on the terms of the nature. The art of the construction was formed by materials available and harsh weather conditions. Since the amount of usable material was limited the durability properties of the structure were optimized in relation to the amount of used material. The light temporary structures built from natural materials didn’t leave any traces to their construction site after leaving the place.

In the Western countries, the built environment acts as a constructed memory of the citizens. In contrast, the unconstructed natural environment left behind by indigenous peoples can be considered as their “built heritage”. This lost connection between building and nature should be re-invented when designing future communities in the Arctic.

The possible new constructions should also be seen as temporal action which is dependent on the economic and political changes. We should try to find step by step built, adaptable, portable and recyclable solutions. We should also re-invent the modernist idea of the minimum space required by each function to find lightweight and environmentally friendly solutions. The use of imported artificial materials should be minimized and local natural materials favoured instead. In addition the lost traditional way of building in each village should be found and learned from.

By combining traditional arctic building techniques and materials with latest technology the new solutions for arctic urban and building design could be found. For example, Halley VI, (see p. 30) in the Antarctic is a modular, portable, self-contained, zero-waste research station that adapts in every way to the harsh cold climate. It can be moved to another place without leaving traces to its previous building site. The design is based on the solutions run by the latest technology. Another recent project also in the Antarctic, Iceberg Living station (see p. 32) is based on the old Inuit way of constructing. It is a temporary living station dug in an iceberg. Nevertheless, the construction is done with modern excavators and the maintenance of its facilities utilizes the latest technology. As the summer comes the iceberg will melt away leaving no sign of a human settlement behind.

Future Business Potential and Challenges in the Arctic

When designing new constructions in the Arctic the keywords that should be lifted up are temporality and continuity. New constructions should not anymore be seen as permanent but as temporal activities, which are dependent on the duration of profitability. Here the continuity means the survival of the nature and the settlements within the new changes. The new businesses with their constructions should be able to support this without leaving abandoned building stock or infrastructures behind them.

To figure the new business potential in the Arctic the future changes (in the middle of the diagram) and their effects (on the blue ring) were analyzed. With the help of the case studies the characters of sustainable arctic construction (on the green ring) could then be identified. They carry the potential for new innovations, but also the need for further research. The possible new innovations that could be generated are represented on the yellow outer ring. According to the findings they can be roughly put in four categories:
the preserving of existing built environment and traditional livelihoods, life span thinking, combining of traditional and new construction methods and temporal constructions. The new ideas should not be categorized just under one heading. The best innovations combine many characteristics from different categories.

Figure 1. A diagram of the forces changing the world in the future and the business potential that they could generate in the Arctic. The forces are presented in the middle of the diagram. The blue ring around them represents the challenges the forces are creating. The green ring shows the ways to answer to these challenges. The business potential that could arise is collected on the yellow outer ring. The ideas can be roughly divided into four categories: the survival of existing built environment and traditional livelihoods, life span thinking, combining of traditional and new methods of construction and the temporality of the new construction. Anniina Valjus. 2013.
Arctic Logistics

Three cases are presented in this section to illustrate the development and business opportunities related to arctic transport and logistics. The first case examines arctic road and railroad infrastructure maintenance coping with the arctic conditions. For many regions in Northern Finland, arctic conditions, decreasing population and transport volumes will entail severe challenges related to accessibility and service level in logistics. Also, in many cases problems with repair or maintenance can be critical because alternative routes and connections in sparsely populated regions are lacking. The second case is about smart logistics in arctic port areas. Arctic conditions are making sea transports very demanding. In this case we use Smartport concept in a general sense to describe the opportunities of port organizations to serve as intelligent nodes in transport corridors especially in the Arctic Regions. The third case gives a view at producing health care related services in arctic conditions. Finnish health care system is facing big challenges in growing costs and new service needs. Arctic conditions as long distances, low density and demanding climate are in many ways intensifying the challenges. One initiative to face these challenges is centralization that requires more attention into logistical systems that can bring benefits in saving costs and enhancing level of service. We take a look at one example: NordLab that is founded to produce laboratory services for five hospital districts in northern Finland.

Case 1. Arctic road and railroad infrastructure maintenance coping with the arctic conditions

There are particular conditions related to the management and maintenance of arctic transport and infrastructure including cold weather, darkness, snow and ice as well as long distances and sparse population. However, it seems that the people and organizations working in northern regions are fairly accustomed to these conditions and stable winter conditions are not considered to be too problematic. Exceptional conditions create more challenges and it is possible that they occur more frequently as climate change progresses.

The Finnish Transport Agency has largely outsourced the maintenance and repair operations to private organizations which has increased efficiency and possibly also the quality of operations. However, especially on the railway infrastructure repair and maintenance side the number of service companies is limited and the potential advantages of competition can soon get exhausted. Also limited infrastructure budgets cause problems and especially the maintenance and repair of lower level transport network has come under jeopardy in peripheral regions.

Traffic and weather information is readily available especially relating to the core transport network where traffic density is high. However, the information is still scattered in diverse systems and the interfaces are not standardized. The primary service providers have their own service centers that can utilize and disseminate various types of information, and thereby direct and control the work of the subcontractors in different regions. The Transport Agency has its own traffic management centers that produce and disseminate transport-related information through the traffic control and operating system. A number of transport-related internet portals can be found that compile traffic and circumstantial information from various sources.

Despite the existence of multiple data sources (including a lot of open data), it seems that “killer applications” delivering timely and relevant traffic and weather information for well-
defined target groups are still missing. A small number of professional users have access to data that they can transform into situational awareness information while others contend with basic information such as current weather data and forecasts provided in the internet, radio, navigation tools, etc. Perhaps the next step in the development of traffic information systems could be to more clearly define the needs of different target groups and develop situational awareness solutions that can be tailored to these needs - if missing information is bad, so is also information overload.

From an arctic transport and logistics point of view, it is hardly feasible to build heavy information superstructure for monitoring and controlling traffic conditions outside the core corridors with high traffic density. However, innovative and affordable solutions should be encouraged for detecting and disseminating information on exceptional conditions and traffic incidents. Mobile applications and common information platforms can offer a good foundation for developing solutions in remote regions. Also vehicle-to-vehicle communication using ad hoc networks can offer new opportunities for improving situational awareness without heavy telematics investments.

The competence requirements in arctic transport and logistics are related with the building and maintenance of physical infrastructure as well as traffic and infrastructure management. Sufficient construction, repair and maintenance services are available in northern regions, but missing education in (infrastructure) construction is seen as a potential problem affecting the availability of competent personnel in near future. Traffic and maintenance management services are divided between private and public operators who run their own operation centers for traffic management. The roles of the different service providers are still in a formative stage and their work to meet the information needs of various user segments is still in its infancy. Although information services tend to get more and more centralized, it is important that traffic management services will be retained in the northern regions – the cooperation and synergies with e.g. police and rescue services should be further investigated. As financial resources on infrastructure development and maintenance are getting tighter and tighter, different actors must work seamlessly together in order to respond to emerging construction, repair and maintenance needs quickly and efficiently. Both technical and operational capabilities must be continuously developed to increase the agility and efficiency of the whole network of actors involved in the development, repair and maintenance activities.

The business opportunities related to traffic and infrastructure management in the arctic regions range from physical operations to management services and system development. For new entrants, the chances of becoming a contractor for Transport Agency can be limited, but opportunities for serving as a subcontractor to construction and maintenance companies are significantly better. Opportunities can also be found in the development of the systems and applications supporting the traffic and infrastructure management operations. The Transport Agency has its own plans and ambitions for developing a national traffic control and operating system, but innovations and experiments can also be made to develop the local business and information ecosystem for transport and infrastructure management. For instance, open data is now available from various public organizations that can open new opportunities for service providers to create user-friendly applications for selected target segments. Cross-border services in transport and infrastructure management are still an under-utilized opportunity that needs public as well as private business attention. New services and solutions are also needed for engaging the public in transport and infrastructure management – the needs of the transport system users must
Case 2. Smartports in the arctic transport network

Smartports in general

The Smartport concept has been used in various contexts, including the research and education services of a university in Europe (Erasmus University & Rotterdam Port), or the process automation capabilities of a cargo handling solutions provider (Cargotec) in Finland. In this study, we use Smartport concept in a general sense to describe the opportunities of port organizations to serve as intelligent nodes in transport corridors especially in the Arctic Regions.

The Smartport Concept

There is a lot of technology used today in ports, such as access control systems, different kinds of identification technologies, gates working by phone calls, computers in cranes and trucks, radio-controlled ramps, electronic surveillance, and radio frequency identification (RFID) in containers. However, much of the technology is used also in other fields of business and transportation. Especially smaller ports do not have many specialized and tailored solutions in use. Technology can make the port smarter but by itself it cannot make the port smart.

Smart solutions and technology decrease manual work at ports. The key to success is in information - it should be accessible and easily found. In Smartports the information moves seamlessly and automatically between the vessel, shipping company and the port organizations. For example, the vehicles coming to the port would be automatically and electronically guided to the right place. Every human activity in the supply chain makes the process slower and prone to mistakes.

The Smartport should be efficient, environmental friendly and safe. Construction takes into account future needs and is environmentally sustainable. Trespass to the port area would be noticed immediately with the help of technology and tariff systems and billing would be automatic, too.

The Arctic Smartport

In winter there is snow and ice in the arctic areas and the weather is cold. Darkness brings another challenge for the workforce. The vessels calling the arctic ports should be ice strengthened. All these factors influence the activities in the arctic ports. However, transport professionals consider winter to be a normal circumstance – there will be snow, ice and darkness every winter and those who want to operate in the arctic areas just have to adjust to it.

All seasons require different equipment which costs money for companies but winter is definitely the hardest and longest season. First, extra ice on quays hinders the mooring of vessels and the ice needs to be either regularly removed or its formation needs to be prevented. For example in the Port of Oulu there is special equipment which blows air under the quay and the descending waves prevent the formation of ice. Second, snow and ice need to be removed from fields and the areas can be large. Third, all areas need to be lit up for safety reasons. Lightning especially can be a major cost item.
Besides hard weather traffic quantities are or can be a challenge for arctic ports. The lesser the traffic quantities, the more important becomes cost management. Smart solutions can save money, time and resources and make the best of the existing resources. Especially during the winter months, capacity management should be done in an integrated manner to minimize turnaround times of vessels and optimize the capacity utilization of port organizations. This may involve improved cross-border coordination of transport resources such as icebreaking capacity, as has in fact already happened between Finland and Sweden in the Bothnian Arc region.

Arctic ports already have smart solutions but more could be also used and developed. Common data systems would benefit all parties and needed information could be found easily from the same place. Accessible information and sharing it involves also icebreaking which is needed in the arctic areas. According to our interviewees icebreaking should be better coordinated - lack of coordination leads to delays in transportation and changing variables are harder to take into account. Information for icebreaking should be gathered from vessels, icebreakers, and the Meteorological Institute. The resources in use should be optimized and the total system should be managed in a coordinated manner — benchmarking from industry and other transport modes can offer good examples.

Smartness can also stem from various smaller things. Smart buoys could measure information such as the thickness of ice and send alarms when their batteries are getting empty. Port lighting can be sensitive to the movement of people and vehicles and light level in unoccupied sectors can be reduced. Vehicles used in the port area could measure the condition of roads and inform others about the quantity of friction. Anticipation is the key word in many functions. The port authorities are late when people have to inform them for example to clean up the sand in the spring rime or to add the sanding in winter. Smartness would be to anticipate these needs and order them in advance. In this respect, the information needs in ports are largely similar to those in road maintenance.

**Case 3. Health care logistics - Case Laboratory services**

Arctic conditions sets challenges in providing public services as health care. Centralizing parts of service processes is seen one option in delivering better service for lower cost in areas with long distances and low density. In northern Finland one example is laboratory services that are lately centralized into one organization called NordLab.

Nordlab is founded by the five hospital districts of northern Finland to produce laboratory services primarily for the public health care system. The samples are taken in hospitals and in local health centres and then transported into bigger, partly specialized laboratories. Currently only administrative functions are centralized into Oulu headquarters.

Operational advantage is reached by optimizing the competencies of various laboratories. Same kinds of samples from bigger area are centralized into more specialized laboratories. In service point of view the goal is that the end user (patient) can leave sample in nearby health centre without having to travel into hospital. Also the results would be quickly usable without end user having to take part and see the processes behind the service. Only the sample is sent into bigger laboratory plausibly long way. Currently main challenge in
that process (despite lack of participant municipals) is the information system´s capability to serve results for the doctors taking care of the patients.

NordLab handles very temperature sensitive goods in challenging, arctic environments that is surprisingly not seen as special challenge. Nordlab need to serve also sparsely-populated areas but at the moment the distances are not a vast challenge as many municipals in the northern Finland haven´t already participated Nordlab. Most samples need to be stored and transported in temperature-controlled conditions, but regular insulated boxes (styrofoam) are in most cases enough to keep the temperature high enough. One challenge is also that some samples need various temperatures. Competencies of arctic conditions are more in working-level, than in management. From management-level the arctic challenge is to recruit valid personnel in peripheral areas.

Nordlab is a new organisation but its functions are mostly been existing for years or decades. Working in and with arctic conditions have been part of everyday life and probably therefore not seen as major challenge. Although arctic conditions are not seen as “a big thing” does not mean they are not taken care of. Maybe one reason for NordLab is public health care system’s better ability to face one of the arctic challenges – to fulfil the service needs (and laws) of sparsely populated areas with long distances. This is done by centralization to optimize the use of laboratory personnel’s work which in low density areas means centralizing the activities from small separate units into bigger units that can service larger areas.

From business opportunity point of view NordLab offers quality and partly differentiated services that could be scaled more widely. Currently Nordlab is a non-profit public enterprise (liikelaitos), which sets some limits into growing the business. Potential of growing internationally mostly in Barents region is seen, but the current type of business entity is not allowing that. Nordlab have interests in becoming a stock company (osakeyhtiö) but currently that is legally not possible. New municipal law might change the situation. NordLab is focused in laboratory samples, but same kind of logistical system could be applied also in other material flows in health care.
**WP3 conclusions:**

This report gives observations and conclusions from logistical, architectural and geoinformatical viewpoints. Also interdisciplinary conclusions were found.

- Same features both separate the Arctic from other areas and join it as one: long distances, remoteness, isolation, sparse population and difficult climate conditions, as well as cultural differences and traditional lifestyle.

- These features have a major impact on the accessibility of the area, and thus in moving and functioning of people living there. Additionally, they affect greatly on the supplying of services, especially health care.

- People living and working in the Arctic are used to the harsh conditions and the everyday working practices and methods are not seen as arctic innovations. These practices should be identified. By combining traditional and new methods, new innovations could be found.

- To ensure accessibility and services in the Arctic, new solutions must be found. Some solutions for ensuring health care services have already been developed. For example, NordLab and E-health make use of smart solutions. This makes it possible to keep health care services in the communities and reduces patients' need to travel. Another example is the concept of combining health care with air traffic. This way, the patients have better access for health care and the general accessibility is also being improved.

- The Geographic information system (GIS) network database offers a possibility for analyzing the Arctic accessibility in different scales: local, regional, national and transnational. It could be utilized for finding the suitable solutions and developing them further.

- Arctic’s distinct features must be noted when working or conducting research in the area. The internally multi-dimensional Arctic should still rather be seen as a larger entity than own separate regions and countries. In this way, better practices for the whole Arctic could be developed. Cooperation between different operators is necessary for ensuring their survival.