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Applying Smart Frameworks to Arctic Cities

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Definition

This entry considers established metrics for smart city development and evaluates their suitability for implementation in Arctic urban settlements. To do this, the entry first surveys smart city literature and the standardization of "smartness" metrics, with particular interest in the International Organization for Standardization's (ISO) categorization efforts. It then proposes a northern framework of measurement to evaluate smart cities that adjusts smart metrics from current non-Arctic scholarship to the relatively low populations, peripheral development, remote locations, and harsh climate conditions of the circumpolar north. Exploring this is important because these frameworks have implications for how policymakers in northern regions choose to plan and implement their city strategies.

From public discourse to media narrations, the Arctic is most often constructed as an uninhabited, aesthetically spectacular land of ice and snow. And yet, in spite of its popularly imagined identity as one of the last remote and inhospitable frontiers of our shared planet, the Arctic and those who call it home have been a part of, and influenced by, the international economic, political, and cultural developments of the wider world since the fifteenth century (Kunz and Mills 2021).

Since the late 1300s, the global trade routes that crisscrossed the Bering Strait between the North American Arctic and Eurasia have been traveled by Indigenous peoples, bringing beads crafted by glassmakers in Venice to northern Alaska along the Silk Road network. The early forms of cities, with their permanently built environments and concentrated economic activities, came later with the arrival of Euro-American colonialism and capitalism, built as extractive communities rather than places to live (Rasmussen et al. 2015, p. 426). Their vitality was dependent on local resource extraction and their creation as small, remote settlements was based on where the highest concentration of these commercialized sea and land resources could be found.

Today, roughly three-quarters of the Arctic's population live in urban areas, with an increasing trend of urbanization to 2055 as the region "is intensely urbanizing" as "towns grow at a rapid pace and people settle in urban centers, often far away from their home settlements" (Dybbroe et al. 2010, p. 120; Heleniak 2021; Heleniak and Bogoyavlenskiy 2015, pp. 93–94). And though much of the regional economy is still reliant on industrial development, bulk trade from primary

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industry, and public administration, urban Arctic economies are diversifying to create a distinct knowledge economy based on increasing primary, secondary, and higher education opportunities (Rasmussen et al. 2015, p. 438). Over the past two decades, globalization processes, political centralization, and market volatility from more competitively priced natural resource production southward have created a space to redefine Arctic settlements as livable communities independent of the extraction of a single resource. These shifts in populations, economies, and ultimately cultures that accompany the circumpolar north's urbanization come with novel opportunities and challenges, making it a critical field for future research. This turns our attention to an emerging but underexplored topic in regional studies: *Arctic smart cities*.

Definition and Dimensions of a Smart Sustainable City

The concept of smart cities, developed and most often applied to cities further south than the Arctic Circle, is derived from a straightforward notion: cities are the source of major local and global challenges, and can also be the source of transformative solutions. Cities fuel economic development as centers of capital, workforce, knowledge, information, and technology. However, global cities are also confronted with a multitude of key challenges, including traffic congestion, unplanned development, poor land use regulation, and greenhouse gas emissions (Bansal et al. 2015, p. 551; Garrido-Marijuan et al. 2017, p. 3). To meet these challenges, urban planners have pioneered solutions that are environmentally sustainable and link all areas of a city's economy together in a more efficient way. This often involves more efficient public transportation, energy efficient buildings, and a stronger focus on research, innovation, and knowledge.

Chief among the frameworks to mitigate these challenges and measure success are strategies to develop "sustainable," "smart," "resilient," and "green" cities, all of which are interconnected in their indicators and goals. While there exists a plethora of development frames within which cities can measure their progress, this entry will focus specifically on smart sustainable cities – the intersection of the two interrelated concepts of sustainable cities and smart cities. Sustainable cities achieve "a balance between the development of the urban areas and protection of the environment with an eye to equity in income, employment, shelter, basic services, social infrastructure and transportation in the urban areas" (Hiremath et al. 2013, p. 556). Within this frame, cities must achieve sustainability in the environmental, social, and economic pillars of the concept; however, there has been criticism that sustainable cities elevate environmental indicators at the expense of social and economic performance metrics (Berardi 2013; Robinson and Cole 2015; Tanguay et al. 2010). During the past decade, sustainability has been superseded in popularity by the concept of "smart cities," as a means to achieve urban sustainability (Ahvenniemi et al. 2017, pp. 235–236; Huovila et al. 2019, p. 142). Smart cities build off the previous work of sustainable cities but instead focus development on the implementation of technology, especially information and communication technologies (ICTs). A smart city exists "when investments in human and social capital and traditional (transport) and modern (ICT) communications infrastructure fuel sustainable economic growth and high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu et al. 2011, p. 70). Building on a public-private-people-partnership approach, which is the cooperation between the public sector, companies and individuals, this definition synthesizes the important aspects of ICTs, sustainable growth, and the human component, both in terms of participation and life quality. Set forth in document ISO 37122, a smart city is one that:

> increases the pace at which it provides social, economic and environmental sustainability outcomes and responds to challenges such as climate change, rapid population growth, and political and economic instability by fundamentally improving how it engages society, applies collaborative leadership methods, works across disciplines and city systems, and uses data information and modern technologies to deliver better services and quality

> of life to those in the city (residents, businesses, visitors), now and for the foreseeable future, without unfair disadvantage of others or degradation of the natural environment. (International Organization for Standardization (ISO) 2019)

Nonetheless, similar to the critique of sustainable cities' environmental focus, the concept of "smart cities" has been widely criticized for its techno-centricity, lacking proper attention to cities' needs and environmental sustainability (Grossi and Pianezzi 2017; Huovila et al. 2019, p. 142; Rosati and Conti 2016). Due to the deficiencies within both sustainable city and smart city frameworks – the former being biased towards environmental components and the latter towards technological ones – there has been a contemporary push towards their integration, founded on the notion that sustainable and technological goals must coexist. In 2015, the United Nations specialized agency for information and communication technologies (ITU) developed a definition combining the two concepts. A "smart sustainable city" is one which

> is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitive- ness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects. (International Telecommunication Union (ITU) 2015)

Although the use of modern technology has been recognized as key aspect of a smart city, both academia and policymakers have developed a great number of different definitions with slightly different angles of what smart means in a city (planning) context (Ahvenniemi et al. 2017; Anthopoulos 2017; Meijer and Bolívar 2016; Mora et al. 2017). To adapt this concept to the Arctic region requires reviewing established, standardized metrics for evaluating both the smartness and sustainability of a city; surveying current and anticipated initiatives, policies, and projects in Arctic cities identified as smart through three cases; identifying which smart city metrics are more prominently pursued in Arctic urban development; and considering the challenges that hinder and catalysts such smart pursuits.

Measuring an Arctic Smart City: Metrics and Standardization

In many ways, Arctic cities reflect their counterparts further south; however, both the built environments and the socioeconomic fabrics of cities in far northern latitudes are climatically, geographically, and demographically unique (Raspotnik et al. 2020). These limitations include, but are not limited to, the North's harsh climate; a low density and uneven distribution of population; long distances to global markets; the difficult access to Arctic-based professional skills training and education; depopulation processes, particularly among youth; and a large share of professionals working in the public sector. These problems are similar for many subregions within the Arctic, and are exacerbated by the movement of populations away from rural areas and into the cities of resource-rich regions (Suter et al. 2017, p. 112).

In order to clarify what an Arctic smart city is and how it can be evaluated, a closer examination of the different aspects that make a city smart and the further contextualization of those aspects to an Arctic context is required. ISO catalogues a set of 22 distinct smart dimensions, each with a set of specific measurements of a smart city that can be quantitatively measured and steer the performance of city services and quality of life. These indicators and their measurements are categorized below into six smart city components, *see* Table 1: Smart people, smart governance, smart mobility, smart environment, smart living, and smart energy (Lombardi et al. 2012).

When applied to the Arctic, each of these metrics requires geographic, climatic, and societal modifications to accommodate the uniqueness of the region. While smart economies for southern cities focus on the development of an economy based on the Internet of Things, from a northern point of view, smart economies should also include the development and implementation of new technologies to redefine "remote," so that projects once deemed inaccessible are economically feasible and communication campaigns to combat Arctic-remote bias for investments. Arctic

Applying Smart Frameworks to Arctic Cities, Table 1 International Organization for Standardization's smart city metrics

People	Governance	Mobility	Environment	Living	Energy
Education	Governance	Transportation	Urban/local agriculture and food security	Housing	Energy
Health	Telecommunications	Finance	Environment and climate change	Population and social conditions	Finance
Economy	Finance	Environment and climate change	Solid waste	Recreation	Telecommunications
Telecommunications		Energy	Wastewater	Safety	Urban/local agriculture and food security
Housing			Water	Sports and culture	
				Urban planning	

aspects of smart people are similar to southern metrics and focus on access to education, social cohesion, and the robustness of public life. But when measuring smart people for a northern city, more attention should also be allocated to Indigenous education and inclusion programming. Arctic aspects of smart governance do not differ greatly from non-Arctic governance metrics. However, because a number of Arctic cities and regional settlements around urban areas – particularly in North America, Greenland, and Russia – have limited access to high-speed internet, northern local governments must be strategic in pursuing a combination of digital and non-digital platforms of transparent, accessible government engagement, also inclusive of Indigenous languages. Arctic smart mobility necessitates a widening of both the modes and the geographic reach of urban transportation networks beyond standard multimodal measurements.

Unique modes of Arctic transportation like cross-country skiing, snowmobiles, dog sleds, and mobility infrastructure and vehicles also require cold climate-tested smart technologies that can withstand freezing temperatures and larger vehicles that transport raw materials to markets; for the latter, road and rail systems must be planned at the regional level to connect surrounding economic activities to the urban hub. Arctic aspects of a smart environment adhere to the evaluations of non-Arctic cities with an added urgency and commitment to cold-climate technologies. Energy efficiency of cold-climate housing and integration of renewable energy systems also take on newfound urgency with high costs of fossil fuel-based electricity, heating, and transport fuel in the Arctic. This is particularly important because, though wide-ranging in the measured sectors, scholars note that smart city frameworks, such as the ISO one, lack robust climate change specific indicators (Ahvenniemi et al. 2017). As climate change is warming the circumpolar north at more than twice the rate of the global average, climate mitigation and adaptation are foundational measures for ensuring that Arctic cities meet present needs without compromising future ones. And finally Arctic aspects of smart living are defined by the added dimension of long, dark winters and bright summers with volatile weather. Public health programs, place-based community building, and dedicated cultural spaces need to be smartly designed for inclusive, year-round use.

Thus, a smart and sustainable Arctic city is one that can score highly in each of these measurement through mobilizing and using "available resources to improve its inhabitants' quality of life, significantly improves its resource-use efficiency, reduces its demands on the environment, builds an innovation-driven and green economy, and fosters a well-developed local democracy" (Garau and Pavan 2018, p. 4).

Conclusion

Far from the pristine, uninhabited images of wide expanses of tundra that have captivated the human imagination since the Age of Exploration, the Arctic is very much alive with vibrant communities, economic growth, and inventive urban development. It is anything but the static tabula rasa that Franklin and Scott set forth to conquer and colonize; each Arctic city – both alone and collectively – are sources of innovation and employment; home to culturally diverse identities; integral nodes of the globe's ecological, economic, and social systems; places of pride and democratic empowerment; and, above all, it is a homeland. In the decades to come, it is projected that Arctic residents will continue to depopulate smaller settlements in favor of concentrated metro areas. As the circumpolar north enters the century of the city, it is critical to examine the ways in which we measure the success of livable, smart urban development and investment.

This entry offers a brief overview and framework through which to apply such analyses, upon which future scholars can build and expand. The proposed framework for Arctic urban analysis must integrate metrics of sustainability, and in particular those related to climate change, into the smart city standardization set forth by ISO (Höjer and Wangel 2015). The Arctic smart city survey to follow also considers quantitative

indicators for performance measurement of smart cities to meet the need of climate mitigation and adaptation by including particular consideration for greenhouse gas emission targets in smart environment and resilience building in smart environment and smart living.

Cross-References

- Big Data for Smart Cities and Inclusive Growth
- Circular Economy Cities
- City Visions: Toward Smart and Sustainable Urban Futures
- Local and Regional Development Strategy
- Making of Smart and Intelligent Cities
- The Sustainable and the Smart City: Distinguishing Two Contemporary Urban Visions
- Toward a Sustainable City

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