



Article

# Measuring Progress toward Urban Sustainability: Do Global Measures Work for Arctic Cities?

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**Abstract:** The International Organization for Standardization recently responded to a growing global interest in cities by developing an index for measuring urban sustainability (ISO 37120). We address how well this standard applies to Arctic cities, and potential modifications that might improve its performance. After briefly discussing the goals of sustainability indicators, we examine the extent to which Arctic cities' remote location, cold and changing climate, and thin, largely resource-based economies may create different sustainability challenges. We then critically examine the content of ISO 37120 and the context in which it was created. We place the index within a broader discussion of urban sustainability indicators and examine the extent to which it really addresses sustainability. We then analyze how well the ISO 37120 accounts for the characteristic features of Arctic cities that produce unique sustainability challenges. Our findings show that only half of ISO 37120's 128 indicators actually measure future-oriented concerns. We suggest that, while the ISO 37120 may be a useful starting point in quantifying Arctic urban sustainability, the index should only be used as a foundation for a more in-depth analysis. To better represent Arctic cities, the ISO 37120 would need to include indicators that situate cities within their regional contexts, addressing both remoteness and the underlying basis of the Arctic city economy. The index should also measure the role of Indigenous populations, and chart the extent to which cities are working to increase levels of sustainability.

**Keywords:** Arctic; ISO 37120; indicators; urban

## 1. Introduction

The Arctic is becoming increasingly urbanized. More than two-thirds of the population lives in larger settlements [1], and the growing concentration of people is likely to continue [2–4]. Despite the trend toward urbanization, relatively little is known about Arctic cities. The Arctic Human Development Report identified “Arctic settlements, cities, and communities” as one of the main gaps in knowledge of the region [5]. One of the most important issues facing Arctic regions is the perceived need to transition from a “boom–bust” cycle, based on resource extraction, to a more diverse and sustainable economy [6–8]. The sustainability challenge is particularly important for Arctic cities, as they will continue to absorb an even greater share of the Arctic population [9].

In order to evaluate progress towards the sustainability of Arctic cities, one has to define sustainability in measurable terms. Responding to a growing interest in measuring urban sustainability globally [10–13], the International Organization for Standardization (ISO) defined a comprehensive set of indicators for measuring urban sustainability. The ISO 37120 standard, Sustainable Cities and Communities—Indicators for City Services and Quality of Life, formally adopted in 2014 and revised in 2018, now includes 128 indicators over 19 domains (dimensions) of sustainability [14,15]. Despite the

enormous diversity in cities, ranging from urban areas dealing with extensive poverty and unmet needs to those that consume enormous resources in wasteful and polluting ways, the ISO standard is intended to apply to cities globally [16]. Is it appropriate for Arctic cities, or do they need their own set of measures?

Our research question is part of a broader literature that addresses the issue of whether one set of standards applies to all cities on the planet, or if there are groups of cities that are sufficiently different from the rest that they deserve special consideration. From one perspective, it is possible to argue that each city is unique, and one must understand the local context in order to measure the level of sustainability with any accuracy. Cities differ across so many dimensions—wealth, history, culture, governance—that it is impossible to come up with a one size fits all solution to sustainability [17]. This rejection of universals might be described as “sustainability nominalism” [18]. On the other hand, cities are all basically alike, in that they have the legitimacy and authority to solve problems within their borders [19]. Seeking the proper balance between uniqueness and generality, the authors of the U.S. National Academy of Sciences’ report on urban sustainability concluded that “Urban leaders and planners should look to cities with similar economic, environmental, social, and political contexts to understand and adapt local and regional sustainability strategies that have proven to provide measurable impact [20]”. While this broader question has been discussed in the literature, this article will be one of the first to examine it in the context of ISO 37120 [21].

To answer our research question—Is ISO 37120 useful in measuring the sustainability of Arctic cities?—we first discuss important features of Arctic cities, focusing on characteristics that set them apart from cities elsewhere and potentially require different sustainability measures. We describe how Arctic cities are embedded in a regional system that is itself connected to larger-scale global systems, and use that context to identify criteria to evaluate how well the ISO standard works to measure Arctic urban sustainability. Next, we critically examine the content of ISO 37120 and the context in which it was created. We place ISO 37120 into the broader discussion of urban sustainability indicators and examine the extent to which it really measures sustainability. Next, we analyze the extent to which ISO 37120 is able to account for the unique features of Arctic cities that produce different sustainability challenges, while also measuring aspects of performance relevant to all cities. The concluding section discusses specific modifications to the ISO standard that might make it more relevant to Arctic cities, and considers what additional changes might make a revised index more useful for local governments as they develop and implement plans to achieve sustainability goals.

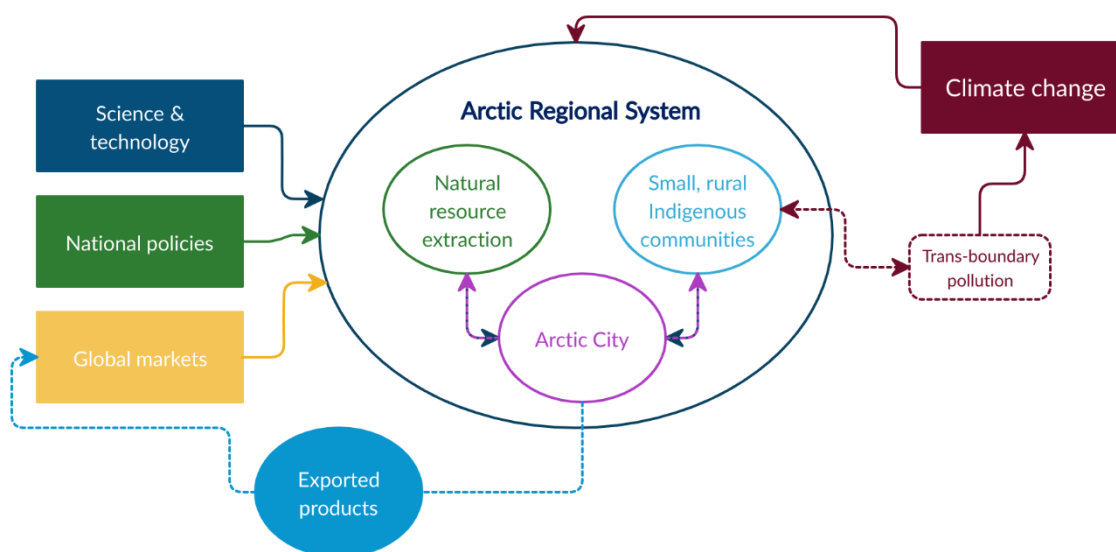
## 2. Arctic Cities in Context

Although Arctic cities share many characteristics and problems with cities worldwide, they differ in important respects [22,23]. Often, these differences are a matter of degree; however, Arctic cities as a group exhibit patterns of similarity that set them apart from global urban norms (Figure 1). Arctic cities tend to be smaller. The largest Arctic city—Arkhangelsk, Russia—contains about 350,000 inhabitants, followed by three others: Yakutsk and Murmansk—also in Russia, and Anchorage, Alaska, with populations around 300,000. Only about a dozen Arctic cities have more than 100,000 residents.

Arctic cities share certain characteristics because of their location. Being in higher latitudes, they experience profound swings in seasonal daylight hours, and of course, are typically cold. The lack of daylight in winter creates a challenge for energy sustainability because it curtails the possibility of using solar energy at the time of year when demand for light and space heating is greatest. Conversely, the higher energy needs in winter make energy efficiency a more salient concern. Cold soil temperatures also mean permafrost. Maintaining the integrity of permafrost and adapting infrastructure to permafrost thaw is a major sustainability challenge for many Arctic cities [24], a challenge that cities elsewhere avoid entirely. Arctic cities, on the other hand, do not avoid issues such as increased floods and droughts, and encroachment of seas associated with a warming climate; in fact, the effects of climate change are magnified in the Arctic [25].



surrounding territory (Figure 2). The regional economy that supports the Arctic city is typically thin. Huskey et al. [26] described three pillars of the Arctic economy: Natural resource extraction, national government administration, and traditional economies of the rural Indigenous population. Natural resource extraction is driven by global markets, over which the Arctic city has no control [38]. In some areas, tourism represents an important part of the private economy, with the Arctic city again providing logistics support for travel to sites in the region. Arctic tourism—predominantly ecotourism and cultural tourism—could be viewed as an extension of natural resource production, also driven by global market forces outside the city’s control [39–41]. National geopolitical interests drive both civilian and military expenditures for administration over lands, resources, and support for residents in the Arctic. In all cases, the regional system, which is itself driven by external forces, shapes the dynamics of the Arctic city, not the reverse.



**Figure 2.** The Arctic Regional System in Context. Global markets, national policies, scientific advances, and climate change are external drivers that affect the Arctic regional system. The Arctic region also exports products such as oil and gas that may affect global markets.

Finally, Arctic cities are relatively recent arrivals in the Arctic region and overall. They can grow and decline rapidly as their regional economies experience waves of expansion and contraction [42,43]. Because of their relatively young age, urban infrastructure is often limited and inadequate to serve the population. Unstable economies suggest that investments to build infrastructure that carries high maintenance costs could be unwise, despite the perceived need. The highly mobile population means that the Arctic city is often contending with assimilating a large cadre of immigrants from outside as well as within the Arctic [44], who may require additional services.

All the characteristics of Arctic cities described above create additional challenges for urban sustainability that cities outside the Arctic typically do not face. Indicators for urban sustainability designed for global cities may or may not be flexible enough to accommodate large differences among cities. Table 1 summarizes the unique features of Arctic cities enumerated above, along with associated criteria for evaluating the suitability of an urban sustainability index such as ISO 37120 for Arctic cities. Table 1 addresses only the potential differences between characteristics of Arctic and non-Arctic cities that the index needs to accommodate. Arctic cities also face many of the same sustainability challenges and opportunities faced by urban centers globally. Accordingly, we recognize and expect that a large set of indicators developed for cities outside Arctic regions will also apply to Arctic cities.



**Table 1.** Characteristic features of arctic cities and associated criteria for evaluating suitability of sustainability indicators.

Characteristic Feature of Arctic City	Criteria for Suitable Indicators
Economic dependence on natural resources	Measure percentage of employment and income not tied to nonrenewable resource extraction
Sustainable urban economy depends on a sustainable regional economy	Maintain regional ecosystem integrity, cultural integrity of regional Indigenous population
Regional economies potentially unstable	Measure adaptive capacity rather than current outcomes
Challenges of climate and latitude	Energy indicators should prioritize efficiency
Permafrost may be present	Appropriate construction standards
Typically smaller cities with limited administrative capacity	Avoid complex measures and administratively costly programs
Internal as well as external remoteness	Measure air connectivity and internet access rather than road connections
Relatively short lifespan	Emphasize investment over capacity
Migrant population	Programs to assist immigrants

Source: Authors' analysis.

Before concluding this section outlining the differences between Arctic cities and non-Arctic cities, we want to stress that despite their many similarities, Arctic cities are themselves quite diverse, and differ from each other in many ways. For example, there are numerous Norths, and the differences often depend on mobility and the level of access to roads [45]. Perhaps even more important is whether the city is located in Russia, Scandinavia, or North America. The differences among these regions are profound in terms of histories, demographics, and governance.

### 3. Origins of ISO 37120

The development of urban sustainability indicators involves science, judgment, and the contributions of many parties, and requires further study [20]. Understanding ISO 37120's origins is important, because the decision to measure something implies a certain set of values around the specific metrics used [46]. Gathering the data to measure city performance is expensive. Once an indicator is defined, it is hard to make changes, in part for fear of reducing the comparability of the metrics over time [47]. Who is at the table and who is not also matters in defining what values inform the standard and what topics it will actually measure [48,49].

The development of ISO 37120 closely follows the professional history of Patricia McCarney, an entrepreneurial professor of political science and the director of the Global Cities Institute at the University of Toronto. Her online biography notes that "she was integral to the development of ISO 37120" (<https://www.dataforcities.org/patricia-mccarney>, accessed 13 February 2020) and continues to play a leading role in its development and implementation. Dr. McCarney drove the process leading to the creation of ISO 37120, drawing on her experiences in the World Bank and other organizations. Her groundwork made it relatively easy to win certification of the standard by the International Organization for Standardization. Currently, she serves as President and CEO of the World Council on City Data (WCCD), an organization working to build a standardized database for cities worldwide in line with ISO 37120. (<https://www.dataforcities.org/patricia-mccarney>, accessed 13 February 2020).

The origins of ISO 37120 lie in the Global City Indicators Facility (GCIF). McCarney established the GCIF in 2008 at the University of Toronto in partnership with the World Bank to study nine pilot cities: São Paulo, Porto Alegre, Belo Horizonte, Bogota, Cali, Montreal, Vancouver, Toronto, and King County (Seattle) [50], supported with funding from the Government of Japan [51]. Additional funding in 2013 came from the government of Ontario and a number of international agencies and corporate partners [52].

Within the International Organization for Standardization (ISO), the process to produce and publish ISO 37120 required 6 international meetings, 5 drafts, and 300 comments [53]. It took only two years to create ISO 37120, “since the indicators were already well tested and reported on by GCIF member cities” [50], which had selected indicators that addressed city priorities, information needs, and challenges [52]. The indicators were designed to be “meaningful to cities across the globe regardless of geography, culture, affluence, size, or political structure” [52]. The process for creating the ISO 37120 also differed from that used for other international standards in that most indicators were tested and reported on by GCIF cities before developing the international standard, rather than first developing and testing the standard within the ISO [50].

The initial standard was published on 15 May 2014, and related data was collected for Amman, Jordan; Barcelona, Spain; Bogotá, Colombia; Boston, USA; Buenos Aires, Argentina; Dubai, UAE; Guadalajara, Mexico; Haiphong, Vietnam; Helsinki, Finland; Johannesburg, South Africa; London, UK; Makati, Philippines; Makkah, Saudi Arabia; Melbourne, Australia; Minna, Nigeria; Rotterdam, the Netherlands; São Paulo, Brazil; Shanghai, China; and Toronto, Canada [14]. Four years later, the ISO issued a revised version. The 2014 version of ISO 37120 had 139 indicators (46 core, 54 supporting, and 39 profile). The revised 2018 version included 128 indicators (45 core, 59 supporting, and 24 profile) (see Table S1, provided as Supplementary Materials). The compilers deleted 20 core and supporting indicators and added 24 new ones, while consolidating the profile indicators. The added indicators focused on culture, urban agriculture and food, and on housing vacancy rates and living space. (<https://www.iso.org/news/ref2305.html>, accessed 13 February 2020). The WCCD hosts a website that publicizes the data provided by cities so far. (<https://www.dataforcities.org/>, accessed 16 April 2020).

#### 4. An Analysis of ISO 37120

While ISO 37120 provides a comprehensive overview of city performance, it lacks a strong theoretical basis. The ISO indicator list covers 19 subject areas (see Table 2), and includes all the usual topics included in assessing urban sustainability, from economics to waste water treatment [20,54,55]. However, it does not provide an overall rationale for what actually makes one city more sustainable than another.

Although ISO 37120 explicitly claims to apply to all cities [53,56], it does not specifically judge cities by setting benchmarks that represent good or poor performance. Instead, by promoting voluntary standards and voluntarily supplied participation [57], the authors of ISO 37120 argue that cities will achieve a number of benefits from collecting the indicator data, such as more effective governance and service delivery, and informed decision making [58].

An explicit theory regarding what determines abstract concepts like urban sustainability would provide guidance in selecting appropriate indicators and avoid the risk of letting the statistical results define the outcome [47]. The ISO does not explicitly state its theoretical foundations; however, several hypotheses about the underlying theory can be inferred from the composition of the indicators included in the standard, and the designation of those included as “core” vs. “supporting” indicators. A first hypothesis is that all of the 19 categories are equally important, because all indicators are equally weighted. ISO 37120 does not rank cities based on their index outcomes, it simply asks cities and researchers to collect a set of data that they can use to benchmark themselves against other cities. There is no declaration that a field like energy is more important than housing or governance or some other aspect of urban life. However, as Table 2 shows, there are more core indicators for some topics: Energy, safety, and solid waste have five core indicators each, while recreation and telecommunications have none.

**Table 2.** ISO 37120 core, supporting, and profile indicators.

Theme	Core Indicators	Supporting Indicators	Profile Indicators
Economics	1	7	3
Education	4	2	0
Energy	5	2	2
Environment and climate change	3	6	0
Finance	2	2	2
Governance	1	3	0
Health	4	2	0
Housing	2	2	6
Population and social conditions	1	2	6
Recreation	0	2	0
Safety	5	5	0
Solid Waste	5	5	0
Sport and Culture	1	2	0
Telecommunications	0	2	0
Transportation	2	5	2
Urban/local agriculture and food security	1	3	0
Urban Planning	1	3	3
Waste water	3	1	0
Water	4	3	0
Total	45	59	24

Source: Table S1.

A second hypothesis implicit in ISO 37120 is that gender equality is considered an important criterion for sustainability. The education component of the standard includes an indicator measuring the percentage of the female school-aged population enrolled in schools. In the area of governance, the percentage of women among the total elected city officials is the only core indicator. Other studies of urban sustainability have focused on the importance of different factors, such as “the level of resources, staffing, funding, technical expertise, community support and leadership for sustainability efforts” as being crucial for sustainability policy making [59]. This focus on gender instead of other factors may skew results for Arctic cities, many of which have historically had high male sex ratios resulting from the composition of jobs in the resource extraction sector and higher female out-migration from the region, although the imbalance has been declining [9].

A third implicit hypothesis is that a relatively large number of indicators is needed to measure a city’s level of sustainability. In each of its specific areas, ISO 37120 often includes a number of core, supporting, and profile indicators. For the economy section, there is one core, seven supporting, and three profile indicators (Table 2). Critics of existing indicator systems often claim that they have too many indicators, which makes them unwieldy to implement in practice [60]. Gathering the data required to complete all of the ISO 37120 requirements is a big job for any city staff or research team.

## 5. ISO 37120 and Other Efforts to Measure Urban Sustainability

There are few available studies of ISO 37120, but a large and rapidly growing literature on urban sustainability indicators reveals how ISO 37120 fits with other efforts to measure urban sustainability [21]. Other indicator sets have a more value-oriented focus. For example, the Ecocity Framework measures cities at 8 different levels from “unhealthy” to “Gaia” across 18 standards in four categories: Urban design, bio-geophysical conditions, socio-cultural features, and ecological imperatives. (<https://ecocitystandards.org/framework/>, accessed 16 February 2020). Rather than just provide a way of measuring cities in relation to each other, Ecocity Builders, the group that supports the Ecocity Framework, has an explicitly stated mission “to reshape and restructure cities to address global environmental challenges.” (<https://ecocitystandards.org/ecocity-builders/>, accessed 16 February 2020). In concrete terms, this translates to indicators with set benchmarks. For example, in the “environmentally friendly transport” category, a city can reach Ecocity Level 1 if 86% of trips are taken by walking, cycling, transit, and freight deliveries.

The European Reference Frameworks for Sustainable Cities (RFSC) contains 30 objectives in 5 dimensions. (<http://rfsc.eu/european-framework/>, accessed 16 February 2020) The initiative is run by the French Ministry in charge of housing and urban development, the Council of European Municipalities and Regions, and CEREMA, a public body in support of national and local authorities in the field of sustainable development, and supports the Leipzig charter, which all EU members signed in 2007. Rather than providing quantitative benchmarks, the RFSC outlines general objectives that cities should strive for, such as “develop sustainable urban planning and land use.”

The Circles of Sustainability approach, which was developed by Paul James, Director of the United Nations Global Compact Cities Program, focuses on four domains—ecology, economics, politics, and culture [61]. Using a simple, circular graphic to display indicators within these domains, the method seeks to get away from more complicated approaches, while demonstrating the interactions among the various domains. Like the EcoBuilders, Circles of Sustainability explicitly seeks to engage with the world and improve it.

Finally, a growing literature on smart cities and resilient cities suggests that smart and/or resilient features could replace sustainability as key urban metrics [23]. The ISO correctly sees smartness and resilience as complementary to sustainability, and has developed a related set of indicators to measure levels of smartness (ISO 37122) and resilience (ISO 37123).

## 6. Does ISO 37120 Measure Sustainability?

Researchers have proposed various ways to evaluate a set of indicators such as those included in the international standard [62,63]. Huovila et al. classified the ISO 37120 indicators by whether they measure input, process, output, outcome, or impact [21]. They categorized 6% of the ISO 37120 indicators as input, 0% process, 25% output, 22% outcome, and 47% impact measures. They concluded that the ISO 37120 was best suited for reporting immediate implementation of policy measures to support sustainability. Their findings suggested that only about half of the core and supporting indicators, those that focused on impact, addressed long-term sustainability.

Another approach would be to examine the extent that the ISO 37120 indicators met the sustainability requirements of being future oriented [64], comprehensive, and defined on the basis of community input. One way to assess future orientation would be to classify indicators by whether they measured outcomes, capacity, or investments. Outcome indicators simply measure the current status, but do not necessarily inform us about the likelihood that current conditions can be maintained over the long term. In contrast, capacity and investment indicators measure the ability and efforts of the city to address longer-term issues. Of the 106 core and supporting indicators, 36% (38) measure capacity, 8% (9) represent investments, and 56% (59) outputs (see Table S2, provided as Supplementary Materials). These findings are similar to the results of the Huovila et al. survey, and suggest that fewer than half of the ISO 37120 indicators actually measure sustainability issues.

In terms of topics covered, the standard seems comprehensive. However, within each of the areas discussed, there is room for more effective choices in indicators. The economics area lacks an indicator assessing the extent to which a city’s economy depends on regional non-renewable fossil fuel extraction or mining, which in the Arctic often underpins the city economy, as described above.

The extent to which ISO 37120 meets the standard of being community defined is difficult to measure. Some cities had a role in identifying the indicators that made up the GCIF. However, were these cities a representative sample of all cities—no arctic cities were included—and who exactly from these cities played a role in selecting the indicators? Most Arctic cities are smaller in size and have limited capacity to task professional staff to participate in such a process. The ISO stresses the public input aspect of its work, but its meetings take place in cities around the world, making it hard for most people to attend, and most comments likely come from the organizations and experts involved in drafting the standard. For Arctic cities, ISO 37120 would be a wholly exogenous set of criteria. It would not meet the four criteria of knowledge co-production as defined in *Nature Sustainability* [65]. These are: Context-based (situating the process in a particular context, place, or issue); pluralistic (explicitly



recognizing the multiple ways of knowing and doing); goal-oriented (articulating clearly defined, shared, and meaningful goals that are related to the challenge at hand); and interactive (allowing for ongoing learning among actors, active engagement, and frequent interactions). ISO 37120 does not set goals that could be used to steer governance [66]. Most importantly for knowledge co-production, the standard is not situated in a specific place, but rather provides a way of looking at all cities and comparing them [67]. Finally, the ISO indicators have nothing to say about implementation. The various measures do not assess the planning process or steps that a city might take to implement measures to increase sustainability or the extent to which a city “takes sustainability seriously [19]”.

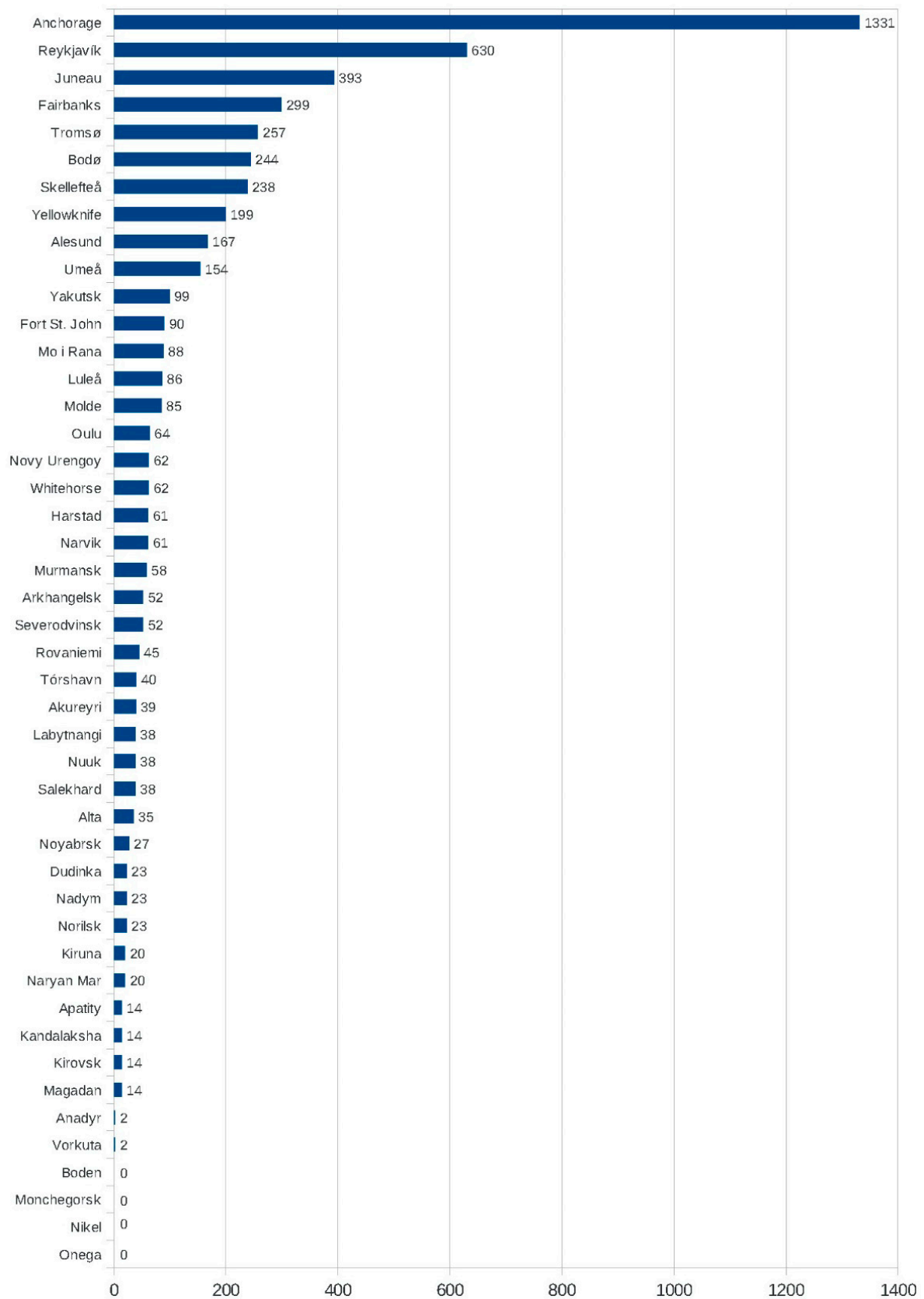
## 7. How Well Does ISO 37120 Work to Measure Urban Sustainability in the Arctic?

Arctic cities, much like the rest of the cities in the world, seek to provide a variety of services to their residents and people living in the surrounding communities. All of the 19 categories of indicators (see Table 2) apply to northern cities in much the same ways that they would apply elsewhere.

In areas where the Arctic cities differ from other cities, ISO 37120 does not always provide a useful metric to make sense of the differences. First, remoteness is a distinguishing feature of Arctic cities. ISO 37120 has one indicator that examines this issue—the number of commercial air destinations connecting each city. This indicator does a good job of highlighting the small number of destinations linking Arctic cities, and it makes clear the exceptional nature of Anchorage and Reykjavik, which have established themselves as transportation hubs between Asia and Europe, and North America and Europe, respectively (Figure 3). However, there is no measure of the road, railroad, or sea or river port connections between cities. Nor are there metrics gauging the distances to large urban centers for land and sea connections that do exist. Such measures would assess the potential role cities play in the international distribution of goods, and how easily they are provisioned. Beyond a simple focus on transportation logistics, measuring such connections would provide information on food security, since a larger number of connections would indicate a lower vulnerability for disruption of the city’s supply of imported foods.

Second, ISO 37120 does not account for climate change in a dynamic sense. This finding is ironic, since the ISO 37120 authors clearly had climate change in mind when preparing the standard [68]. While there is an indicator for greenhouse gas emissions that measures the city’s contribution to global climate change, there is no indicator to assess how climate change is affecting a city and how that city is responding. This is an important shortcoming, given that the Arctic region is warming much faster than the earth as a whole [69]. For example, a city might record decreasing total energy use per capita, which could either mean that the city is becoming more sustainable, or that the temperature is increasing and there is less need for space heating. Understanding the message of the indicators is often difficult, since they could be describing many different causal relationships [70]. Additionally, there are no measures of city preparations to address hazards related to a changing climate, including infrastructure engineering for permafrost thawing, coastal erosion, various types of flooding, and wildfire hazards. Some of the consequences of these events, such as increased air pollution from wildfires, would be picked up in the pollution measures, but this data would have to be interpreted in the context in which it is collected.

Third, Arctic city economies are closely tied to resource production in their immediate vicinity, whether oil and gas in the energy sector or mining. In this sense, outcome indicators ostensibly measuring the strength of the economy may be misleading because Arctic cities are more susceptible than most to swings of the boom–bust economy. Other factors that are important for Arctic city production efforts are relations with the local Indigenous population and the vagaries of constantly shifting geopolitical interests. Arctic cities depend much less on the innovation generated by the concentration of people and financial resources that is the main economic driver for most cities [71]. While scholars like Andrey Petrov have demonstrated the extent of creative capital in northern cities, northern urban areas clearly have fewer resources than their southern counterparts [72,73].



**Figure 3.** Commercial air connectivity of Arctic cities. (Source: ISO 37120 and <http://flightradar24.com>).

## 8. Conclusions

This article argues that although Arctic cities confront many of the same challenges as cities worldwide, they also face challenges associated with their unique geography, climate, economies, and histories. The ISO 37120 standard's comprehensive set of indicators work to benchmark Arctic urban sustainability in terms of the universal attributes of cities, but does not address the areas where they are unique in terms of remoteness, extreme climate, and economic vulnerability. Although detailed and specific, the technical complexity and large data requirements of ISO 37120 likely raise an obstacle to its widespread use in the Arctic, where cities are typically smaller and lack large professional staffs to compile the figures. At the same time, the ISO does not address important northern sustainability issues related to climate change, economic dependence on non-renewable resource extraction, and vulnerability to changing national geopolitical objectives. To be more responsive to these issues, the indicator set should focus more on measuring capacity and investments to reduce economic and social vulnerability, with less emphasis on current outcomes.

Given the proliferation of ways to measure urban sustainability, it is certainly easy to criticize ISO 37120 and other existing metrics. For example, Gómez-Álvarez et al. describe ISO 37120 as a good example of a third generation set of indicators and call for a fourth generation that would provide "a broader, people-centered approach", which would stimulate urban governance [74]. While we do not reject the use of indicators as fundamentally wrong-headed, as some have [75], we see them rather as the beginning of a conversation, a way to hold local governments accountable, and a useful component of a multi-method urban analysis [13]. ISO 37120 could be improved by more clearly articulating a theory of sustainability that would define what factors are crucial in making one city more sustainable than another. Doing so would make the assumptions underlying the choice of indicators more explicit.

To work more effectively in the Arctic, our content analysis of ISO 37120 in the light of Arctic urban conditions suggests that it should also include indicators that emphasize:

- Reliance on non-renewable resource production in the surrounding region as a central component supporting the city's economy,
- connections between a city and its broader regional ecosystem,
- relationships with and status of local Indigenous populations, and
- severity of climate vulnerability concerns such as permafrost thaw and coastal erosion, and the city's efforts to address these vulnerabilities.

Additionally, the standard should include more measures of the efforts that the city leadership is taking to increase the level of the city's sustainability overall [76].

**Supplementary Materials:** The following are available online at <http://www.mdpi.com/2071-1050/12/9/3708/s1>, Table S1: ISO 37120 Indicators, Types, Functions, and Relevance to Arctic Cities, Table S2: Summary of ISO 37120 Indicator Types, Functions, and Relevance to Arctic Cities.

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