THE USAGE OF INDICATORS FOR CITY SERVICES AND QUALITY OF LIFE DEFINED BY ISO 37120 IN SUPPLY CHAINS

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Abstract

A smart city is a complex system emerging from a million individual actions of citizens and producers, which city planning attempts to coordinate and give coherence. It is a cyber-physical engine for improving logistics resources of the supply chains, integrating digital and non-digital components. Standard ISO 37120, Sustainable cities and communities – Indicators for city services and quality of life, defines indicators to measure smart city performance and on the level of management supports standard ISO 37101, Sustainable development in communities – Management system for sustainable development – Requirements with guidance for use on the level of leadership. With the help of the first mentioned standard, the situation when existing indicators at the local level are often not standardized, consistent, or comparable over time or across cities is exceeded. These indicators can monitor city performance progress to achieve sustainable supply chain development. Some indicators are directly related to individual logistics resources and supply chains, and some are indirect. This paper will describe a model using the indicators and their application in logistics and supply chains.

Key words: ISO 37101, ISO 37120, Smart City, Supply Chain, Logistics

1. INTRODUCTION

Cities must plan to deliver the resources and services, required to ensure their future populations survival and their thriving. Public transport and facilities, water supply, sanitation, energy, food, and security are some pressure points that will be affected by rising urbanization. ISO international standards represent international consensus on best practices from variety of fields (Midor & Płaza, 2020), providing tools, foundations, and platforms for cities to enable productivity in the future, protection of environment and ensuring prosperity of all (Midor & Płaza, 2020). The challenges that cities face (and will continue to face) are complex and multi-sectorial, such as establishment of sustainable development (Melo et al., 2020). These challenges are also particular, as no two cities are the same.

Informal and formal standards have been shaping the cities for long (White, 2020). Benefits of international standards enable cities to achieve appropriate technical, environmental, and social indicators that have a significant impact on the infrastructure, safety, and life of residents. ISO standards represent the international consensus on best practices in many areas that contribute to making a smart city better and fulfilling the United Nations Sustainable Development Goals to end poverty, ensure prosperity for all, and protect our environment. These include overarching frameworks that city leaders and planners can use to define objectives and priorities for making their cities more sustainable, as well as specific guidelines for things like energy management systems, road safety, intelligent transport, responsible water consumption, health and well-being, cybersecurity, connectivity, and more.

Groups of experts develop ISO standards within technical committees (TCs). TCs comprises representatives from industry, non-governmental organizations, governments, and other stakeholders who ISO's members put forward. Each TC deals with a different subject, such as energy management, water quality, or intelligent transport systems.

ISO/TC 268, Sustainable cities and communities, comprises city and standardization experts from more than fifty countries worldwide. It is responsible for the ISO 37100 series of standards to help cities define their sustainability objectives and implement strategies to achieve them. Sustainable cities and community's politics, guidelines, and, consequently, standards consider the following facts (Habitat III, 2016):

- By 2050 the world population is expected to reach nearly 10 billion people (UNDP, 2017).
- 80% amount of people living in cities in 2050 (World Food Research and Innovation Forum, 2022).
- 2% surface occupied by today's cities on the earth's surface.
- 60% amount of energy consumed by actual cities.
- 70% amount of waste and greenhouse gas emissions produced by cities.

The ISO standards for smart cities aim to provide cities with measurement of their sustainability and to seek answers for the following question: "how can cities adapt and establish to provide adequate resources and a sustainable future?" (Midor

& Płaza, 2020). Cities need indicators to measure their performance to improve sustainability and quality of life. Existing indicators at the local level are often not standardized, consistent, or comparable over time or across cities. Because of this challenge, ISO 37120 focuses on city services and quality of life as a contribution to the sustainability of a city (ISO, 2018) and establishes a set of standardized indicators, which provide a wholesome approach to what and how it is measured. (ISO, n. d.) These indicators can be used to track and monitor progress on city performance. To achieve sustainable development, the whole city system must be considered. Planning for future needs should consider the current use and efficiency of resources to better plan for tomorrow. (ISO, 2018) Alongside, ISO 37101 establishes a coherent framework to enable the community to develop its purposes and vision. It sets out requirements and guidance to help communities achieve a framework that will allow them to become more sustainable. It does not set benchmarks or expected levels of performance. (ISO, 2016a)

While the challenge of sustainable development is global, the strategies for achieving it at the community level are local to a large extent. They can therefore differ in context and content from country to country and region to region. Community strategies must reflect the context, preconditions, priorities, and needs, particularly in the social environment, e.g., social equity, cultural identity and traditions, heritage, human health, safety and comfort, and social infrastructure. (ISO, 2018)

This paper reviews the core and supporting indicators for city services and quality of life described by ISO 37120. In addition, the following has been found: a) direct and indirect connections to the issues from ISO 37101 connected to logistics and supply chains and b) the connections to the contributions to the purposes of the city defined by ISO 37101.

2. THEORETICAL BACKGROUND

Standards present our everyday life. They regulate human and non-human behaviours, the physical forms of buildings, land, and roads (White, 2020). They also have an essential role in business through cooperation, improved productivity, reduction of information asymmetry, and increase of trust (Castka, 2020). Standards have the power to impact entire supply chains, innovation eco-systems (Teece, 2018), and national economies with their established reference points and platforms (Blind et al., 2018). The concept of smart city is regulated by standards in a way that regulates the functioning of the city (Lai et al., 2020). To ensure effective provision of better services and increased quality of life, smart cities have to function based on correlated and integrated systems (Midor & Płaza, 2020).

A management system is a set of policies, processes, and procedures that help an organization meet the requirements expected by its stakeholders. It is based on the continual improvement principle represented by the Plan-Do-Check-Act cycle, a four-step management method used by organizations to control and continually improve processes, products, and services (like: ISO 9001, ISO 14001, and ISO 37001).

Figure 1 represents sustainable cities and communities' standards activity. In this paper, the focus will be on ISO 37120 in connection with ISO 37101. The latter is a

standard about the strategic level used by community or city leadership, while standard ISO 37120 is partly about the strategic and the process level to manage the communities or cities.

**Figure 1.** Sustainable and communities' standards activity
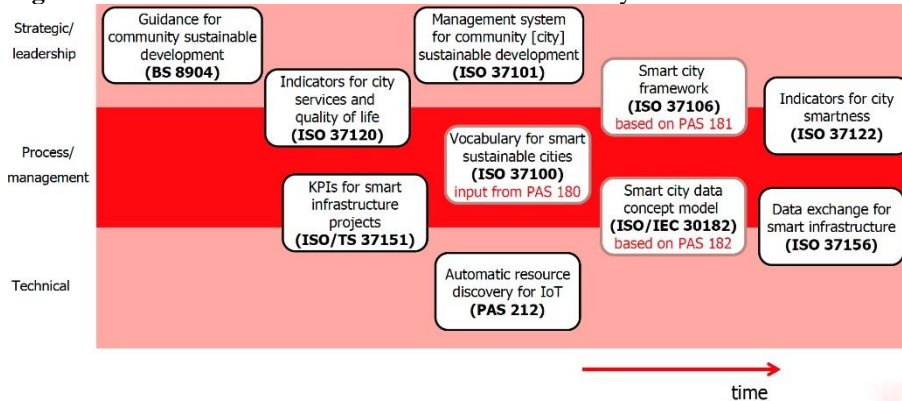
Source: ISO, 2016b

ISO standards for sustainable cities represent a family of four basic standards, which are: ISO 37101, ISO 37120, ISO 37122, and ISO 37123. Implementation of ISO 37101 standard helps cities to establish consensus on sustainable development, and to increase efficiency and attractiveness of cities, among other (da Silva de Santana et al., 2018; Fitsilis, 2018). While ISO 37120 establishes methodologies for number of indicators to measure and monitor the performance of city services and quality of life. These two standards can be applied om conjunction (Midor & Płaza, 2020) since ISO 37120 supports ISO 37101 with specific guidance for developing and implementing strategies.

Sustainable development can be defined as development that meets the environmental, social, and economic needs of the present, without compromising the ability of future generations to meet their own needs (Ayodele & Ogunlola, 2016). The intersection of sustainable development is represented in Figure 2.

Figure 2. General view of dimensions of sustainable development
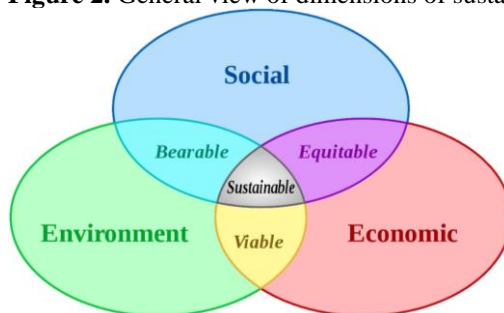
Source: Ayodele & Ogunlola, 2016

ISO 37101 sets out the basic requirements for sustainable development in communities, helps cities determine their sustainable development objectives, and puts in place a strategy to achieve them (ISO, 2016a). Directly aimed at city leaders, this management system standard covers everything a city must address to become more competent, such as responsible resource use, environmental management, citizens' health and well-being, governance, mobility, and more.

2.1. ISO 37101 – Sustainable development in communities – Management system for sustainable development – Requirements with guidance for use

ISO 37101 adopts a holistic approach to the establishment of the requirements of a management system for sustainable development in communities, including cities, and provides guidance aimed at (ISO, 2016a):
1. improving the contribution of communities to sustainable development;
2. fostering smartness and resilience in communities, while taking into account the territorial boundaries to which it applies;
3. assessing the performance of communities in progressing towards sustainable development.

The organization shall identify, review and document all the purposes and issues contributing to sustainability, as outlined in Table 1 (ISO, 2016a).

Table 1. Purposes and issues that contribute to sustainability

Attractiveness	Appeal to citizens and other interested parties, e.g., investors; belonging; culture; place; sense of identity.
Preservation and improvement of environment	Improved environmental performance, including reducing greenhouse gas emissions; protection, restoration and enhancement of biological diversity and ecosystem services, including protection of ecosystems, plant and animal diversity and migration as well as genetic diversity; reduced health hazard.
Resilience	Anticipation; climate change mitigation and/or adaptation; economic shocks and stresses preparedness, social evolution.
Responsible resource use	Consumption; distribution; improved land management; reducing, reusing, and recycling of materials; respect for scarcity of all types of resources (natural, human, financial); sustainable production, storage, and transport.
Social cohesion	Accessibility; culture; dialogue with external parties not limited by boundaries, diversity; equity; heritage; inclusiveness; inequalities reduction; rootedness; sense of belonging and social mobility.
Well-being	Access to opportunities; creativity, education; happiness; healthy environment; human capital improvement; live-able city; prosperity; quality of life; security; self-confidence; welfare.

Source: Adapted based on ISO, 2016a

To evaluate the contribution to achieving the six purposes of sustainability (Represented in Table 1), it is necessary to consider the twelve sustainability issues described (ISO, 2016a):

1. Governance, empowerment, and engagement;
2. Education and capacity building;
3. Innovation, creativity, and research;
4. Health and care in the community;
5. Culture and community identity;
6. Living together, interdependence and mutuality;
7. Economy and sustainable production and consumption;
8. Living and working environment;
9. Safety and security;
10. Community infrastructures;
11. Mobility;
12. Biodiversity and ecosystem services.

When reviewing all strategies, programs, projects, plans, and services for inclusion in the organization's strategic plan, the organization shall evaluate their contribution to achieving the six purposes of sustainability and how they take the sustainability issues into account. To do so, the organization shall undertake an iterative cross-analysis of objectives and topics.

By twelve issues and six purposes of sustainability, the organization shall evaluate their contribution to achieving the six purposes of sustainability and how they take the sustainability issues into account by together 72 evaluations.

ISO 37101 has been designed to help communities: define their sustainable development objectives and put in place a strategy to achieve them. The aim of ISO 37101 is to set out the broad principles (referred to in the standard as "purposes of sustainability") of what a community may wish to achieve with a sustainable development strategy, such as responsible resource use, preserving the environment, and improving the well-being of citizens. It requires communities to consider sustainability issues such as governance, empowerment, education, health, and mobility, which will help to define their sustainable development objectives. (ISO, 2016a)

ISO 37101 sets out the steps a community needs to take to achieve its sustainable development goals, such as creating an action plan, allocating responsibilities, and measuring performance. It is based on the continual improvement principle, meaning users must regularly adjust their objectives and strategy to ensure they are constantly moving forward. (ISO, 2016a)

ISO 37101 sets out the steps a community needs to take to achieve its sustainable development goals, such as creating an action plan, allocating responsibilities, and measuring performance. It is based on the continual improvement principle, meaning users must regularly adjust their objectives and strategy to ensure they are constantly moving forward. (ISO, 2016a)

This standard has been designed to be used at the community level by a multi-actor structure. One of the first steps when using the standard is to create the group or system that will implement it on behalf of the community. ISO 37101 defines a

community as a "group of people with an arrangement of responsibilities, activities, and relationships." (ISO, 2016a)

Figure 3 represents the structure of ISO 37101. The content of the standard establishes requirements for a management system for sustainable development in communities, including cities, using a holistic approach to ensure consistency with the sustainable development policy of communities in the following areas (ISO, 2016a):

1. context of the organization;
2. leadership
3. planning;
4. support;
5. operation;
6. performance evaluation;
7. improvement.

The first step is understanding the organization and its context. In this step, we need to understand the needs and expectations of interested parties, then determine the scope of the management system for sustainable development in communities and establish a management system for sustainable development in communities. We also define six sustainability purposes and 12 sustainability issues in this step.

Figure 3. Relationship between PDCA model and ISO 37101
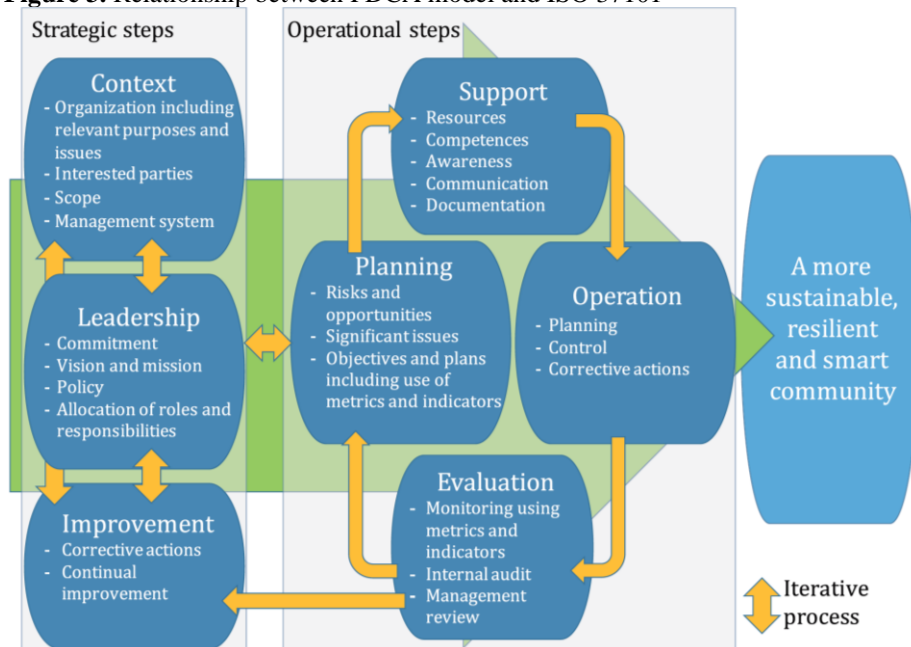
Source: ISO, 2016a

2.2. ISO 37120 – Sustainable development of communities – Indicators for city services and quality of life

The standard establishes and defines the methodologies for a set of indicators to measure and steer the performance of city services and quality of life. (ISO, 2018)

The core, supporting, and profile indicators are classified into themes according to the different sectors and services provided by a city. The classification structure denotes each indicator type's services and application area when a municipality reports. This classification of themes has no hierarchical significance and is organized alphabetically. The indicators are structured around the following themes (ISO, 2018):

- economy;
- education;
- energy;
- environment and climate change;
- finance;
- governance;
- health;
- housing;
- population and social conditions;
- recreation;
- safety;
- solid waste;
- sport and culture;
- telecommunication;
- transportation;
- urban/local agriculture and food security;
- urban planning;
- wastewater;
- water.

Recognizing the differences in resources and capabilities of cities worldwide, the comprehensive set of indicators for city performance has been divided into (ISO, 2018):

1. Core indicators: indicators that are required to demonstrate performance in the delivery of city services and quality of life.
2. Supporting indicators: indicators that are recommended to demonstrate performance in the delivery of city services and quality of life. These indicators can be selected according to city objectives.
3. Profile indicators: indicators that are recommended to provide basic statistics and background information to help cities determine which cities are of interest for peer comparisons. Profile indicators are used as an informative reference.

Users may also consider the following aspects, which shall be clearly stated in the paper and justified (ISO, 2018):

1. indicators can be aggregated to larger administrative areas (e.g., region, metropolitan area);
2. since some indicators are indirectly linked to sustainability, there is a need to consider the resource efficiency of a city;
3. indicators can be grouped together for analysis when taking into consideration holistic characteristics of a city; and
4. this set of indicators may be complemented by other indicator sets in order to have a more comprehensive, holistic approach to analysis on sustainability.

Furthermore, it is also essential to acknowledge the potential antagonistic effects of the outcome of particularly positive or negative indicators when analyzing results. For example, the number of automobiles per capita will potentially increase greenhouse gas emissions.

For each indicator, the correspondence with the issues of ISO 37101 is noted in the next chapter.

3. METHODS

This paper starts with the ISO 37101 sustainable issues "Community infrastructure" and "Mobility" as the main issues connected to logistics and supply chains. For this paper, they have been named "Direct issues" associated with some other issues from the list of twelve. The "Indirect issues" are defined as issues that are mentioned in the table "Mapping of indicators to ISO 37101 issues and purposes" with the origin in "Direct issues". There also exists "Other issues", which are not mentioned in the table "Mapping of indicators to ISO 37101 issues and purposes", and they haven't the origin in "Direct issues".

Figure 4 represents how core, supporting indicators and contributions to the purposes of a smart city based on sustainable **issues** in supply chains were defined. The following essential steps were followed (see Figure 4):

1. From the twelve sustainability issues described in ISO 37101, "Community infrastructure" and "Mobility" were chosen as "Direct issues" regards to the supply chain.
2. By the "Mapping of indicators to ISO 37101 issues and purposes" (described in Annex B of ISO 37120), the set of ISO 37120 core and supplying **indicators** derived from both above defined "Direct issues" were obtained.
3. The set of indicators, as mentioned earlier, defines all the issues back as "Direct" and "Indirect issues". The remaining issues are "Other issues", which are not the subject of interest in this paper.
4. From the set of indicators, defined in step 2, the "Contribution to **purposes** of the city as defined in ISO 37101" was obtained.
5. Set of indicators defined in step 2 are classified into themes (e.g., Transportation, Economy, Urban plan, etc.).

Following this procedure, the indicators and purposes in the smart city supply chains were obtained, based on the sustainable issues connected with the logistics and supply chains with their interdependencies or interrelationships. The issues (named

"Indirect issues") were also acquired, which are related to the origin sustainable issues ("Direct issues" which are "Community infrastructure" and "Mobility").

Figure 4. The algorithm to define Sustainable issues and Contributions to purposes of smart city in a supply chain from "Community infrastructure" and "Mobility" issue.
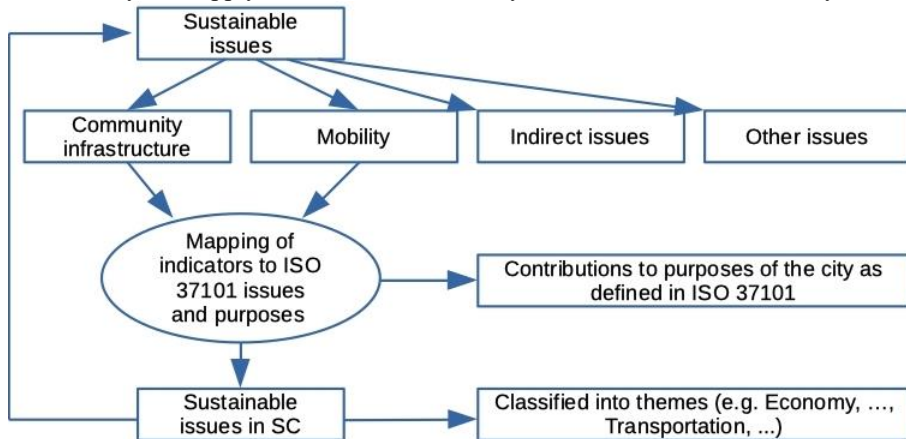
Source: Own source

4. RESULTS: APPLYING BOTH STANDARDS TO LOGISTICS AND SUPPLY CHAINS

### 4.1. Interconnections between indicators, themes, and direct issues

The research began with the ISO 371012 "direct issues" which are during the procedure "Mapping ISO 37120 indicators to ISO 37101 issues and purposes" connected with the following indirect issues: "Health and care in the community", "Living together, interdependence and mutuality", "Economy and sustainable production and consumption", "Living and working environment", "Safety and security" and "Biodiversity and ecosystem services".

On the other hand, it was found that all six purposes are connected to the two direct issues presented.

Figure 5 represents:
1. indicators belong to themes that are connected with both direct issues;
2. purposes, connected with the indicators which are connected to both direct issues;
3. issues, directly connected with the logistics and supply chain and indirectly connected with the direct issues;

Figure 5. Interconnections between indicators, themes, and direct issues
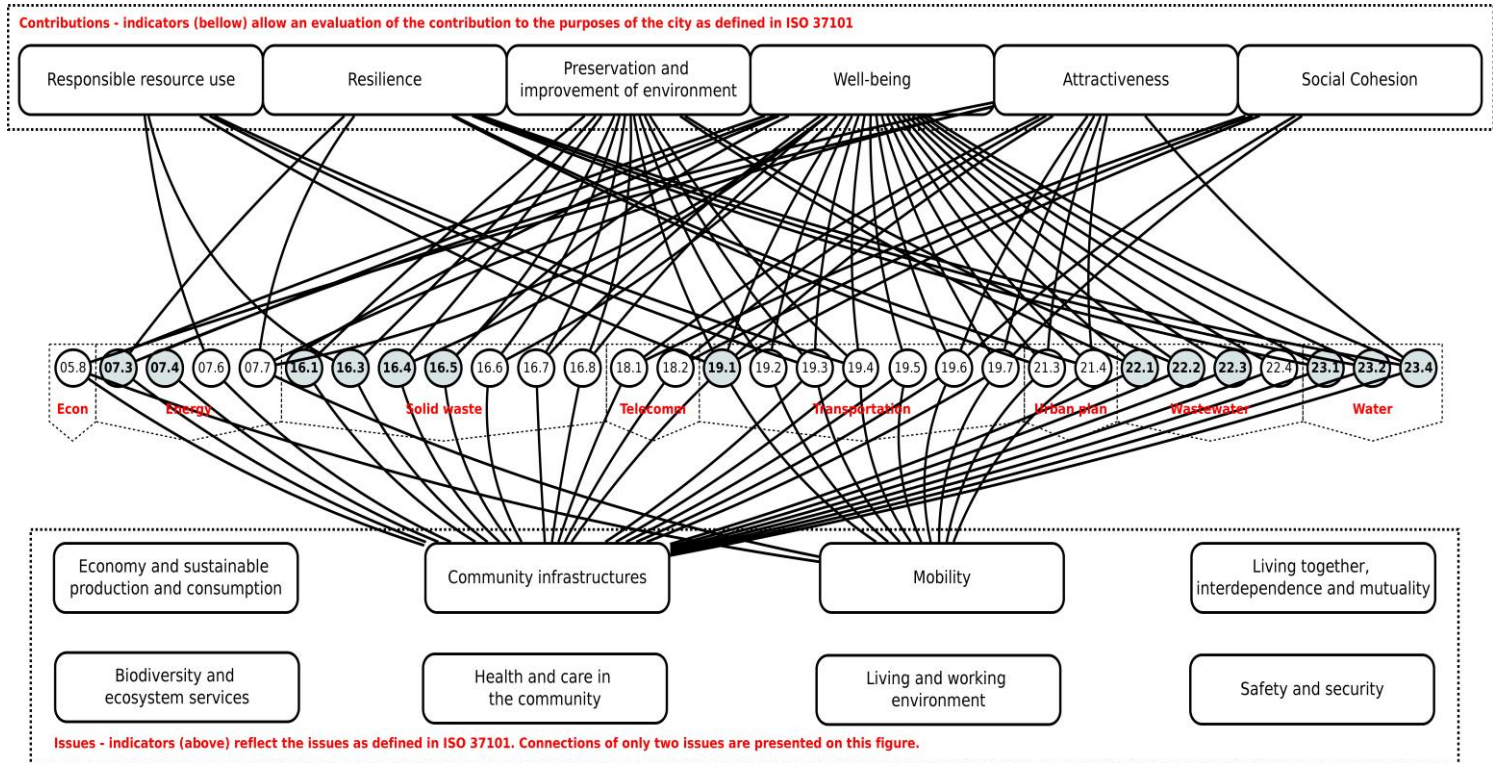
Source: Authors

Examples of purposes related to the issue of "Community infrastructure" are represented in Table 2, and purposes related to the point of "Mobility" are defined in Table 3.

Table 2. Examples of purposes related to the issue "Community infrastructure"

Attractiveness	How does the capacity and quality of infrastructures available in communities contribute to their attractiveness?
Preservation and improvement of environment	How do communities reduce the environmental impact of their infrastructures and of their use?
Resilience	How is the resilience of infrastructures evaluated? How is the impact of the environment on the infrastructure assessed?
Responsible resource use	How do communities ensure efficient use of natural resources and energy in the operation of their infrastructures, e.g., by implementing smarter solutions?
Social cohesion	How do communities ensure that infrastructures provide the same level of service for everyone?
Well-being	To what extent do the services provided by community infrastructures satisfy everyone? How can they be improved, particularly by making them smarter?

Source: Adapted based on ISO, 2016a

Table 3. Examples of purposes related to the issue "Mobility"

Attractiveness	How does investment in improved mobility show a return in terms of greater economic interaction, opening new contacts, diversifying local trade and contribute to the attractiveness of communities?
Preservation and improvement of environment	What steps are taken to reduce pollution (noise, air quality, greenhouse gas emissions throughout the associated life cycle) resulting from improved or increased mobility in communities?
Resilience	How is the resilience of mobility services evaluated? What plans and capabilities are in place to restore services in the event of a disaster or disruption?
Responsible resource use	How do communities develop and encourage sustainable mobility, e.g., by adopting a sustainable mobility policy?
Social cohesion	How does improved mobility bind communities together and increase shared experience?
Well-being	How do mobility conditions in communities enhance quality of life?

Source: Adapted based on ISO, 2016a

4.2. Indicators, connected with issues "Community infrastructures" and "Mobility"

Both two direct issues ("Community infrastructure" and "Mobility") define the core and supporting ISO 37120 indicators which belong to the following themes: "Economy", "Energy", "Solid waste", "Telecommunication", "Transportation", "Urban planning", "Wastewater" and "Water". Each theme has many indicators. In Table 4, some indicators are connected with the direct issue of "Community infrastructures", while in Table 5 are indicators associated with the immediate problem of "Mobility". In both tables, core indicators are boldfaced, while the supporting indicators are written in standard text.

Table 4. Indicators, connected with the direct issue "Community infrastructures"

ID	Theme	Indicator
05.8	Economy	Commercial air connectivity (number of non-stop commercial air destinations)
07.3	Energy	**Percentage of city population with authorized electrical service**
07.4	Energy	**Number of gas distribution service connections per 100 000 population (residential)**
07.6	Energy	Electricity consumption of public street lighting per kilometre of lighted street (kWh/year)
07.7	Energy	Average annual hours of electrical service interruptions per household
16.1	Solid waste	**Percentage of city population with regular solid waste collection (residential)**
16.3	Solid waste	**Percentage of the city's solid waste that is recycled**
16.4	Solid waste	**Percentage of the city's solid waste that is disposed of in a sanitary landfill**
16.5	Solid waste	**Percentage of the city's solid waste that is treated in energy- from-waste plants**
16.6	Solid waste	Percentage of the city's solid waste that is biologically treated and used as compost or biogas
16.7	Solid waste	Percentage of the city's solid waste that is disposed of in an open dump
16.8	Solid waste	Percentage of the city's solid waste that is disposed of by other means
18.1	Telecommunication	Number of internet connections per 100 000 population

ID	Theme	Indicator
18.2	Telecommunication	Number of mobile phone connections per 100 000 population
19.1	Transportation	**Kilometres of public transport system per 100 000 population**
19.3	Transportation	Percentage of commuters using a travel mode to work other than a personal vehicle
19.4	Transportation	Kilometres of bicycle paths and lanes per 100 000 population
19.5	Transportation	Transportation deaths per 100 000 population
19.6	Transportation	Percentage of population living within 0,5 km of public transit running at least every 20 min during peak periods
19.7	Transportation	Average commute time
22.1	Wastewater	**Percentage of city population served by wastewater collection**
22.2	Wastewater	**Percentage of city's wastewater receiving centralized treatment**
22.3	Wastewater	**Percentage of population with access to improved sanitation**
22.4	Wastewater	Compliance rate of wastewater treatment
23.1	Water	**Percentage of city population with potable water supply service**
23.2	Water	**Percentage of city population with sustainable access to an improved water source**
23.4	Water	**Compliance rate of drinking water quality**

Source: Own source

Table 5. Indicators, connected with the direct issue "Mobility"

ID	Theme	Indicator
05.8	Economy	Commercial air connectivity (number of non-stop commercial air destinations)
19.1	Transportation	**Kilometres of public transport system per 100 000 population**
19.2	Transportation	**Annual number of public transport trips per capita**
19.3	Transportation	Percentage of commuters using a travel mode to work other than a personal vehicle

ID	Theme	Indicator
19.4	Transportation	Kilometres of bicycle paths and lanes per 100 000 population
19.5	Transportation	Transportation deaths per 100 000 population
19.6	Transportation	Percentage of population living within 0,5 km of public transit running at least every 20 min during peak periods
19.7	Transportation	Average commute time
21.3	Urban planning	Jobs–housing ratio
21.4	Urban planning	Basic service proximity

Source: Own source

5. CONCLUSION

The popularity of technology innovations is causing a lot of noise in many industries. Amongst them, supply chains could be the ones that are impacted the most due to, as described in theory, intertwined networks of different stakeholders.

In a competitive and ever-challenging environment, we must plan today to be prepared for tomorrow. This mantra should be the core "business" idea of every city initiative and management operation. The planning, execution of ideas, and management of cities can be done based on theoretical knowledge presented to us in the form of ISO standards. As it had been explained in an example, standards are meant to be used in different environments for various purposes.

This paper has presented the example of standard ISO 37120 usage in connection with standard ISO 37101. Based on the covered indicators, themes, and issues, the direct issues were emphasized, "Community infrastructures" and "Mobility", extract their relationships with different indicators (which are directly corresponding to these two direct issues), and indicate their intertwinement with six contributions.

For future research, the same method can be used to emphasize other ten (out of twelve) existing issues, which are resented with the ISO standard, and indicate their connections with different indicators, contributions, and themes.

ISO standards present the international consensus on best practices in a wide range of areas, which contribute to the better functioning of a city and should be acknowledged as fundamental components of city management.

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