Towards Data Ecosystems in Smart Cities: Success Factors of Urban Data Spaces

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Abstract: In planning and designing public urban services, cities are increasingly relying on digital systems and data. Urban Data Spaces represent the data ecosystem of a city or region, bringing together municipalities, municipal companies, citizens, and businesses. They enable the development and management of data-driven services and aim to combat siloed data storage and usage. The main goal of this research paper is to examine the success factors for public sector stakeholders in creating and managing Urban Data Spaces. Using a multi-method approach (literature analysis, expert interviews, focus groups, and survey), we identified, validated, and quantified 23 success factors. The success factors were categorized into five dimensions: Platform Design, Platform Governance, Technical Platform Design, Platform Management Capabilities, and Stakeholder Involvement. Key findings are: A shared vision of an open and interoperable Urban Data Space, supported by a Life Cycle Management enables public management to benefit from data-driven services and become more sustainable. In addition, a cross-organizational data governance and strategy with a focus on the development of data competence and data quality management form the foundation of those Data Ecosystems. Based on the identified success factors, this article presents recommendations for scientists and practitioners.

1 INTRODUCTION

Planning and maintaining urban systems with a focus on the common good is described by (Taylor, 1998) as one of the historically essential goals of urban planning. In the context of technological development, cities and municipalities are pursuing the goal of becoming smarter and more connected (Albino et al., 2015) but also more liveable and sustainable (Creutzig et al., 2019; EIP-SCC, 2016).

By facilitating data-driven and innovative urban services, digital technologies can help cities' managers to address these challenges and achieve sustainable prosperity (Hamalainen, 2021). Data, according to (Charalabidis et al., 2022), hereby is a fundamental resource for the implementation of all government activities, from regulation to public service delivery. Municipal decision-makers believe that its systematic use would lead to a significant improvement in the quality of work and life, as well as to greater security and better policymaking (Schieferdecker et al., 2018). Innovation from data arises especially when data from different data sources and contextual data is combined and analysed. An intermodal mobility service, for example, requires timetable data from different modes of transport, movement data from many travellers and information about traffic jams, disruptions on railway lines or major events (Otto & Burmann, 2021). Urban Data Spaces, which represent the data ecosystem of a city or region (Barns, 2018), enable the development and operation of data-driven services by the municipality, municipal companies or third parties. In particular, Urban Data Spaces should avoid the current problem of often siloed data storage and use (Schlüter & Strelau, 2021), as well as enable data sovereignty and data privacy (Creutzig et al., 2019; Otto & Steinbuß, 2019; Tcholtchev et al., 2018). In contrast, the current handling of data is characterised by the fact that municipalities and municipal enterprises do not make sufficient use of their data sets; they are often neither combined with data from other providers nor made available for further use by third parties (Bagheri et al., 2021;

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Barns, 2018; Cuno et al., 2019). Efforts towards common data platforms and integrated urban services are thus needed (Creutzig et al., 2019).

Schieferdecker et al. (2018, p. 102) as well mention the need for "municipalities to share their knowledge across regions and internationally in order to learn from each other and benefit from the experiences of others" as well as the creation of best practices to provide orientation for municipalities.

The future of these ecosystems therefore depends on whether they are effectively planned, designed, and managed. Bagheri et al. (2021) developed corresponding success and value creation factors for Urban Data Spaces from the perspective of the platform providers and formulate the development of success factors for Urban Data Spaces from the perspective of the demand side, the municipalities, as an open research gap.

The objective of this paper is to identify the aspects that stakeholders, especially in public administration, regard as success factors for Urban Data Spaces. Their different technological, societal, and administrative dimensions will be discussed in the context of this study. Accordingly, the research questions (RQ) are:

- RQ1: *What factors influence the success of an Urban Data Space?*
- RQ2: *Which recommendations for action can be derived for public sector stakeholders?*

The structure of this paper is as follows: Firstly, relevant terms related to the topic will be explained to establish a common understanding. Next, the multimethod research approach will be introduced. The results of the study will then be presented and explained through the analysis of the research questions. In the discussion, the findings will be critically reflected upon and the need for further research will be identified.

2 THEORETICAL BACKGROUND

This section introduces and defines the key terms as they are used in this research. These are: *Smart City*, *Data Spaces*, *Urban Data Space*, and *Success Factor*.

Smart City defines a city based on an intelligent exchange of information between different subsystems of a city and the analysis, use and implementation of data in terms of services for citizens and businesses (Gartner, 2011). According to Albino et al. (2015), a smart city can be characterized by four aspects: (1) the *network infrastructure* of a city that enables politic al efficiency as well as social and cultural development; (2) the *business-led urban development* to promote urban growth; (3) the *social sustainability* in form of social inclusion of different city residents and social capital in urban development; (4) the *natural environment* as a strategic component for the future.

Data Space defines a level of abstraction that provides a collection of data sources, services and devices in one space (Franklin et al., 2005). These data sources and services may be physically distributed but are presented as a single entity through the data space, making it easier for users to access and use them, while data remains at their source. Based on this explanation, the EU initiative Gaia-X defines Data Spaces as a virtual data integration concept (GAIA-X, 2021). Otto (2022) also refers to this technological definition and specifically points out the current use of the term: According to him, the increasing use of the term in the business world has led to the Data Space being understood as a form of collaboration with data.

Urban Data Space is a special Data Space for a Smart City. Schieferdecker et al. (2018) refer to an Urban Data Space as one that contains the types of data that may be relevant to the municipal community, economy and policy space. Bagheri et al. (2021) refer to Urban Data Spaces as a subset of multi-sided digital platforms which enable the secure and trustworthy exchange of data between different user groups such as citizens, municipalities and businesses. Bagheri et al. (2021) refer to the added value of an Urban Data Space, which is supposed to come by fostering the ecosystem of cities in such a way that their (open) data (sources) are accessible to others. Therefore, the Urban Data Space is seen as an essential infrastructure for supporting data-driven innovative services and to implement smart city initiatives for a smart, sustainable and resilient city (Barns, 2018; Cuno et al., 2019).

Success Factor refers to a cause or condition that significantly contributes to the success or failure of a company or project in business administration and management research (Porter, 1998; Zhang and Li, 2010). Research on success factors is of great importance for companies and public sectors as it helps in developing strategies that increase the likelihood of success. In information systems, the term success factor refers to factors that influence the success of information systems and their use in companies (Fischer, 1993). Such factors may include employee acceptance, data quality, integration into business processes, and security and data protection measures. Identifying and considering these factors is

important to ensure that information systems are used effectively and efficiently and contribute to the success of the company. For our research, this means that functional requirements with a high priority are considered as success factors if they are crucial for the success of a system (e.g., Urban Data Space).

3 RESEARCH METHODOLOGY

Figure 1 illustrates our multi-method research approach to identify and validate the success factors for Urban Data Spaces. The methods (literature review, expert interview, focus group interviews, and survey) were conducted between November 2022 and March 2023.

In the *first step*, we conducted a literature review to identify the basic dimensions and requirements of Urban Data Spaces. We followed the approach suggested by vom Brocke et al. (2009) and analyzed the results according to Webster and Watson (2002). We used ACM Digital Library, Google Scholar, IEEE Xplore Digital Library, Science Direct, and Springer Link to identify relevant literature. We used the search term [("Smart City" OR "Smart Region") AND ("Data Space" OR "Data Platform") AND ("success factors" OR "requirements" OR "functions" OR "dimensions")] and analyzed the keywords and abstract of each article. We considered a total of 44 publications focused on data platforms and ecosystems in smart city contexts, as shown in Figure 1. From the results of the review, we derived a total of 17 requirements using a requirements elicitation process according to ISO/IEC/IEEE (2018) and categorized them into five dimensions according to Bagheri et al. (2021): Platform Vision, Platform Governance, Technical Platform Design, Platform Management Capabilities, and Stakeholder Involvement.

This categorization refers to Data Spaces as a whole, with a specific focus on urban spaces and the public sector. In comparison, Nagel et al. (2021) distinguish the "Building Blocks" only into "Technical" and "Governance".

In the *second step*, we conducted interviews with seven experts (Gläser & Laudel, 2010). The aim was to examine the requirements for the urban data infrastructure and prioritize the dimensions. The experts are responsible for the urban data infrastructure on a technological or strategic level in Darmstadt, Frankfurt, Hamburg, Leipzig, Ulm and Vienna. We used a semi-structured questionnaire with 21 questions and analyzed the answers using qualitative content analysis (Mayring, 2022). Each interview lasted approximately one hour and was conducted online. To participate, an Urban Data Space had to be in operation in the respective city. As a result, it was determined that the five dimensions were complete. The associated priority per dimension was determined using a five-point Likert scale (1 = lowest and 5 = highest priority) per expert and presented as an arithmetic mean in the form of a priority score (PS) in Table 1. We were also

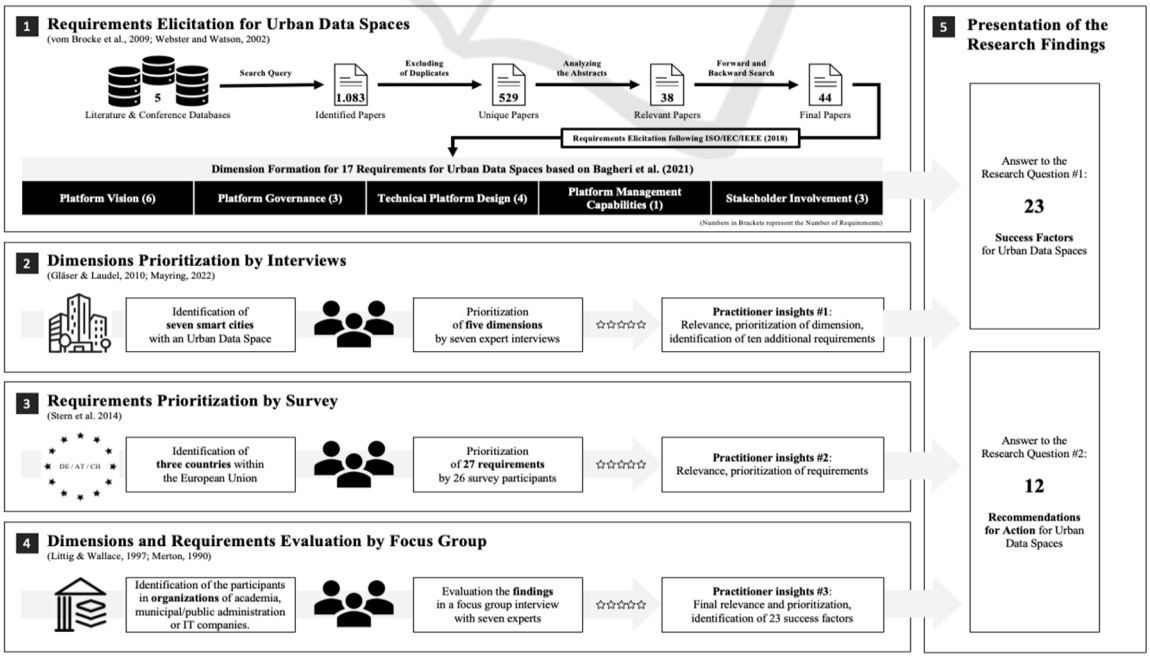

Figure 1: Overview of the Research Methodology.

able to identify ten additional requirements, so that we now have a total of 27 requirements.

In the *third step*, we conducted an online survey in Germany, Austria and Switzerland to determine the practical relevance and priority of the 27 requirements (Stern et al., 2014).

We specifically invited experts from the urban environment who are at different stages of implementing Urban Data Spaces. In total, 26 people participated in the survey, including 20 from public administration, three from urban IT services, and three from general IT consulting. The questionnaire consisted of 27 questions that corresponded to the requirements. Each requirement was rated using a five-point Likert scale (1 = lowest priority and 5 = highest priority). The result is the priority score (PS) per requirement as an arithmetic mean.

In the *fourth step*, a focus group interview was conducted with seven participants in order to evaluate and finally prioritize the results from steps 2 and 3 with regard to their practical relevance (Littig & Wallace, 1997; Merton, 1990). Participants work in municipal/public administration, academia, or IT companies and are responsible for topic areas related to technological and/or strategic issues in the context of urban data infrastructure. The focus group interview lasted 75 minutes and was conducted online. The evaluation revealed 23 success factors for Urban Data Spaces.

In the *fifth step*, the results were made available. In section 4, the 23 success factors according to RQ1 are presented in tables 2-6, structured according to the dimensions or in descending order according to the priority score (PS) determined, and then explained in text. In section 5, twelve recommendations for action according to RQ2 are drawn up based on the findings from research steps 1-4.

The bibliographic data of the 44 publications as well as the complete questionnaire of the expert interviews and survey are available from the authors upon request.

4 FINDINGS

This section presents the identified success factors in the context of Urban Data Spaces according to the research approach described in section 3.

The success factors are mapped to the five dimensions of Bagheri et al. (2021), which are listed in Table 1 in descending order of priority score (PS).

Table 1: Overview of Dimensions of Urban Data Spaces.

#	Dimension	PS
D.1	Platform Vision	4,2
D.2	Platform Governance	3,8
D.3	Technical Platform Design	3,6
D.4	Platform Management Capabilities	2,6
D.5	Stakeholder Involvement	2,2

To enable a better understanding of the ranking of the success factors, the corresponding dimension is explained briefly in each subsequent section. A table is then presented in each case with the associated success factors and their priority score by the experts. Each success factor is then explained in detail and backed up with the experts' opinions and experiences. The success factors are illustrated in the order of the priority score from highest to lowest. This is to ensure that special attention is paid to the most important success factors and that they are given appropriate consideration in the context of Urban Data Spaces.

In total, then, five dimensions and their associated success factors are explained and discussed in detail in the following sections. This should help to develop a comprehensive understanding of which factors are of particular importance in the implementation of Urban Data Spaces.

4.1 Platform Vision

The *Platform Vision* defines the purpose of a platform or ecosystem that is essential for attracting user groups (Bagheri et al., 2021; Schreieck et al., 2018). Table 2 lists the five success factors of the platform vision with priority score from the experts, which are explained below.

Table 2: Success Factors of Platform Vision.

#	Success Factor	PS
D.1.1	Sustainability	4,8
D.1.2	Provisioning of Citizen Services	4,4
D.1.3	Data-Driven Public Management	4,3
D.1.4	Economic Development	4,0
D.1.5	Social Impact	3,8

Sustainability (D.1.1) is a critical consideration for cities, and many municipalities are recognizing the potential of an Urban Data Space to help achieve sustainability goals. Some cities are even positioning themselves as "smart green cities," with municipal administrations taking a leading role in promoting ecological sustainability and climate resilience through various use cases, such as mobility and energy solutions. Additionally, it was suggested that using an Urban Data Space for energy management could lead to more sustainable and efficient use of

resources, reducing carbon emissions and promoting a greener urban environment.

Provisioning of Citizen Services (D.1.2) was claimed by experts to be provided better and more intelligent through Urban Data Spaces. Cities thereby would be able to improve citizen services in general and therewith involve citizens better in public decisions by also providing participation tools and methods as parts of an Urban Data Space.

Data-Driven Public Management (D.1.3) was identified as a success factor, with experts emphasizing the importance of offering and maintaining data-driven services and applications for internal administrative management purposes. A Business Intelligence Infrastructure and respective services were seen as driving acceptance and enabling holistic decision making within public administration. Urban use cases in the field of analytics were also highlighted as potential areas for improving cities' decision making. Examples of such use cases include route optimization for urban waste collection vehicles, measuring pedestrian frequencies to improve the location of citizen offices, forecasting the occupancy rate of schools, or energy management in buildings as part of a digital twin.

Economic Development (D.1.4) was considered a crucial factor for success, as per the experts. They suggested involving local businesses and start-ups in the ideation and development of use cases to improve the economic ecosystem of cities. In addition, the use of data-driven solutions and services could also attract new businesses and investment to the city, enhancing its economic competitiveness. Furthermore, a focus on sustainable economic development could be achieved through the development of innovative and environmentally friendly use cases within the Urban Data Space.

Social Impact (D.1.5) was identified as a further success factor regarding the Platform Vision of an Urban Data Space, particularly through the implementation of use cases in Healthcare or Energy Management. Experts stated that the use of an Urban Data Space can contribute to better health outcomes for citizens by providing data-driven insights into healthcare needs and identifying areas for improvement. For example, the European project "BigMedilytics" uses an Urban Data Space to develop innovative solutions for healthcare, such as personalized medicine and predictive analytics for disease prevention (Ruiz et al., 2018). Another example is the "Healthy New Towns" initiative in the UK, which uses an Urban Data Space to gather data on the health and well-being of residents in new housing developments (Watts et al., 2020). Overall, the use of an Urban Data Space in the healthcare sector has the potential to drive research and innovation, improve patient outcomes, and promote healthy living environments.

4.2 Platform Governance

The *Platform Governance* defines who makes the respective decisions in the urban data ecosystem and builds the necessary regulations (Bagheri et al., 2021). Table 3 lists the four success factors of the platform governance with priority score from the experts, which are explained below.

Table 3: Success Factors of Platform Governance.

#	Success Factor	PS
D.2.1	Unified Data Governance and Strategy	4,7
D.2.2	Openness, Transparency, Interoperability	4,6
D.2.3	Digital Sovereignty	4,4
D.2.4	Business and Operating Model	2,8

Unified Data Governance and Strategy (D.2.1) has been emphasized as a critical factor in building successful urban data ecosystems: As mentioned by the experts, Cities often rely on top-down, technically separated, line management approaches, resulting in data silos in separate departments. Due to this distribution of responsibilities and resources, a comprehensive organised data governance, as well as corresponding responsibility structures and a role management in dealing with data were deemed as particularly necessary. The internal IT as well as implementing departments and partners must be able to rely on them to guarantee data integrity, data quality and data excellence. Accordingly, the overarching development of a data strategy was mentioned as of particular importance to create a common goal and big picture. Additionally, elaborated data ethics concepts and automated data integration processes were considered as essential for efficient and long-term data provision.

Openness, Transparency, and Interoperability (D.2.2) as foundation principles regarding Urban Data Spaces were highlighted in various contexts and parts of this research as a success factor. Cities must rely on open and interoperable platforms and ecosystems to use standardized products, services, or interfaces. Data usage and publication must be transparent within Public Administration across different departments, to improve general data quality and quantity. Open licenses and open data use are particularly important and have proven to be a success factor in different cities. Publishing Open

Data and using Open-Source (Software)-Components are helping cities achieve these goals.

Digital Sovereignty (D.2.3) was considered a success factor, as municipalities and cities often reported problems in an increasing dependence on individual software or infrastructure providers, leading to dependency in service quality, financial aspects, and regulatory aspects, e.g., certain software providers not complying with specific privacy or security guidelines. Apart from so-called Vendor Lock-ins, those aspects can be drawn from the perspective of Data Ownership regulations developed by cities. Cities are able to combat those challenges through diversification in the used products, services and providers as well as through the use of Open-Source-Software.

Business and operating model (D.2.4) refers to cities needs of aligning their business and operating model to public management goals. Business models regarding urban data usage are rarely based on data monetization – as reported by the experts, no relevant positive experience has been made e.g., through Data Marketplaces. As stated in the research, until now those Urban Data Spaces often have been just seen as project-based, short term funded, work – city stakeholders reported that this often led to problems. An important success factor identified in regard to urban data business and operating models for cities is to see Urban Data Spaces as a municipal infrastructure task inside the city budget, with corresponding long term focused financial and operation plans.

4.3 Technical Platform Design

The *Technical Platform Design* describes the technical architecture and infrastructure behind Urban Data Spaces (Bagheri et al., 2021). Table 4 lists the five success factors of the technical platform Design with priority score from the experts, which are explained below.

Table 4: Success Factors of Technical Platform Design.

#	Success Factor	PS
D.3.1	Data Privacy	4,9
D.3.2	IT Security	4,8
D.3.3	Technical Competence	4,5
D.3.4	Data Analytics	4,4
D.3.5	Standardization and Scalability	3,9

Data Privacy (D.3.1) was identified as an important criterion. To ensure data privacy, experts highlighted the need to improve and specify the data sharing and release process and ensure high-quality data classification. Different technical departments are responsible for sharing and classifying data, such as personal or infrastructure data, which should not be released openly. Therefore, those specialized data owners must be trained in data privacy regulations. Additionally, data synthesis and anonymization are also crucial for cities to meet the challenges and requirements of data privacy. Experts viewed Data Privacy as a positive aspect rather than a restraint, as it would build citizens' confidence in their decision to participate in the Urban Data Space.

IT Security (D.3.2) was also identified as an important factor for cities to consider, as they often rely on external partners in this field. However, according to the experts, cities are increasingly appreciating the value of resilient infrastructure and services. Cross-city cooperation projects are being implemented to share resources and build up security audit levels regarding Urban Data Spaces.

Technical Competence (D.3.3) must be developed and expanded within the public administration. Cities must increase the technical competencies of their employees through new hires and training, especially in the areas of IT management, software development and data science. In addition, public IT service providers must also build up their technological competencies in their services and employees.

Data Analytics (D.3.4) was deemed a success factor as an additional layer to the current possibilities that cities often use today - providing data as open data on their website and only visualizing it. In addition to the above-mentioned factor (D.1.3), the use of internal data-driven applications in public management to foster digital processes or improve holistic decision-making is crucial. Analytics methods can also be used to improve citizen services, such as providing information dashboards.

Standardization and Scalability (D.3.5) activities are also described as an essential aspect. Cities should base their Urban Data Spaces on appropriate reference models and standardizations, e.g., DIN SPEC 91357, which is used by most cities in this research. This allows modularity of the systems and thus facilitates reproducibility and extensibility. Therefore, standardized APIs need to be created within the Urban Data Space and they should be provided in a stable and reliable way. In addition, a higher level of standardization in other areas, including data models and APIs, is also needed to enable extensibility and inter-municipal scalability. The use of standardization and related activities can ensure the development of efficient and reliable Urban Data Spaces.

4.4 Platform Management Capabilities

Platform Management Capabilities describe the

skills required to effectively manage and coordinate an Urban Data Space (Bagheri et al. 2021), including organizational change, new ways of working, change management processes, modernized procurement processes and laws, staff training, and establishing a data culture to ensure high-quality data. Table 5 lists the three success factors of the platform management capabilities with priority score from the experts, which are explained below.

Table 5: Success Factors of Platform Management Capabilities.

#	Success Factor	PS
D.4.1	Cross-organisational Cooperation and Collaboration	4,7
D.4.2	Data Quality Management	4,4
D.4.3	Life Cycle Management	4,3

Cross-organizational Cooperation and Collaboration (D.4.1) are of paramount importance in managing and nurturing an ecosystem. Therefore, the Urban Data Space must be given high priority in cities' organizational management and recognized at both operational and strategic levels, as mentioned by the experts, to increase usage and acceptance of the platform by different departments and promote its growth. Another factor in ecosystem nurturing was identified as having corresponding leadership within the organization that drives digital and data use like an evangelist or guru. This guru could be represented, for example, by a mayor or a Chief Information Officer.

Data Quality Management (D.4.2) was considered crucial because citizens must rely on the integrity and quality of data published by official public agencies. To support the responsible data owners in different departments, it is essential to develop appropriate data retrieval and updating guidelines that ensure regularity and high quality. In addition to this, having a central quality control mechanism for metadata and content-based control is also necessary to maintain the accuracy and consistency of data published in the Urban Data Space.

Life Cycle Management (D.4.3) refers to optimizing the entire lifespan of Urban Data Spaces. These spaces are considered a part of urban infrastructure and must have a corresponding Life Cycle Management, including a long-term operational concept, professional IT management, and appropriate financing models. Urban Data Spaces should be viewed as long-term infrastructural investments, as stated in D.2.4, rather than one-time funded projects. Experts have criticized that currently concepts of Urban Data Spaces fail in some cities because they are seen as one-time projects rather than being considered with the long-term focused Life Cycle Management mentioned.

4.5 Stakeholder Involvement

Stakeholder Involvement describes the extent to which an Urban Data Space enables collaboration, partnerships, and co-creation among different stakeholders (Bagheri et al., 2021). Table 6 lists the six success factors of the stakeholder involvement with priority score from the experts, which are explained below.

Table 6: Success Factors of Stakeholder Involvement.

#	Success Factor	PS
D.5.1	Boards and Committees	4,6
D.5.2	Inter-Municipal Cooperation	4,5
D.5.3	Citizen-Involvement	4,3
D.5.4	Political Stakeholders	4,2
D.5.5	Cooperation on different Government Levels	3,7
D.5.6	Joint further Development of the Urban Data Space	3,3

Boards and Committees (D.5.1) formed at inter-agency levels were deemed important in the success of Urban Data Spaces. Implementing them on strategic and regulatory levels, as well as working groups on operational levels involving different city stakeholders, were identified as a central success factor in involving stakeholders and bringing various advantages. These advantages including critical perspectives, increased acceptance in different city departments, and a joint enhancement of the platform ecosystem.

Inter-municipal Cooperation (D.5.2) and knowledge exchange, including sharing of applications and services, was identified as a key success factor for Urban Data Spaces. This includes efforts towards replicability, resource savings, and the recognition that "data does not end at city limits", with regional cooperation playing a critical role in achieving success according to experts.

Involving Citizens (D.5.3) was deemed a further success factor, for example through participation measures. Cities have had positive experiences with regular meetings to promote new platform features and gather feedback from citizen.

Political Stakeholders (D.5.4) play a crucial role in decision-making processes in a city and involving them is essential for the success of Urban Data Spaces. Their support can lead to greater acceptance of the platform ecosystem and better financial

backing, as important decisions are often made on this level.

Cooperation on different Government Levels (D.5.5) is viewed as important, even though municipalities bear the primary responsibilities in Urban Data Spaces. Collaboration at the state or European Union level allows for standardization efforts, replicability, and participation in financial support measures.

Joint further Development of the Urban Data Space (D.5.6) was deemed important to allow for participation from citizens, start-ups, scientific institutions, and businesses. Cities often seek cooperation to gather new ideas and implementations to further develop an Urban Data Space, through participation events like a Smart City Forum or dedicated hackathons. Civic developers are allowed to bring in their solutions and perspectives. Cities often provide the data for those events and have had positive experiences with both civic developers and start-ups providing their services and ideas. Experts mentioned that cities are often unable or unwilling to be solely responsible for the ideation and development of all use cases. Therefore, they value this form of civic involvement and participation, which leads to more and better applications and services as part of the Urban Data Space.

5 DISCUSSION

In this section, the results of the previous section are critically examined and reflected upon. In particular, the identified success factors for an Urban Data Space and their significance for public administration are addressed. Critical aspects such as data protection are also considered, and the importance of open and interoperable platform ecosystems as well as a suitable data governance structure are emphasized. The aim of this section is to place the results of the research in a broader context and to highlight further implications for the development and operation of Urban Data Spaces.

5.1 Opportunities and Challenges

Experts identify the platform vision as the highest priority for the Urban Data Space in public administration. Sustainability is considered a key success factor and includes environmental sustainability and climate resilience. The use of data-driven services and applications in public administration is important to increase the acceptance and quality of Urban Data Spaces and to provide better services for citizens. Openness, transparency and interoperability are other success factors, while business models to monetize data should not play a visible role.

However, there are also challenges. These include privacy concerns, vendor lock-in, the need for comprehensive organized data governance, specialized data owners, staff training, change management processes, financial sustainability, conflicts of interest, and ensuring equal participation of all stakeholders. This research suggests that the long-term sustainability and success of Urban Data Spaces will require significant organizational, financial, and managerial changes that could be challenging for cities. Therefore, cities need to carefully consider the long-term implications and resource requirements before embarking on urban data space projects. Other implementation challenges could include:

***Technical Difficulties*:** There could be technical issues that impact the performance and scalability of the platform. For example, this could be due to the complexity of the data, the size of the data sets, and the computing power required.

***Legal and Regulatory Issues*:** There could be legal issues affecting the use and management of the data, particularly with regard to data privacy and data security. Compliance with data privacy and security regulations is critical to the success of the platform.

***Lack of Support*:** there could be a lack of support from the city government and policy makers responsible for funding and operating the platform. Without the necessary support and resources, it will be difficult to successfully operate the platform.

***Difficulties in Collaboration*:** there might be difficulties in collaboration with other institutions and organizations responsible for providing and using data. Close collaboration and coordination between all stakeholders are essential for the success of the platform.

***Acceptance Problems*:** there could be problems with user acceptance of the platform. If the platform is not user-friendly or does not provide the expected benefits, it may not be used, which will affect the success of the platform.

5.2 Implications for Practice

Urban Data Spaces can play an important role in supporting urban development processes and improving the quality of life of citizens if the challenges associated with them are successfully addressed.

Our research has led to twelve recommendations that public sector stakeholders should consider when designing, implementing, and operating Urban Data Spaces. These recommendations consider the main findings of our research and differ from data spaces in an industrial context. The recommendations for action were derived from the expert interviews, survey and focus group (see figure 1 from step 2 to step 4) and are as follows:

1. A *shared vision* to achieve the goals of the Urban Data Space is necessary to promote user adoption.
2. The use of *data-driven tools and services* in public administration promotes holistic decision-making and leads to better services for citizens. Furthermore, those also lead to higher participation and acceptance inside different public administration departments.
3. A *cross-organizational data governance* structure and data strategy are the cornerstone of successful Urban Data Spaces.
4. *Openness, transparency and interoperability* are basic principles that enable standardization, flexible extensibility and modularity and reflect the Urban Data Ecosystem.
5. Ensure *digital sovereignty* to avoid lock-in to specific providers and continue to decide ownership of city and citizen data.
6. *Data protection* is essential for acceptance and trust and must be ensured, especially through strong European data protection regulations.
7. Cities and public IT infrastructure partners must develop their *technical and technological competencies*.
8. Public administration must become more *flexible and open* for the establishment and operation of successful Urban Data Spaces.
9. Consider Urban Data Spaces as a *long-term municipal infrastructure task* and not treat them as a one-off project concept.
10. Involve *civil society and start-ups* in the development of applications and services and in the development of new use cases.
11. *Inter-municipal collaboration* enables resource savings, exchange of ideas and experiences, as well as replication and sharing of applications and services.
12. *Evaluation and review* of the Urban Data Space are important to ensure success and effectiveness.

6 CONCLUSION

In conclusion, this research has examined the essential success factors for Urban Data Spaces and the challenges that cities face in creating and managing such platforms. The research has highlighted the importance of platform vision, platform governance, technical design, platform management capabilities, and stakeholder involvement for the successful development and sustainability of Urban Data Spaces.

By analyzing current literature and expert opinions, this study has identified key factors that can enable cities to create and manage effective Urban Data Spaces, which can support evidence-based decision-making, enhance citizen services, and promote sustainable urban development.

This final section summarizes the limitations of the work and provides recommendations for future research in the field of Urban Data Spaces.

6.1 Limitations

This research on the topic of success factors of Urban Data Spaces for public administration has some limitations that should be taken into account when interpreting the results.

First, the study was limited to the European region and thus the results cannot be easily transferred to other regions. In addition, the data was obtained from a limited number of expert interviews, which could limit the representativeness of the results. Furthermore, only the success factors of the specific Urban Data Space project were investigated and other aspects such as political, social or economic factors were not included. Finally, the limitations of the methods used for data collection and analysis were not explicitly discussed.

Therefore, it is advisable to look critically at the results of the study and future research should consider other aspects to gain a more comprehensive understanding of the success factors of Urban Data Spaces.

6.2 Future Research

Further future work could include a case study, based on a practical implementation of the given success factors in one selected city.

Additionally, in a practical context an evaluation of current solutions and concepts in cities contrasted to this success factors would be interesting. Resulting from this work, important functions and new success factors for Urban Data Spaces could then be included,

implemented and evaluated. This framework could then be expanded at an international level, and differences between regions could be further illuminated.

Moreover, there is the need to take a further look into the success factors. Each success factor could be presented and elaborated deeper. Therefore, e.g., the development of a Data Governance Structure would be important for city stakeholders and future research. Cities and future research must further ensure the security of urban data and infrastructure.

Additionally, examining the impact of emerging technologies such as artificial intelligence or further sustainability potentials on Urban Data Spaces could be an interesting avenue for future research.

REFERENCES

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *Journal of Urban Technology*, *22*(1), 3–21.

Bagheri, S., Brandt, T., Sheombar, H., & van Oosterhout, M. (2021). Value Creation through Urban Data Platforms: A Conceptual Framework.

Barns, S. (2018). Smart cities and urban data platforms: Designing interfaces for smart governance. *City, Culture and Society*, *12*, 5–12.

Charalabidis, Y., Flak, L. S., & Viale Pereira, G. (2022). *Scientific Foundations of Digital Governance and Transformation* (Vol. 38). Springer Wiesbaden.

Creutzig, F., Lohrey, S., Bai, X., Baklanov, A., Dawson, R., Dhakal, S., Lamb, W. F., McPhearson, T., Minx, J., Munoz, E., & Walsh, B. (2019). Upscaling urban data science for global climate solutions. *Global Sustainability*, *2*.

Cuno, S., Bruns, L., Tcholtchev, N., Lämmel, P., & Schieferdecker, I. (2019). Data Governance and Sovereignty in Urban Data Spaces Based on Standardized ICT Reference Architectures. *Data*, *4*(1), 16.

EIP-SCC. (2016). EIP-SCC Urban Platform Management Framework: Enabling cities to maximize value from city data. EIP-SCC.

Fischer, T. M. (1993). Kostenmanagement strategischer Erfolgsfaktoren: Instrumente zur operativen Steuerung der strategischen Schlüsselfaktoren Qualität, Flexibilität und Schnelligkeit. Vahlen.

Franklin, M., Halevy, A., & Maier, D. (2005). From databases to dataspaces. *ACM SIGMOD Record*, *34*(4), 27–33.

GAIA-X. (2021). Gaia-X Architecture Document - master Release. Gaia-X European Association for Data and Cloud AISBL. 21.12).

Gartner. (2011). Market Trends: Smart Cities Are the New Revenue Frontier for Technology Providers. Gartner .

Gläser, J., & Laudel, G. (2010). *Experteninterviews und qualitative Inhaltsanalyse als Instrumente rekonstruierender Untersuchungen*. VS, Verl. für Sozialwiss.

Hamalainen, M. (2021). Connected Smart Cities -- Urban Development with Dynamic Digital Twins. *AMCIS 2021 TREOs*.

ISO/IEC/IEEE. (2018). Systems and Software Engineering: Life Cycle Processes Requirements Engineering (ISO/IEC/IEEE 29148).

Littig, B., & Wallace, C. (1997). *Möglichkeiten und Grenzen von Fokus-Gruppendiskussionen für die sozialwissenschaftliche Forschung: Vol. Bd. 21*.

Mayring, P. (2022). *Qualitative Inhaltsanalyse.* Beltz, Weinheim.

Merton, R. K. (1990). *Focused interview* (2nd ed.). Free Press.

Nagel, L., Lycklama D. (2021). Design Principles for Data Spaces. International Data Space Association

Otto, B. (2022). The Evolution of Data Spaces. In B. Otto, M. ten Hompel, & S. Wrobel (Eds.), *Designing Data Spaces* (pp. 3–15). Springer Wiesbaden.

Otto, B., & Burmann, A. (2021). Europäische Dateninfrastrukturen. *Informatik Spektrum*, *44*(4), 283–291.

Otto, B., & Steinbuß, S. (2019). *IDS Reference Architecture Model 3.0*. International Data Spaces Association.

Porter, M. E. (1998) *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York.

Ruiz, E. M., Rodríguez-González, A., Martin, C. G., Zanin, M., ... & Nuñez, B. (2018). IASIS and BigMedilytics: Towards personalized medicine in Europe.

Schieferdecker, I., Bruns, L., Cuno, S., Flügge, M., Isakovic, K., Klessmann, J., Lämmel, P., Stadtkewitz, D., Tcholtchev, N., Lange, C., & et al. (2018). *Urbane Datenräume - Möglichkeiten von Datenaustausch und Zusammenarbeit im urbanen Raum*.

Schlüter, K., & Strelau, L. (2021). *Die Stadt der Zukunft mit Daten gestalten: Souveräne Städte -- nachhaltige Investitionen in Dateninfrastrukturen*.

Schreieck, M., Hein, A., Wiesche, M., & Krcmar, H. (2018). The Challenge of Governing Digital Platform Ecosystems. In *Digital Marketplaces Unleashed* (pp. 527–538). Springer Wiesbaden.

Stern, Michael J., Bilgen, Ipek & Dillman, Don A. (2014). The State of Survey Methodology: Challenges, Dilemmas, and New Frontiers in the Era of the Tailored Design. Field Methods 26(3):284 301

Taylor, N. (1998). *Urban planning theory since 1945* (Reprinted.). Sage.

Tcholtchev, N., Lammel, P., Scholz, R., Konitzer, W., & Schieferdecker, I. (2018). Enabling the Structuring, Enhancement and Creation of Urban ICT through the Extension of a Standardized Smart City Reference Model. Proceedings *of IEEE/ACM 2018*.

vom Brocke, J., Simons, A., Niehaves, B., Niehaves, B., Reimer, K., Plattfaut, R., and Cleven, A. (2009). Reconstructing the giant: On the importance of rigour in documenting the literature search process. *Proceedings of ECIS 2009*.

Webster, J., & Watson, R. (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. *MIS Quarterly*, *26*.

Watts, P., Rance, S., McGowan, V., Brown, H., Bambra, C., Findlay, G., & Harden, A. (2020). The long-term health and wellbeing impacts of Healthy New Towns (HNTs): protocol for a baseline and feasibility study of HNT demonstrator sites in England. *Pilot and Feasibility Studies*, 6, 1-13.

Zhang, H., & Li, J. (2010). Identifying key success factors for new product development in SMEs: A case study in a Chinese mechanical engineer company. *Journal of Manufacturing Technology Management,* 21(4), 449-469.