CITYAM empowers responsible urban air mobility

Deliverable of Activity 1.5 - **Setting up the evaluation framework**

Jaanus Müür

Tallinn University of Technology

15.01.2024

Summary

The current report is Deliverable 1.5, part of Activity 1.5 "*Setting up the evaluation framework*" under Work Package 1 in the CITYAM project funded by Interreg Baltic Sea Region (2023-2025). The work related to Activity 1.5 was carried out during the first year of the project. **The main part of Deliverable 1.5 consists of four societal embeddedness assessment questionnaires** that will be used to evaluate the impact of the CITYAM project in the context of drone adoption in six partner cities. The targets of the questionnaire in each partner city will be the project partners representing these municipalities (see more in Section 4).

The evaluation framework builds on top of the technology readiness assessment framework and distinguishes four levels of societal embeddedness (SEL) of a technology: SEL1 Exploration, SEL2 Development, SEL3 Demonstration, SEL4 Deployment. Societal embeddedness is assessed in each of the following four dimensions: *Environment*, *Stakeholder involvement*, *Policy & Regulations*, and *Market & Resources*. The societal embeddedness assessment framework and its questionnaire also function as a checklist of activities that a municipality should implement to ensure that the adoption of drones takes into account wider societal concerns.

The current report gives an overview of the process that led to choosing the societal readiness assessment framework for the project impact assessment, describes how the framework was modified so that it would meet the needs of the CITYAM project, and explains how the impact assessment will be carried out. The four questionnaires which are the main component of Deliverable 1.5 are added as annexes to this report.

1. Introduction

Urban air mobility (UAM) and the use of drones is a fast-developing industry. There are already some ongoing drone operations in European cities and municipalities such as inspections, mapping, and scanning. While technology and regulations advance, also the number and types of use cases increase: both commercial use cases as well as those owned by local authorities and their subsidiaries. The purpose of CITYAM is to prepare local authorities for an acceptable, responsible, and sustainable up-scaling of the use of UAM. The project brings together six cities across the Baltic Sea region for that purpose: Hamburg, Helsinki, and Stockholm as the lead cities and Gdansk, Riga, and Tartu as the replicator cities.

During the second year of the CITYAM project, in 2024, the three lead cities Hamburg, Helsinki, and Stockholm will run different use case pilots with drones and their landing sites. They will also test the public acceptance toolkit and the geospatial (GIS) tool for landing site planning that are developed as part of the CITYAM project (Activities 1.2 and 1.4 under WP1 respectively). During the project, the three replicator cities Gdansk, Riga, and Tartu will learn from the experiences of the lead cities. A replication plan for UAM will be developed for the three replicator cities under Activity 3.1 which covers the replication of the Landing Site Selection Tool, use cases and landing site infrastructure (paperwork exercise), UAM Public Acceptance Toolkit, and UAM Capacity building & policy/strategy development. The plan will be implemented as part of Activity 3.2.

The aim of Activity 1.5 has been to set up an evaluation framework that forms the basis for impact and process evaluation under Activity 2.5. More precisely, the aim of Activity 1.5 has been to suggest and develop a framework that can be used to assess the readiness of partner cities to adopt drones and the impact that the CITYAM project has had on these cities. The CITYAM partners agreed that the assessment of the drone flights as such is part of Activity 2.2 "*Piloting use cases and landing sites*" and will therefore be carried out in 2024 within that activity. The tool can also be used by other cities and municipalities interested in assessing their readiness to adopt drones.

The framework that has been chosen for this purpose is called the societal embeddedness assessment framework (Geerdink *et al*. 2020). This has been a deviation from the original plan to use the PESTEL framework as described in the project plan. The reasons for this are described in Section 2. The current report is divided into the following sections. Section 1 is an introduction and gives a brief overview of the project and Activity 1.5. Section 2 describes the SEL framework and explains why it was chosen. Section 3 focuses on what modifications were done in the framework so it would fit the needs of the CITYAM project and gives an overview of what this process looked like. Section 4 describes how exactly the framework will be used to assess the impact of the CITYAM project. The questionnaires that will be used for the assessment can be found at the end as annexes.

2. Overview of the Societal Embeddedness Assessment Framework

2.1. From technological readiness to societal readiness

New technological developments are seen by cities and municipalities around Europe as a key means to reach Smart City ambitions and achieve their carbon neutrality goals. In the current fast-developing world a growing number of technological solutions are under development. While some of the solutions have a rather limited target market (military, space), others try to access a wider consumer market. However, regarding both, there is a need to be able to estimate the readiness of end-users to use such innovative technologies.

Throughout the years a number of tools and frameworks have been developed and used to assess the maturity of different technologies. Probably the most well-known of such tools is the technology readiness levels (TRL) assessment framework which originally was adopted by NASA (Mankins 1995; Olechowski *et al*. 2015). TRLs enable consistent and uniform discussions of technical maturity across different types of technology. Throughout the years, the scale itself has gone through updates and it is now widely used by companies and government agencies active in different sectors (Olechowski *et al*. 2015).

However, it has been realised that in the context of technology adoption, it is not enough to focus only on technology readiness purely from the technical point of view. There are several examples of technological solutions in the world that have fully been developed but have faced difficulties or resistance in the adoption phase. The reasons for this can be environmental, legal, social, ethical or other. Different frameworks have been developed and used in practice to analyse technology readiness and challenges related to adoption from the perspective of these non-technical aspects. The next subsections will give an overview of some of these frameworks.

2.2. PESTEL

The first of such frameworks is PESTEL (or PESTLE) which focuses on **p**olitical, **e**conomic, **s**ocial, **t**echnological, **e**nvironmental, and **l**egal aspects. PESTEL was also initially planned to be the framework for conducting the impact and process evaluation of the CITYAM project and for evaluating the solutions and outputs. A number of academic publications have used PESTEL to analyse challenges and opportunities related to a specific economic sector (Mihailova 2020), technology (Do Thi *et al*. 2021; Kremer and Symmons 2015; Thomas *et al*. 2021) or both (Capobianco *et al*. 2021; Christodoulou and Cullinane 2019; Dalirazar and Sabzi 2023). The framework has also been used in some innovation projects to analyse challenges, opportunities, and impact. For example, PESTEL was used in the Sohjoa Baltic project funded by Interreg Baltic Sea Region to give an overview of challenges and opportunities related to running open road pilots with electric autonomous buses in the urban environment (Müür *et al*. 2020) as well as in the EU-funded project FABULOS on the similar topic of automated last-mile passenger transport (Rutanen *et al*. 2021).

However, it can also be argued that PESTEL itself is not actually a framework, but rather a categorisation tool that can be used for framing purposes in different types of analyses. It is the task of the person or group conducting the analysis to operationalise the PESTEL categories by filling them with specific measures and factors. This can be challenging. That is why many analyses using PESTEL are rather descriptive (e.g., Sohjoa Baltic and FABULOS reports) and therefore do not provide good grounds for impact analysis, or comparison (e.g., between cities) nor provide specific recommendations and suggestions for next steps. These are the reasons why in the CITYAM project the use of PESTEL was largely abandoned.

2.3. Attempts to operationalise PESTEL categories

After it was realised that PESTEL provides only categories for analysis, a search started for frameworks and tools that could be used to operationalise the PESTEL categories or that could be used as an off-the-shelf framework as a whole. The starting point was the TRL scale. The idea was to look for scales that would cover non-technical aspects important in the context of technology adoption which would complement the TRL scale.

Several such frameworks and scales were found. One of the most notable of these was from Bruno *et al*. (2020) who have suggested expanding TRL logic for assessing societal readiness level (SRL), organisational readiness level (ORL), and legal readiness level (LRL). As with the TRL scale, SRL, ORL, and LRL would also be assessed on a scale of 1-9. Vik *et al*. (2021) have proposed a similar idea which is called the balanced readiness level assessment (BRLa) framework that focuses on assessing TRL, market readiness level (MRL), regulatory readiness level (RRL), acceptance readiness level (ARL), and ORL.

The main issue with these frameworks is that they are rather descriptive, meaning that they do not come with assessment tools that could be used to actually assess and compare cities' readiness from the point of these different dimensions. That is why the next step was trying to find an assessment framework that actually does come with such assessment tools. The exception here was the societal readiness thinking tool proposed by Bernstein *et al*. which is meant for "*anticipating and reflecting on social and ethical dimensions of research and innovation processes*" (2022, 2). However, the framework is mostly meant for researchers to help them think about the social and ethical dimensions of their research and therefore too limited for the CITYAM project.

2.4. Societal embeddedness assessment framework

The search led to the societal embeddedness assessment framework that was originally developed during the DigiMon project which focused on carbon capture and storage solutions (Sprenkeling *et al*. 2022). It aimed to develop and demonstrate an affordable, flexible, societally embedded, and smart digital monitoring early warning system for any subsurface CO_2 storage field.

The project ran from January 2019 until December 2022 and was funded by the international initiative ACT, which was put up by governments and industry to establish CO_2 capture, utilisation, and storage as a tool to combat global warming. DigiMon was led by the research institute NORCE from Norway. The framework was developed by research institute TNO from the Netherlands. Based on the suggestion from TalTech, the CITYAM consortium decided during the consortium meeting in Tartu in June 2023 to use it for the assessment and evaluation framework.

2.4.1. Societal embeddedness assessment logic

The societal embeddedness of technology refers to how fixed or integrated is a technology into the societal context. The framework builds on top of the TRL assessment framework and distinguishes four levels of societal embeddedness (SEL) of a technology: SEL1 Exploration, SEL2 Development, SEL3 Demonstration, and SEL4 Deployment. Societal embeddedness is assessed in each of the following four dimensions: *Environment*, *Stakeholder involvement*, *Policy & Regulations*, and *Market & Resources*. Figure 1 from the original DigiMon Societal Embeddedness Assessment Guideline shows the connection between TRL and SEL.
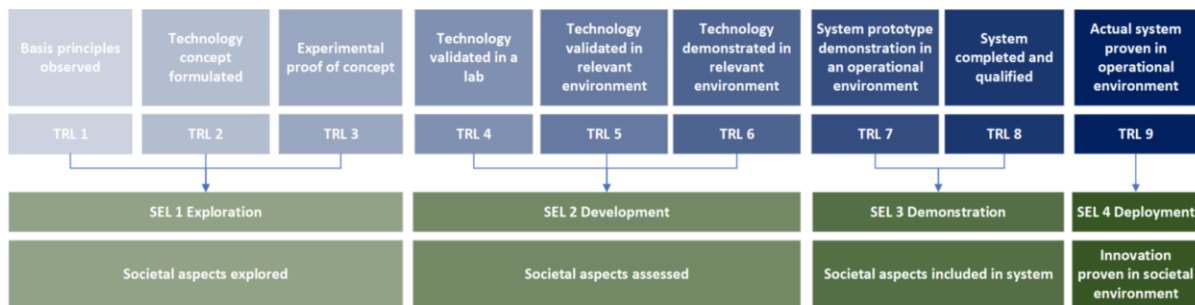
Figure 1 Connection between TRL and SEL. Source: Geerdink *et al*. (2020, 11).

The assessment of the societal embeddedness level is conducted for each of the four dimensions. However, the overall societal embeddedness level equals the level of the lowest dimensional one. This logic is based on the idea that in order to adopt a certain technology, issues under *all* the societal dimensions covered in the framework should get attention. For example, societal embeddedness assessment is conducted in the context of an unknown technology with the results as illustrated in Table 1. Based on this example, the overall SEL is at level 2 which equals the SEL of Environment and Stakeholder involvement dimensions.

	SEL1 Exploration	SEL2 Development	SEL3 Demonstration	SEL4 Ready for deployment
Dimension 1: Environment	All milestones reached	All milestones reached	Not all milestones reached	Not all milestones reached
Dimension 2: Stakeholder involvement	All milestones reached	All milestones reached	Not all milestones reached	Not all milestones reached
Dimension 3: Policy & Regulations	All milestones reached	All milestones reached	All milestones reached	Not all milestones reached
Dimension 4: Market and Resources	All milestones reached	All milestones reached	All milestones reached	All milestones reached

Table 1 Example of societal embeddedness assessment. Source: Based on Geerdink *et al.* (2020, 22).

Going into greater detail, each SEL dimension consists of various milestones which in turn consist of dichotomous YES/NO questions which help to determine whether the technological innovation has met a certain milestone (Figure 2). In practical terms, the questions ask whether the subject of the analysis - the CITYAM partner cities in this case - have carried out different activities that are important in the context of technology adoption (related to unmanned aerial vehicles, in the case of CITYAM) and whether certain readiness has been achieved. A milestone is reached if all the questions under it are answered positively. Similarly, a SEL is reached if all the milestones under it are reached (see Table 1 and Figure 2). It means that the questionnaire functions as a checklist of activities related to different dimensions that an organisation should carry out to adopt a particular technology in a socially responsible manner. Also, this ensures that the results of the CITYAM partner cities are easily comparable.

The original framework has a total of 74 milestones with 234 questions to assess the societal embeddedness of a technology: 26 milestones with 88 questions under the *Environment* dimension, 17 milestones with 50 questions under the *Stakeholder involvement* dimension, 16 milestones with 43 questions under the *Policy & Regulations* dimension, and 15 milestones with 53 questions under the *Market & Resources* dimension. This has, however, been adjusted for CITYAM purposes, as will be described in the following section.

Dimension: *Environment*

SEL1 Milestone 5
Potential impacts of drones used for services on the built and artificial environment are explored.

☐ Are potential impacts of drones used for services on buildings explored?

☒ Are potential impacts of drones used for services on airspace usage explored?

☐ Are potential impacts of drones used for services on infrastructure explored?

Milestone not reached as two questions about important steps related to adoption in the context of environment are not answered positively.
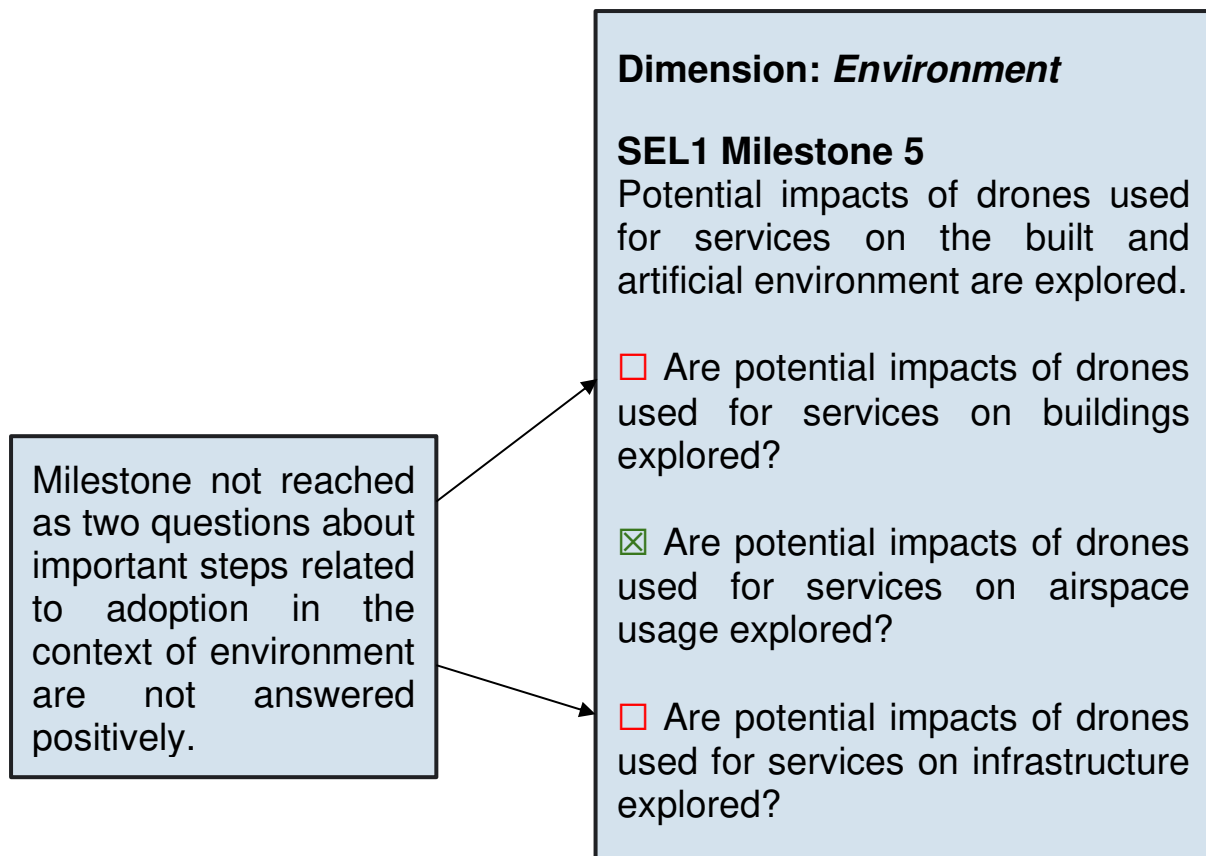
Figure 2 Example of a milestone not reached from the adjusted questionnaire focusing on the *Environment* dimension. Source: based on Geerdink *et al*. (2020, 23) and the author.

3. Adjusting societal embeddedness assessment framework for the CITYAM project

In order to adopt the societal embeddedness assessment framework for the evaluation of the CITYAM project's impact and the state of partner municipalities in terms of drone adoption, and provision of recommendations to the partner cities, several adjustments had to be made. These changes have been both structural and substantive. The following subsections give an overview of these changes.
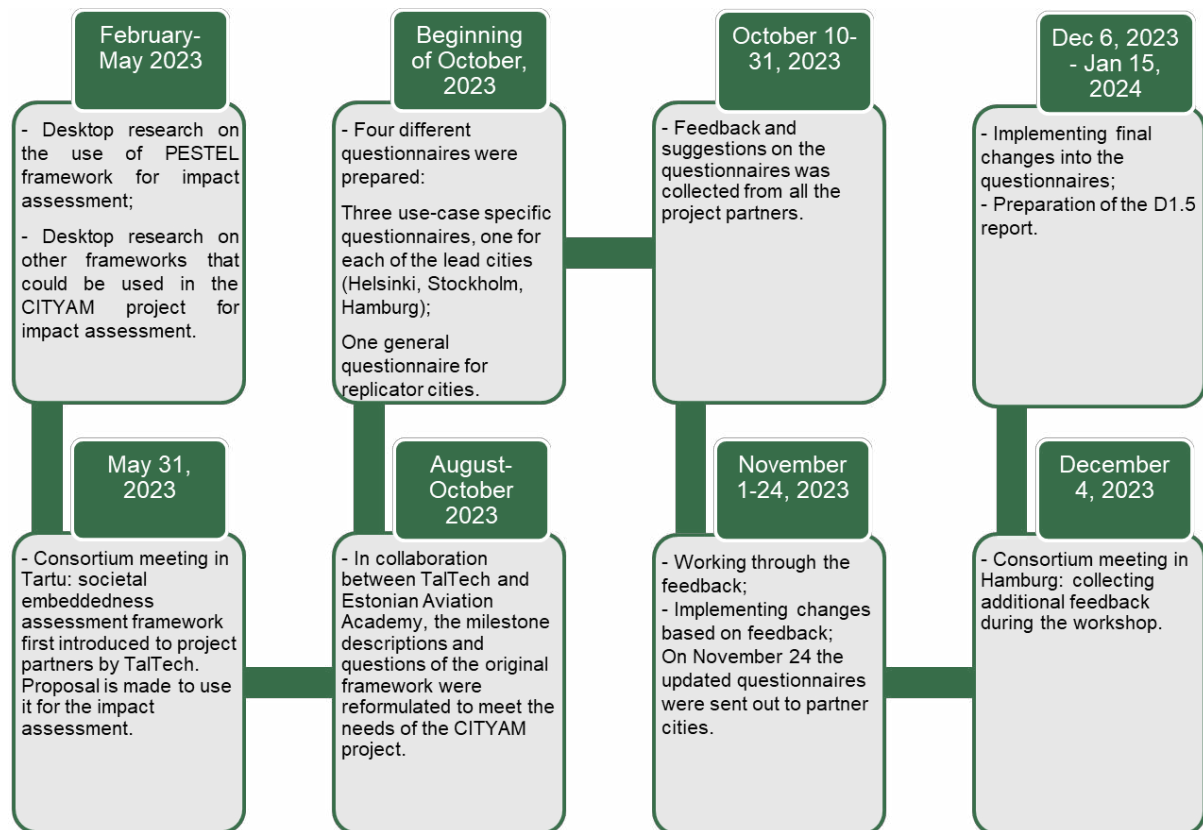

Figure 3 Timeline summarising activities related to Activity 1.5.

3.1. Structural changes in the questionnaire

The initial plan was to modify the original societal embeddedness assessment questionnaire by reformulating the milestone descriptions and questions so that they would be in the context of drones and meet the needs of the CITYAM project, but keep the original structural logic of the questionnaire. The latter meant the inclusion of all four dimensions into one questionnaire and not changing the sequence of milestones which in the original questionnaire was based on societal embeddedness levels. Following the initial plan, four different questionnaires were prepared. As it was already known which use cases the lead cities Hamburg, Helsinki, and Stockholm plan to pilot, a use case-specific questionnaire was prepared for each of them. More specifically, it meant that the milestone descriptions and

questions were reformulated by considering their specific use cases. As by that time it was not certain which use cases will the replicator cities pilot in the future, a separate and more general questionnaire was developed for them where the milestone descriptions and questions were still put into the context of drones, but they were not addressing specific use cases.

The first round of feedback brought several significant changes related to structure. First, it was decided to move forward only with the general questionnaire which originally was meant for replicator cities. Based on internal discussions it was realised that use case-specific questionnaires would mean that the assessment would only show the societal embeddedness in the context of these specific drone use cases and therefore not assess the overall UAM readiness level of a city. This would also make it hard to compare the results between all six partner cities and it would make it more difficult to scale the assessment beyond the project partners. Although it was not a structural change by itself, it paved the way towards structural changes described next.

The second big change was to divide the general questionnaire into four shorter ones, each focusing on one dimension. One of the main feedbacks was that not all the partner organisations have the necessary knowledge regarding all the dimensions that the framework covers. In addition, even if an organisation does have the knowledge to answer the questions under all four dimensions, it would take too much time. Shorter questionnaires that cover only one dimension enable to divide the task of responding to the questionnaires between different city units and organisations and also enable better time management.
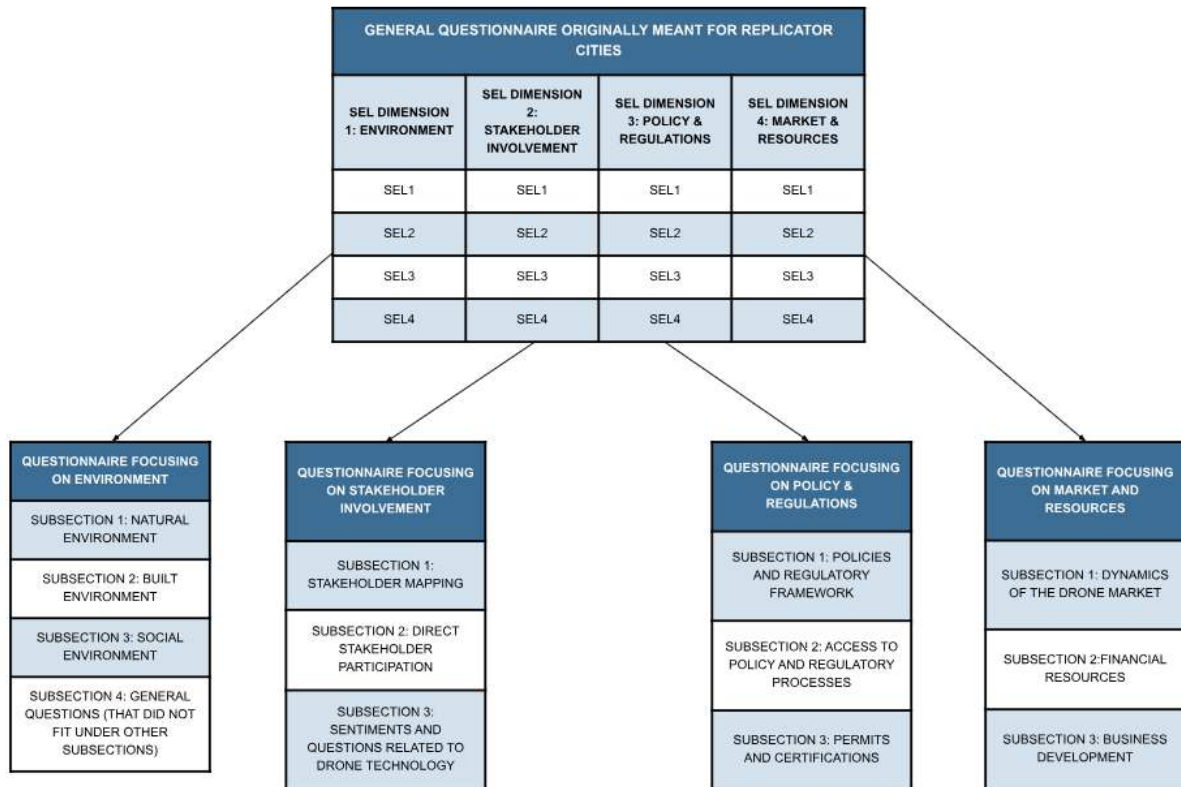
Figure 4 Structural changes in the societal embeddedness evaluation questionnaire.

The last major change was related to changing the sequence of milestones. As already mentioned, initially the sequence was based on societal embeddedness levels. However, in such a structure each level would touch several different topics. For example, each SEL under the *Environment* dimension would have several milestones and questions about natural, built and artificial, and social environments. Based on feedback from project partners, such a structure is confusing as a respondent must constantly switch between different topics. That is why the structure of the questionnaire has been changed in a way where milestones and questions focusing on the same or similar topics have been brought together under a single subsection of the questionnaire. This does not impact the final evaluation which is still carried out based on the original structure. However, it could enable us to more clearly identify which topics require greater attention from the cities in the context of adopting drones. The structural changes are illustrated in Figure 4.

Based on the feedback, another minor change was implemented related to milestones. In the questionnaire, the milestones under each dimension were numbered based on SEL and its sequence number under that SEL (e.g., SEL2 Milestone 3). Now the milestones are renamed as question blocks and based on their sequence in the questionnaire (e.g., Question block 1, Question block 2 *etc*).

3.2. Substantive changes: putting the assessment questionnaire into the context of drones

The milestone descriptions and questions in the survey of the original societal embeddedness assessment framework are formulated in a general way, meaning that they do not focus on any particular technology. Generally formulated milestone descriptions and questions could be used for the assessment if such an assessment would be carried out with the use of interviews. However, as the preference of the partner cities was to carry out the assessment via a survey, it became important to reformulate the milestone descriptions and questions to put them into the context of drones. This was done with most of the milestones and questions but not with all of them. The first round of reformulation of the milestone descriptions and questions was carried out between August and October 2023 with the help of CITYAM partner Estonian Aviation Academy.

Additional explanatory guidelines were also added to most of the milestones which should additionally help the respondents to think in the context of drones. Such guidelines were also added to milestones where the formulation of the milestone description and the questions did not require drone-specific changes. Table 2 brings out two examples of how milestones and questions were reformulated, and which guidelines were added.

There were also other important reasons why some milestone descriptions and questions required changes. Under the *Market & Resources* dimension, for example, some milestones and questions originally were rather suitable to be asked from the private sector - in CITYAM's case companies providing drone services. However, in the CITYAM project, the target group of the assessment are municipalities that are looking to adopt drones for purposes related to public services and tasks of different city departments or subsidiaries of public organisations active in the municipality and also want to be ready for the commercial spread of drones. Therefore, these milestones and questions in the questionnaire covering the *Market & Resources* dimension were refocused and are now targeting cities (question blocks 6 and 10 in the questionnaire).

Another such reason is the fact that in the original form of the questionnaire, several questions under the *Stakeholder involvement* dimension can be considered grey or ambiguous as they are formulated in a way that in practice does not enable clear YES or NO answers. These questions did not only require reformulation to put them into the context of drones but also reformulation so that it would be possible to clearly answer YES or NO them. The examples can be found in Table 3.

Regarding the answers, there was a request from the project partners to add ONGOING as a third answer option. The assessment of the societal embeddedness level is still based on YES/NO answers meaning that the value of answer option ONGOING equals answer option NO. However, this option helps to better distinguish between activities that are not addressed yet and activities that are not finished but are ongoing which is important for providing cities

the recommendations on the next steps that they should take based on the societal embeddedness assessment questionnaire. In addition, at the end of every subsection, there is an open answer box where additional information related to the topic of that subsection can be provided.

ORIGINAL VERSION	REFORMULATED VERSION
Environment dimension, SEL2 Milestone 5 Potential impacts of the system on the built environment are explored.	**Environment dimension, Question block 10 (SEL2 Milestone 5)** Potential impacts of the drone-based services' support systems on the built and artificial environment are explored. **Guidelines** Here the exploration of potential impacts refers to ex-ante analysis taking place before the pilot or adoption on what could be the potential impacts of the drone-based service's support system on the built and artificial environment. Focus on support systems necessary for drone-based services your city has thought of piloting.
1. Are the potential impacts of the system on buildings explored?	1. Are the potential impacts of the drone-based services' support systems on buildings explored?
2. Are the potential impacts of the system on spaces explored?	2. Are the potential impacts of the drone-based services' support systems on airspace usage explored?
3. Are the potential impacts of the system on infrastructure explored?	3. Are the potential impacts of the drone-based services' support systems on infrastructure explored?
Policy & Regulations dimension, SEL3 Milestone 4 The regulatory and policy framework supports the demonstration of the technology and its system.	**Policy & Regulations dimension, Question block 6 (SEL3 Milestone 4)** The regulatory and policy framework supports the demonstrations of drone-based services and their support systems. **Guidelines** Focus on drone-based services that your city is going to or has piloted. Available support schemes refer to EU, national, regional or local funding that can be used to organise drone demonstration pilots.
1. Is the policy and regulatory framework to support the demonstration of the technology and its system in place, either by law or by regulatory sandboxes?	1. Is the policy and regulatory framework to support the demonstrations of drone-based services and their support system in place, either by law or by regulatory sandboxes?
2. If necessary, are available support schemes used?	2. Are available regulatory, policy, and financial support schemes used to organise demonstration pilots?
3. Is innovation embedded in policy strategies (national, regional, local)?	3. Are drones embedded in policy strategies (national, regional, local)?

Table 2 Examples of how milestone descriptions and questions have been reformulated.

ORIGINAL VERSION	REFORMULATED VERSION
Stakeholder involvement dimension, SEL2 Milestone 3 Design of stakeholder participation tailored to the stage of development.	*Stakeholder involvement* dimension, **Question 6 block (SEL2 Milestone 3)** Design for stakeholder participation for drone-based services tailored to the stage of development. **Guidelines** Focus on drone-based services that your city has thought of piloting or is going to pilot.
4. Are all the stakeholders informed (taking along the process) at the moment that benefits them the most?	4. Are stakeholders informed on the development of drone-based service(s) at the moment they can influence the development process?
Stakeholder involvement dimension, SEL3 Milestone 3 Design for stakeholder participation tailored to the stage of demonstration of the technology and its system.	*Stakeholder involvement* dimension, **Question block 8 (SEL3 Milestone 3)** Design for stakeholder participation tailored to the stage of demonstration of drone-based services and their support systems. **Guidelines** Focus on drone-based services that your city is going to pilot.
4. Are all the stakeholders informed (taking along in the process) at the moment that benefits them the most?	4. Are stakeholders informed on the development of drone-based service(s) at the moment they can influence the development process?

Table 3 Examples of ambiguous questions and how they have been reformulated.

4. How the impact assessment will be carried out

As described in Subsection 2.4, the selected societal embeddedness assessment framework helps to find out the societal embeddedness level of a technology at the moment of assessment. To assess the impact of the CITYAM project in each of the six partner cities, it is planned to carry out two assessments by using the survey method. The first assessment will be carried out in the spring of 2024 before the lead cities start running their drone use case pilots. The second assessment will be carried out sometime after the pilots, most likely in spring 2025. The difference between the results of the two assessments should indicate the impact of the CITYAM project. This, in turn, will then be described in Deliverable 2.5 titled "Process and Impact Evaluation Report", which will be published in the last quarter of 2025. The assessment will also be carried out for replicator cities to see their progress during the CITYAM project.

The foreseen respondent(s) of the questionnaire in each partner city will be the project partners. However, if the staff members of partner organisations do not have all the knowledge related to a particular dimension, they need to include the right department, unit or organisation from their city. During the Activity 2.5 workshop that took place as part of the consortium meeting in Hamburg in December 2023, one of the tasks for the representatives of the project partners was to think which organisations in their city would be the most suitable to answer the four questionnaires.

TalTech, as the project partner responsible for both Activity 1.5 (during 2023) and Activity 2.5 (during 2024), will provide the necessary support and advice on this matter. An additional online seminar may be organised before the assessments take place. This could be especially crucial before the first assessment round to ensure a solid basis for further analysis and recommendations.

Even if the results show that in some dimension(s) a city remained at the same level (e.g., SEL1 in *Environment*), based on the logic of the framework it is still possible to identify more detailed progress at the level of individual milestones. The results would then be the basis for further recommendations for each of the partner cities. If necessary, interviews will be carried out to gather additional information and clarify the results of the surveys.

The societal embeddedness assessment framework that has been adjusted to meet the requirements of the CITYAM project will be publicly available. Any city or municipality that wishes to assess its current readiness to adopt drones and monitor their progress can use the framework for that purpose.

References

Bernstein, Michael J., Mathias Wullum Nielsen, Emil Alnor, André Brasil, Astrid Lykke Birkving, Tung Tung Chan, Erich Griessler, Stefan de Jong, Wouter van de Klippe, Ingeborg Meijer, Emad Yaghmaei, Peter Busch Nicolaisen, Mika Nieminen, Peter Novitzky, and Niels Mejlgaard (2022). The Societal Readiness Thinking Tool: A Practical Resource for Maturing the Societal Readiness of Research Projects. *Science and Engineering Ethics*, 28:6. https://doi.org/10.1007/s11948-021-00360-3

Bruno, Ilenia, Georges Lobo, Beatrice Valente Covino, Alessandro Donarelli, Valeria Marchetti, Anna Schiavone Panni, and Francesco Molinari (2020). Technology readiness revisited: a proposal for extending the scope of impact assessment of European public services. *Proceedings of the 13th International Conference on Theory and Practice of Electronic Governance (ICEGOV '20)*. Association for Computing Machinery, New York, NY, USA, 369–380. https://doi.org/10.1145/3428502.3428552

Capobianco, Nunzia, Vincenzo Basile, Francesca Loia, and Roberto Vona (2021). Toward a Sustainable Decommissioning of Offshore Platforms in the Oil and Gas Industry: A PESTLE Analysis. *Sustainability*, 13:11, 6266. https://doi.org/10.3390/su13116266

Christodoulou, Anastasia, and Kevin Cullinane (2019). Identifying the Main Opportunities and Challenges from the Implementation of a Port Energy Management System: A SWOT/PESTLE Analysis. *Sustainability*, 11:21, 6046. https://doi.org/10.3390/su11216046

Dalirazar, Sadaf and Zahra Sabzi (2023). Strategic analysis of barriers and solutions to development of sustainable buildings using PESTLE technique. *International Journal of Construction Management*, 23:1, 167-181. https://doi.org/10.1080/15623599.2020.1854931

Do Thi, Huyen Trang, Tibor Pasztor, Daniel Fozer, Flavio Manenti, and Andras Jozsef Toth (2021). Comparison of Desalination Technologies Using Renewable Energy Sources with Life Cycle, PESTLE, and Multi-Criteria Decision Analyses. *Water*, 13:21, 3023. https://doi.org/10.3390/w13213023

Geerdink, Tara, Marit Sprenkeling, Adriaan Slob, Hanneke Puts (2020). D3.1. Guideline Societal Embeddedness Assessment. Available: https://norceresearch.brage.unit.no/norceresearch-xmlui/bitstream/handle/11250/3063714/D3.1.%20Guideline%20Societal%20Embeddedness%20Assessment%20%281%29.pdf?sequence=1

Kremer, Paul D. and M. A. Symmons (2015). Mass timber construction as an alternative to concrete and steel in the Australia building industry: a PESTEL evaluation of the potential. *International Wood Products Journal*, 6:3, 138-147. https://doi.org/10.1179/2042645315Y.0000000010

Mankins, John C. (1995). Technology readiness levels. *White paper*, April 6, 1995. Available: https://aiaa.kavi.com/apps/group_public/download.php/2212/TRLs_MankinsPaper_1995.pdf

Mihailova, Mihaela (2020). The state of agriculture in Bulgaria – PESTLE analysis. *Bulgarian Journal of Agricultural Science*, 26:5, 935–943.

Müür, Jaanus, Eetu Rutanen, and Rebecca Ronke. 2020. "Starting Your Own Pilot – Sohjoa Baltic. The Roadmap to Automated Electric Shuttles in Public Transport." Publications of Metropolia UAS, OIVA-series 25. Available: https://urn.fi/URN:ISBN:978-952-328-246-9

Olechowski, Alison, Steven D. Eppinger, and Nitin Joglekar (2015). Technology readiness levels at 40: A study of state-of-the-art use, challenges, and opportunities. *2015 Portland International Conference on Management of Engineering and Technology (PICMET)*, Portland, OR, USA, 2084-2094. https://doi.org/10.1109/PICMET.2015.7273196

Rutanen, Eetu, Marika Koskinen, Eero Tuuliainen, and Oscar Nissin (2021). Policy paper: Deliverable 5.6 - Future application and impact of project results and learnings. *FABULOS project deliverable*. Available: https://drive.google.com/file/d/1sHQb-82jN7Az5i0j4LKzvdi0WUXVs6fF/view

Sprenkeling, Marit, Tara Geerdink, Adriaan Slob, and Amber Geurts (2022). Bridging Social and Technical Sciences: Introduction of the Societal Embeddedness Level. *Energies*, 15, 6252. https://doi.org/10.3390/en15176252

Thomas, Peter J.M., Philip Sandwell, Samuel J. Williamson, and Paul W. Harper (2021). A PESTLE analysis of solar home systems in refugee camps in Rwanda. *Renewable and Sustainable Energy Reviews*, 143, 110872. https://doi.org/10.1016/j.rser.2021.110872

Vik, Jostein, Anders Mahlum Melås, Egil Petter Stræte, and Roger Andre Søraa (2021). Balanced readiness level assessment (BRLa): A tool for exploring new and emerging technologies. *Technological Forecasting and Social Change*, 169, 120854. https://doi.org/10.1016/j.techfore.2021.120854

Annex 1 - Societal embeddedness assessment questionnaire for *Environment* dimension

The current questionnaire is one out of four questionnaires that are used in the CITYAM project to evaluate the project's impact on cities in the context of adopting drones by cities or other entities for public value purposes in urban environments. More specifically, the questionnaires evaluate societal embeddedness level (SEL) of your municipality based on four dimensions: *Environment*, *Stakeholder involvement*, *Policy & Regulations*, and *Market & Resources*.

This questionnaire focuses on the *Environment* dimension and evaluates the environmental readiness of your city to adopt drones. The questions are divided into subsections focusing on the natural environment, built and artificial environment, and social environment.

From the analysis perspective, the questions under these three subsections ask whether the three environments have been identified in the context of drones used for services and the necessary support system, has the municipality analysed the potential impact of drones used for services and their support systems on these environments and whether the impact analysis was carried out after the piloting the drone-based service(s). The questionnaire uses multiple-choice questions with three answer options: YES, NO, ONGOING. In addition, at the end of every subsection, there is an open box for leaving additional information related to that section.

The survey has separate questions on drones used for services and the support systems. **Support system** refers to other critical components and elements that enable the core technology (drone) to fulfil its function. In the context of drones and the CITYAM project, it can include access to electricity, charging stations, landing areas (e.g., vertiport), communication infrastructure etc that are required for drones to operate.

To answer the questions, we ask you to think in the context of drone-based service pilots that your city is planning to run as part of CITYAM and if possible other projects, or has already run.

Do not be afraid of answering "NO", even if it happens many times. The purpose of the questionnaire is not only to assess the current SEL but also to provide guidelines to cities on which topics and activities should get more attention to move forward with piloting and future adoption of drones. It is at this moment that many cities are starting to think about how drones could be adopted in the context of different services.

More information about the societal embeddedness framework can be found through this LINK.

SUBSECTION 1 – NATURAL ENVIRONMENT
Guidelines
Natural environment includes naturally occurring living and non-living things such as water areas, airspace, land areas, flora and fauna.

Question block 1 MILESTONE 1 SEL2
Identification of natural environments of the drone-based services' support systems.
Guidelines
Focus on natural environments that could be relevant for the support systems in the context of services your municipality has thought of piloting by using drones.
Are land areas identified that could be relevant or impacted in the context of the drone-based services' support systems (e.g., pollution, endangerment)?
Are airspaces identified that could be relevant or impacted in the context of the drone-based services' support systems?
Are water areas identified that could be relevant or impacted in the context of the drone-based services' support systems?

Question block 2 MILESTONE 4 SEL1
The potential impacts of flights of drones used for services on the natural environment are explored.
Guidelines
Here the exploration of potential impacts refers to ex-ante analysis taking place before the pilot or adoption on what could be the potential impacts of drone flights on the natural environment.
Focus on drone flights in the context of services your municipality has thought of piloting. Separate questions about the potential impacts of the support system are below.
Are the potential impacts of flights of drones used for services on land (including flora) explored?
Are the potential impacts of flights of drones used for services on air (e.g., pollution, noise) explored?
Are the potential impacts of flights of drones used for services on water explored?
Are the potential impacts of flights of drones used for services on animal life explored?

Question block 3 MILESTONE 4 SEL2
The potential impacts of the drone-based services' support systems on the natural environment are explored.
Guidelines
Here the exploration of potential impacts refers to ex-ante analysis taking place before the pilot or adoption on what could be the potential impacts of the drone-based services' support systems on the natural environment.
Focus on support systems necessary for drone-based services your municipality has thought of piloting.
Are the potential impacts of the drone-based services' support systems on land (including flora) explored?
Are the potential impacts of the drone-based services' support systems on air (e.g., pollution) explored?
Are the potential impacts of the drone-based services' support systems on water (e.g., pollution) explored?
Are the potential impacts of the drone-based services' support systems on animal life explored?

Question block 4 MILESTONE 7 SEL2

The actual impacts of flights of drones used for services on the natural environment are assessed.

Guidelines

Here the impact assessment refers to an analysis based on data gathered from the pilot to assess what impacts drone flights have on the natural environment. Such analysis can take place during the pilot or after (ex-post).

Focus on drone flights in the context of services your municipality has piloted. Separate questions about the actual impacts of the support system are below.

Are the impacts of flights of drones used for services on land (including flora) assessed?
Are the impacts of flights of drones used for services on air (e.g., pollution, noise) assessed?
Are the impacts of flights of drones used for services on water (e.g., pollution) assessed?
Are the impacts of flights of drones used for services on animal life assessed?

Question block 5 MILESTONE 1 SEL3

The actual impacts of the drone-based services' support systems on the natural environment are assessed.

Guidelines

Here the impact assessment refers to an analysis based on data gathered from the pilot to assess what impacts the drone-based services' support systems have on the natural environment. Such analysis can take place during the pilot or after (ex-post).

Focus here on support systems necessary for drone-based services your municipality has piloted.

Are the impacts of the drone-based services' support systems on land (including flora) assessed?
Are the impacts of the drone-based services' support systems on air (e.g., pollution, noise) assessed?
Are the impacts of the drone-based services' support systems on water (e.g., pollution) assessed?
Are the impacts of the drone-based services' support systems on animal life assessed?

Question block 6 MILESTONE 4 SEL3

The (possible) negative impacts of drones used for services and their support systems on the natural environment are mitigated to limit the (possible) harm caused.

Guidelines

This includes (possible) negative impacts that were predictable before the pilot and the ones that emerged during the pilot.

Are (possible) negative impacts of drones used for services and their support systems on land (including flora) mitigated?
Are (possible) negative impacts of drones used for services and their support systems on air mitigated?
Are (possible) negative impacts of drones used for services and their support systems on water mitigated?
Are (possible) negative impacts of drones used for services and their support systems on fauna mitigated?

Open block for additional explanations and information

Please add additional explanations and information regarding the work you have done on identifying, analysing, and preparing the natural environment in the context of the adoption of drones for public value purposes.

SUBSECTION 2 – BUILT AND ARTIFICIAL ENVIRONMENT

Guidelines

Built and artificial environment refers to the human-made environment that provides the setting for human activity (buildings, cities and beyond), for example, buildings and spaces that are created or modified by humans. Electric transmission lines and landfills (underground) are part of the built environment as well.

Although airspace is part of the natural environment, it is actively managed to ensure the safety of flights. This is done by dividing it into flight areas with different levels of restriction. Therefore, in the context of aviation and this survey, flight areas are considered as part of the artificial environment.

The questions under this subsection focus on buildings, flight areas and infrastructure. They are defined the following way:

- **buildings** refer to a construction work that has an interior space that is separated from the external environment by the roof and other parts of the building envelop;
- **flight areas** refer to non-restricted air spaces up to 120m in height (if not defined otherwise;
- **infrastructure** refers to facilities and systems that provide services necessary for the functioning of the economy, households, and firms. This includes powerlines, roads, communication towers etc.

Question block 7 MILESTONE 2 SEL1

Identification of built and artificial environments relevant to drones used for services.

Guidelines

Focus on built and artificial environments that could be relevant in the context of services your municipality has thought of piloting by using drones. Separate questions focusing on the support systems are below.

Are buildings relevant to drones used for services identified?
Are flight areas relevant to drones used for services identified?
Is infrastructure relevant to drones used for services identified?

Question block 8 MILESTONE 5 SEL1

The potential impacts of flights of drones used for services on the built and artificial environment are explored.

Guidelines

Here the exploration of potential impacts refers to ex-ante analysis taking place before the pilot or adoption on what could be the potential impacts of drone flights on the built and artificial environment.

Focus on drone flights in the context of services your municipality has thought of piloting. Separate questions about the potential impacts of the support system are below.

Are the potential impacts of flights of drones used for services on buildings explored?
Are the potential impacts of flights of drones used for services on airspace usage explored?
Are the potential impacts of flights of drones used for services on infrastructure explored?

Question block 9 MILESTONE 2 SEL2

Identification of built and artificial environments of the drone-based services' support systems.

Guidelines

Focus on built and artificial environments that could be relevant for the support systems in the context of services your municipality has thought of piloting by using drones.

Are buildings identified that could be relevant or impacted in the context of the drone-based services' support systems?
Are flight areas identified that could be relevant or impacted in the context of the drone-based services' support systems?
Is infrastructure identified that could be relevant or impacted in the context of the drone-based services' support systems?

Question block 10 MILESTONE 5 SEL2

The potential impacts of the drone-based services' support systems on the built and artificial environment are explored.

Guidelines

Here the exploration of potential impacts refers to ex-ante analysis taking place before the pilot or adoption on what could be the potential impacts of the drone-based services' support systems on the built and artificial environment.

Focus on support systems necessary for drone-based services your municipality has thought of piloting.

Are the potential impacts of the drone-based services' support systems on buildings explored?
Are the potential impacts of the drone-based services' support systems on airspace usage explored?
Are the potential impacts of the drone-based services' support systems on infrastructure explored?

Question block 11 MILESTONE 8 SEL2

The actual impacts of flights of drones used for services on the built and artificial environment are assessed.

Guidelines

Here the impact assessment refers to an analysis based on data gathered from the pilot to assess what impacts drone flights have on the built and artificial environment. Such analysis can take place during the pilot or after (ex-post).

Focus on drone flights in the context of services your municipality has piloted. Separate questions about the actual impacts of the support system are below.

Are the impacts of flights of drones used for services on buildings assessed?
Are the impacts of flights of drones used for services on airspace usage assessed?
Are the impacts of flights of drones used for services on infrastructure assessed?

Question block 12 MILESTONE 2 SEL3

The actual impacts of the drone-based services' support systems on the built and artificial environment are assessed.

Guidelines

Here the impact assessment refers to an analysis based on data gathered from the pilot to assess what impacts the drone-based services' support systems have on the built and artificial environment. Such analysis can take place during the pilot or after (ex-post).

Focus here on support systems necessary for drone-based services your municipality has piloted.

Are the impacts of the drone-based services' support systems on buildings assessed?
Are the impacts of the drone-based services' support systems on airspace usage assessed?
Are the impacts of the drone-based services' support systems on infrastructure assessed?

Question block 13 MILESTONE 5 SEL3
The (possible) negative impacts of drones used for services and their support systems on the built and artificial environment are mitigated to limit the (possible) harm caused.
Guidelines
This includes (possible) negative impacts that were predictable before the pilot and the ones that emerged during the pilot.
Are (possible) negative impacts of drones used for services and their support systems on buildings mitigated?
Are (possible) negative impacts of drones used for services and their support systems on airspace usage mitigated?
Are (possible) negative impacts of drones used for services and their support systems on infrastructure mitigated?
Open block for additional explanations and information
Please add additional explanations and information regarding the work you have done on identifying, analysing, and preparing the built and artificial environment in the context of the adoption of drones for public value purposes.
SUBSECTION 3 – SOCIAL ENVIRONMENT
Guidelines
The Social environment is the actual physical, social, and cultural context in which people live and interact. It also includes the institutions with whom citizens interact.
The questions under this subsection focus on social interactions, physical surroundings, institutions, and cultural milieus. They are defined the following way:
social interactions refer to interactions that take place between people that could be impacted by drones;
physical surroundings refer to built and natural surroundings where people live and interact;
institutions refer to public institutions such as schools, kindergartens, prisons, government areas etc that might be sensitive to drone usage;
cultural milieus refer to cultural and social context and meaning of physical surroundings where people live and interact. For example, a park in a municipality is a physical surrounding where people interact while its cultural milieu gives these interactions a meaning as usually they take place for reasons related to leisure time.
Question block 14 MILESTONE 3 SEL1
Identification of social environments relevant to drones used for services.
Guidelines
Focus on social environments that could be relevant in the context of services your municipality has thought of piloting by using drones. Separate questions focusing on the support systems are below.
Are social interactions identified that could be relevant or impacted in the context of drones used for services?
Are physical surroundings identified that could be relevant or impacted in the context of drones used for services?
Are institutions identified that could be relevant or impacted in the context of drones used for services?
Are cultural milieus identified that could be relevant or impacted in the context of drones used for services?

Question block 15 MILESTONE 6 SEL1

The potential impacts of flights of drones used for services on the social environment are explored.

Guidelines

Here the exploration of potential impacts refers to ex-ante analysis taking place before the pilot or adoption on what could be the potential impacts of drone flights on the social environment.

Focus on drone flights in the context of services your municipality has thought of piloting. Separate questions about the potential impacts of the support system are below.

Are the potential impacts of flights of drones used for services on social interactions explored?
Are the potential impacts of flights of drones used for services on physical surroundings explored?
Are the potential impacts of flights of drones used for services on institutions explored?
Are the potential impacts of flights of drones used for services on cultural milieus explored?

Question block 16 MILESTONE 3 SEL2

Identification of social environments of the drone-based services' support systems.

Guidelines

Focus on social environments that could be relevant for the support systems in the context of services your municipality has thought of piloting by using drones.

Are social interactions identified that could be relevant or impacted in the context of the drone-based services' support systems?
Are physical surroundings identified that could be relevant or impacted in the context of the drone-based services' support systems identified?
Are institutions identified that could be relevant or impacted in the context of the drone-based services' support systems?
Are cultural milieus identified that could be relevant or impacted in the context of the drone-based services' support systems?

Question block 17 MILESTONE 6 SEL2

The potential impacts of the drone-based services' support systems on the social environment are explored.

Guidelines

Here the exploration of potential impacts refers to ex-ante analysis taking place before the pilot or adoption on what could be the potential impacts of the drone-based services' support systems on the social environment.

Focus on support systems necessary for drone-based services your municipality has thought of piloting.

Are the potential impacts of the drone-based services' support systems on social interactions explored?
Are the potential impacts of the drone-based services' support systems on immediate physical surroundings explored?
Are the potential impacts of the drone-based services' support systems on institutions explored?
Are the potential impacts of the drone-based services' support systems on cultural milieus explored?

Question block 18 MILESTONE 9 SEL2
The actual impacts of flights of drones used for services on the social environment are assessed.
Guidelines
Here the impact assessment refers to an analysis based on data gathered from the pilot to assess what impacts drone flights have on the social environment. Such analysis can take place during the pilot or after (ex-post).
Focus on drone flights in the context of services your municipality has piloted. Separate questions about the actual impacts of the support system are below.
Are the impacts of flights of drones used for services on social interactions assessed?
Are the impacts of flights of drones used for services on immediate physical surroundings assessed?
Are the impacts of flights of drones used for services on institutions assessed?
Are the impacts of flights of drones used for services on cultural milieus assessed?
Question block 19 MILESTONE 3 SEL3
The actual impacts of the drone-based services' support systems on the social environment are assessed.
Guidelines
Here the impact assessment refers to an analysis based on data gathered from the pilot to assess what impacts the drone-based services' support systems have on the social environment. Such analysis can take place during the pilot or after (ex-post).
Focus here on support systems necessary for drone-based services your municipality has piloted.
Are the impacts of the drone-based services' support systems on social interactions assessed?
Are the impacts of the drone-based services' support systems on immediate physical surroundings assessed?
Are the impacts of the drone-based services' support systems on institutions assessed?
Are the impacts of the drone-based services' support systems on cultural milieus assessed?
Question block 20 MILESTONE 6 SEL3
The (possible) negative impacts of drones used for services and their support systems on the social environment are mitigated to limit the (possible) harm caused.
Guidelines
This includes the (possible) negative impacts that were predictable before the pilot and the ones that emerged during the pilot.
Are the (possible) negative impacts of drones used for services and their support systems on social interactions mitigated?
Are the (possible) negative impacts of drones used for services and their support systems on immediate physical surroundings mitigated?
Are the (possible) negative impacts of drones used for services and their support systems on institutions mitigated?
Are the (possible) negative impacts of drones used for services and their support systems on cultural milieus mitigated?
Open block for additional explanations and information
Please add additional explanations and information regarding the work you have done on identifying, analysing, and preparing the social environment in the context of the adoption of drones for public value purposes.
SUBSECTION 4 - GENERAL QUESTIONS

Here are general questions that did not fit under other subsections.
Question block 21 MILESTONE 1 SEL4   The (possible) negative impacts of drone-based services and their support systems that emerged from the demonstration phase are mitigated to limit their (possible) harm.
Are (possible) negative impacts on the natural environment which emerged from the demonstration phase sufficiently mitigated?
Are (possible) negative impacts on the built and artificial environment which emerged from the demonstration phase sufficiently mitigated?
Are (possible) negative impacts on the social environment which emerged from the demonstration phase sufficiently mitigated?
Open block for additional explanations and information   Here you can add additional information and explanations regarding the remaining general question under Subsection 4.

Annex 2 - Societal embeddedness assessment questionnaire for *Stakeholder involvement* dimension

The current questionnaire is one out of four questionnaires that are used in the CITYAM project to evaluate the project's impact on cities in the context of adopting drones by cities or other entities for public value purposes in urban environments. More specifically, the questionnaires evaluate the societal embeddedness level (SEL) of your municipality based on four dimensions: *Environment*, *Stakeholder involvement*, *Policy & Regulations*, and *Market & Resources*.

This questionnaire focuses on the *Stakeholder involvement* dimension and evaluates the readiness of your city to adopt drones from the perspective of stakeholder participation. The questions are divided into subsections focusing on stakeholder mapping, direct stakeholder participation, and sentiments and questions related to drone technology.

From the analysis perspective, the questions under these three subsections ask whether stakeholders that can have an impact on drone-based services and their support systems or be impacted by them are identified, are decisions made on stakeholder inclusion, and are their opinions identified and taken into account. The questionnaire uses multiple-choice questions with three answer options: YES, NO, ONGOING. In addition, at the end of every subsection, there is an open box for leaving additional information related to that section.

The survey has separate questions on drones used for services and the support systems. **Support system** refers to other critical components and elements that enable the core technology (drone) to fulfil its function. In the context of drones and the CITYAM project, it can include access to electricity, charging stations, landing areas (e.g., vertiport), communication infrastructure etc that are required for drones to operate.

To answer the questions, we ask you to think in the context of drone-based service pilots that your city is planning to run as part of CITYAM and if possible other projects, or has already run.

Do not be afraid of answering "NO", even if it happens many times. The purpose of the questionnaire is not only to assess the current SEL but also to provide guidelines to cities on which topics and activities should get more attention to move forward with piloting and future adoption of drones. It is at this moment that many cities are starting to think about how drones could be adopted in the context of different services.

More information about the societal embeddedness framework can be found through this LINK.

SUBSECTION 1 – STAKEHOLDER MAPPING   **Guidelines**   The questions under this subsection focus on the mapping of stakeholders in the context of drone-based services.
Question block 1   Inventory of stakeholders linked to drone-based services and their support systems your municipality has thought of piloting or is planning to pilot.   **Guidelines**   Map out the exact stakeholder organisations or their categories (e.g., "hospitals") if a specific organisation is not yet identified.   Think of organisations that could have a positive or negative impact on the demonstration and deployment of drone-based services and their support systems. Think also of organisations that could be impacted by the demonstration and deployment of drone-based services and their support systems.
Open answer
Question block 2 MILESTONE 1 SEL1   Basic inventory of stakeholders linked to drone-based services and their support systems.   **Guidelines**   Focus on drone-based services that your municipality has thought of piloting.   Basic inventory refers to an initial list of (most obvious) stakeholders or categories of stakeholders when the exact stakeholders of that category are not known yet that could have an impact on the service and its support system or be impacted by them.   For example, the organisers of the pilot could come to the conclusion that the pilot itself could most probably impact hospitals. However, as the exact pilot area is not known yet, the exact hospitals are also not known.
Are stakeholders who could be impacted by drone-based services and their support systems identified?
Are stakeholders who can have an impact on drone-based services and their support systems identified?
Question block 3 MILESTONE 1 SEL2   Inventory of all relevant stakeholders in the field of drone-based services.   **Guidelines**   Focus on drone-based services that your municipality has thought of piloting or is going to pilot.   Most of the stakeholders who can have an impact on the service or be impacted by it are known in detail. This does not include the support system (separate questions focusing on the support system below).   For example, while in the previous level, only the type of stakeholders was known such as hospitals, then now it is also known which exact stakeholders (e.g., specific hospitals that plan or are already using the service).
Are stakeholders who could be impacted by the drone-based services identified?
Are stakeholders who can have an impact on the drone-based services identified?
Question block 4 MILESTONE 5 SEL2   Inventory of all relevant stakeholders linked to drone-based services' support systems.   **Guidelines**

Focus on drone-based services that your municipality has thought of piloting or is going to pilot. Think about the providers and users of different elements that are part of support systems necessary for drone operations (e.g., hardware, software, services), direct and possible indirect stakeholders who can have an impact on the usage of these support system elements and who can be impacted by it.

Are stakeholders who could be impacted by the drone-based services' support systems identified?

Are stakeholders who can have an impact on the drone-based services' support systems identified?

Open block for additional explanations and information

Please add additional explanations and information regarding the work you have done on stakeholder mapping in the context of the adoption of drones for public value purposes.

SUBSECTION 2 – DIRECT STAKEHOLDER PARTICIPATION
Guidelines
The questions under this subsection focus on stakeholder involvement in the context of drone-based services.

Question block 5 MILESTONE 2 SEL2
Decision on the level of participation of the stakeholders in the development process of drone-based services.
Guidelines
Focus on drone-based services that your municipality has thought of piloting or is going to pilot.

Are stakeholders who are relevant to the development of drone-based services identified?

Is the best fitting participation level for every stakeholder determined?

Is the potential contribution of stakeholders to the development of drone-based services identified?

Question block 6 MILESTONE 3 SEL2
Design for stakeholder participation for drone-based services tailored to the stage of development.
Guidelines
Focus on drone-based services that your municipality has thought of piloting or is going to pilot.

Is stakeholder participation in the development phase arranged?

Are stakeholders that may have a positive impact on the drone-based services involved?

Are stakeholders that may have a negative impact on the drone-based services involved?

Are stakeholders informed on the development of drone-based service(s) at the moment they can influence the development process?

Question block 7 MILESTONE 2 SEL3
Decision on the level of participation of the stakeholders in the demonstration process of the drone-based services and their support systems.
Guidelines
Focus on drone-based services that your municipality is going to pilot.

Are stakeholders who are relevant for the demonstration of drone-based services identified?

Is the best fitting participation level for every stakeholder in the demonstration phase determined?

Is the potential contribution of stakeholders to the demonstration of the drone-based services identified?

Question block 8 MILESTONE 3 SEL3
Design for stakeholder participation tailored to the stage of demonstration of drone-based services and their support systems.
Guidelines

Focus on drone-based services that your municipality is going to pilot.
Is stakeholder participation in the demonstration phase arranged?
Are stakeholders who can have a positive impact on the demonstration involved?
Are stakeholders who can have a negative impact on the demonstration involved?
Are stakeholders informed on the demonstration of drone-based service(s) at the moment they can influence the demonstration process?
Question block 9 MILESTONE 1 SEL4 Decision on the level of participation of stakeholders in the deployment process of drone-based services and their support systems. **Guidelines** Focus on drone-based services that your municipality is planning to deploy.
Are stakeholders who are relevant to the deployment of drone-based services identified?
Is the best-fitting participation level for every stakeholder in the deployment phase determined?
Is the potential contribution of stakeholders to the deployment of drone-based services and their support systems identified?
Question block 10 MILESTONE 2 SEL4 Design for stakeholder participation tailored to the deployment stage of drone-based services and their support systems. **Guidelines** Focus on drone-based services that your municipality is planning to deploy.
Is stakeholder participation in the deployment phase arranged?
Are stakeholders who can have a positive impact on the deployment involved?
Are stakeholders who can have a negative impact on the deployment involved?
Are the majority of stakeholders informed on the deployment of drone-based service(s) at the moment they can influence the deployment process?
Question block 11 MILESTONE 4 SEL4 The relevant stakeholders are included in the deployment process of drone-based services and their support systems. **Guidelines** Focus on drone-based services that your municipality is planning to deploy.
Are stakeholders provided with information on the deployment of drone-based services and their support systems?
Are relevant stakeholders included in the deployment process of drone-based services and their support systems?
Is there a coordinated knowledge flow by the sector in place, to ensure the sharing of knowledge and experience between the implementers/organisations in the sector?
Are stakeholders taken along in the process from the moment they could be involved?
Open block for additional explanations and information Please add additional explanations and information regarding the work you have done on stakeholder participation in the context of the adoption of drones for public value purposes.
SUBSECTION 3 – SENTIMENTS AND QUESTIONS RELATED TO DRONE TECHNOLOGY **Guidelines** The questions under this subsection focus on societal attitudes towards novel drone technology.
Question block 12 MILESTONE 2 SEL1

Insight into the societal attitude towards novel technologies in the sectors where drones could be adopted.
Are sentiments and questions that stakeholders have had so far concerning innovations in this or related sectors identified?
Is the potential influence of (social) media on the knowledge, opinions, questions, and concerns of stakeholders regarding (the purpose of the) drones identified?
Question block 13 MILESTONE 4 SEL2 Sentiments and questions of relevant stakeholders regarding drone-based services are assessed and integrated into its development plan or strategy.
Are sentiments and questions of stakeholders regarding drone-based services which can hamper its further development assessed?
Is the influence of (social) media on the public, and stakeholders' perspective and attitude assessed?
Are actions for information providing, trust building and securing the cooperation of stakeholders and the public developed?
Question block 14 MILESTONE 6 SEL2 Identification of possible trust issues over drone-based services that are linked to drone technology and their support systems. **Guidelines** Focus on drone-based services that your municipality has thought of piloting, is going to pilot or has already piloted. The trust issues can be related to privacy, safety, security, service accessibility etc.
Are possible trust issues linked to drone-based services from a drone technology perspective identified?
Are possible trust issues linked to drone-based services' support systems identified?
Question block 15 MILESTONE 4 SEL3 Sentiments and questions of the majority of relevant stakeholders linked to demonstration site(s) of drone-based services and their support systems included in the project design/strategy for further development. **Guidelines** Focus on drone-based services that your municipality has thought of piloting, is going to pilot or has already piloted.
Are sentiments and questions of the majority of relevant stakeholders linked to demonstration site(s) taken into account and included in the project design/strategy for further development of the drone-based services and their support systems?
Is the influence of (social) media on the public and stakeholders' attitudes towards the drone-based services assessed and translated into the project design/strategy for further development of the services and their support systems?
Are the needs, concerns and values of the majority of relevant stakeholders taken into account and translated into the project design/strategy for further development of the drone-based services and their support systems?
Question block 16 MILESTONE 5 SEL3 Trust-building actions are taken for demonstrations of drone-based services and their support systems. **Guidelines**

Focus on drone-based services that your municipality is going to pilot or has already piloted. The difference between measures and actions is that the latter supports the former. For example, one of the trust-building measures could focus on building trust among the citizens living next to a landing site. This can be done through different actions such as public seminars, distribution of leaflets etc.
Are stakeholder expectations assessed?
Are necessary actions for information, trust building and securing the cooperation of stakeholders and the public on the demonstration site taken?
Are measures for information providing, trust-building, and securing the cooperation of stakeholders and the public on the demonstration site taken?
Are the majority of relevant stakeholders acknowledged in the impact they experience?
Question block 17 MILESTONE 3 SEL4 Deployment of drone-based services and their support systems are supported by a sufficient number of relevant stakeholders. **Guidelines** Focus on drone-based services that your municipality is planning to deploy.
Are compensation or other measures available to contribute to public support?
Are expectations of stakeholders and the public managed well?
Is (social) media strategy in place?
Open block for additional explanations and information Please add additional explanations and information regarding the work you have done on identifying and analysing sentiments, questions, and trust issues in the context of the adoption of drones for public value purposes.

Annex 3 - Societal embeddedness assessment questionnaire for *Policy & Regulations* dimension

The current questionnaire is one out of four questionnaires that are used in the CITYAM project to evaluate the project's impact on municipalities in the context of adopting drones by municipalities or other entities for public value purposes in urban environments. More specifically, the questionnaires evaluate the societal embeddedness level (SEL) of your municipality based on four dimensions: *Environment*, *Stakeholder involvement*, *Policy & Regulations*, and *Market & Resources*.

This questionnaire focuses on the *Policy & Regulations* dimension and evaluates the readiness of your municipality to adopt drones from the perspective of policies and regulations. The questions are divided into subsections focusing on policies and regulatory framework, access to policy and regulatory processes, and permits and certifications.

From the analysis perspective, the questions under these three subsections ask about the identification and assessment of existing policies and regulations, openness of the policy and regulatory processes, and availability of permits and certifications. The questionnaire uses multiple-choice questions with three answer options: YES, NO, ONGOING. In addition, at the end of every subsection, there is an open box for leaving additional information related to that section.

The survey has separate questions on drones used for services and the support systems. **Support system** refers to other critical components and elements that enable the core technology (drone) to fulfil its function. In the context of drones and the CITYAM project, it can include access to electricity, charging stations, landing areas (e.g., vertiport), communication infrastructure etc that are required for drones to operate.

To answer the questions, we ask you to think in the context of drone-based service pilots that your municipality is planning to run as part of CITYAM and if possible other projects or has already run.

Do not be afraid of answering "NO", even if it happens many times. The purpose of the questionnaire is not only to assess the current SEL, but also to provide guidelines to municipalities on which topics and activities should get more attention to move forward with piloting and future adoption of drones. It is at this moment that many cities are starting to think about how drones could be adopted in the context of different services.

More information about the societal embeddedness framework can be found through this LINK.

SUBSECTION 1 – POLICIES AND REGULATORY FRAMEWORK
Guidelines
The questions under this subsection aim to identify the current state regarding the identification and assessment of policies and regulations.

Question block 1 MILESTONE 1 SEL1
The current political climate and context are explored for drone technology.

Do you have an overview of the current political climate and context related to drone-based services?
Is there security of regulatory support and policy certainty regarding innovations in similar sectors?

Question block 2 MILESTONE 2 SEL1
Existing policies and regulatory framework related to drones identified.
Guidelines
Focus on drone-based services that your municipality has thought of piloting or is going to pilot.

Are possible relevant existing European, national, regional, and local policies and regulations for drones identified?
Is the way how European, national, regional, and local policies and regulations are interacting with each other identified?

Question block 3 MILESTONE 1 SEL2
Existing policies and regulatory framework for drone-based services assessed.
Guidelines
Focus on drone-based services that your municipality has thought of piloting or is going to pilot.

Are possible relevant existing European, national, regional, and local policies and regulations for drone-based services assessed?
Is the way how European, national, regional, and local policies and regulations are interacting with each other assessed?
Is it clear what is needed to embed drone technologies in policy strategies (national, regional, local)?

Question block 4 MILESTONE 2 SEL2
Policy and regulatory drivers and barriers are assessed for drone-based services.
Guidelines
Focus on drone-based services that your municipality has thought of piloting or is going to pilot.

Is there a regulatory push to develop and adopt drone-based services?
Are the policy and regulatory barriers assessed?
Are current policies sufficiently effective for further development of drone-based services?
Are needs for new policies and/or regulations assessed?

Question block 5 MILESTONE 3 SEL3
Policy and regulatory drivers and barriers are assessed for drone-based services' support systems.
Guidelines
Focus on drone-based services that your municipality has thought of piloting or is going to pilot.

Are the policy and regulatory barriers assessed?
Are needs for new policies and/or regulations assessed?
Is there a way to avoid potential regulatory barriers regarding drone-based services' support systems?

Question block 6 MILESTONE 4 SEL3
Regulatory and policy framework supports the demonstrations of drone-based services and their support systems.
Guidelines
Focus on drone-based services that your municipality is going to or has piloted.
Available support schemes refer to EU, national, regional, or local funding that can be used to organise drone demonstration pilots.
Is the policy and regulatory framework to support the demonstrations of drone-based services and their support system in place, either by law or by regulatory sandboxes?
Are available regulatory, policy, and financial support schemes used to organise demonstration pilots?
Are drones embedded in policy strategies (national, regional, local)?
Question block 7 MILESTONE 1 SEL4
Regulatory barriers are overcome for drone-based services and their support systems.
Guidelines
Focus on drone-based services that your municipality has piloted and/or is planning to deploy.
Is there the ability to pass legislation (or reduce resistance)?
Are regulatory barriers dealt with accordingly?
Question block 8 MILESTONE 2 SEL4
Supporting policies, laws, and regulations are in place for drone-based services and their support systems.
Guidelines
Focus on drone-based services that your municipality is planning to deploy.
Are required adjustments made to regulations, e.g., new regulations in place?
Do drone-based services and their support systems work in a legal sense as part of laws and regulations, standards, protocols, and professional codes?
Are supportive policies and regulations in place for the deployment of drone-based services and their support systems?
Question block 9 MILESTONE 4 SEL4
(Inter)national policy and regulatory framework supports deployment of drone technology and its support system.
Guidelines
Focus on drone-based services that your municipality is planning to deploy.
Available support schemes refer to EU, national, regional, or local funding that can be used to support the deployment of drones.
Is the national policy and regulatory framework to support the deployment of drone technology and its support system in place?
Is the international policy and regulatory framework to support the deployment of drone technology and its support system in place?
Are available regulatory, policy, and financial support schemes used for deployment?
Are drones embedded in policy strategies (national, regional, local)?
Open block for additional explanations and information
Please add additional explanations and information regarding the current state of policies and regulatory framework.

SUBSECTION 2 – ACCESS TO POLICY AND REGULATORY PROCESSES

Guidelines

The questions under this subsection focus on the accessibility of policy and regulatory processes.

Question block 10 MILESTONE 3 SEL1

Access to regulatory processes relevant in the context of drone-based services.

Do you know which jurisdiction levels/governments are relevant in the context of drone-based services?

Are necessary contacts made with relevant jurisdictions/governments?

Question block 11 MILESTONE 4 SEL1

First interactions between developers and governments to create support for drone technology.

Guidelines

The key support system element is an element necessary for the service provision but is currently missing or under development.

Are contacts established to enable collaboration with and between different departments/governments on all relevant levels for the development of key support system elements?

Question block 12 MILESTONE 4 SEL2

Interactions between developers and governments to secure support for drone technology development is underway.

Guidelines

The key support system element is an element necessary for the service provision but is currently missing or under development.

Is collaboration with and between different departments/governments established on all relevant levels for the key support system element?

Is there professional lobbying through (newly established) platforms and existing interest groups in place for the key support system element?

Question block 13 MILESTONE 2 SEL3

Interactions between developers and governments are in an advanced stage and have secured support for the demonstration of drone-based services and their support systems.

Guidelines

Focus on drone-based services that your municipality is planning to pilot or has already piloted.

Is support for demonstrations of drone-based services and their support systems secured through collaboration with and between different departments/governments?

Is there professional lobbying through newly established platforms and existing interest groups in place for the drone-based services' support systems?

Open block for additional explanations and information

Please add additional explanations and information regarding access to policy and regulatory processes.

SUBSECTION 3 – PERMITS AND CERTIFICATIONS

Guidelines

In the context of drones, think of permits and certificates that are required to operate the drones. These include permits and certificates directly linked to drones (flight permits, certification of operators) but also the ones that are required to provide specific services.

In the context of support systems, these can include permits to construct, install and operate elements of the support system that are necessary for drone-based service and certificates that these elements must have.

Question block 14 MILESTONE 3 SEL2

Certification and permit requirements for drone-based services are assessed.

Guidelines

Focus on drone-based services that your municipality has thought of piloting or is going to pilot. Focus only on certifications and permits directly related to services and not their support system (separate questions below).

Are requirements for permits assessed for drone-based services?
Are requirements for certificates assessed for drone-based services?

Question block 15 MILESTONE 1 SEL3

Certification and permit requirements for drone-based services' support systems are assessed.

Guidelines

Focus on drone-based services that your municipality has thought of piloting or is going to pilot.

Are requirements for permits assessed for drone-based services' support systems?
Are requirements for certificates assessed for drone-based services' support systems?

Question block 16 MILESTONE 3 SEL4

Required permits and/or certificates for the deployment of drone-based services and their support systems are awarded.

Are conditions for obtaining the required permits identified?
Are required permits obtained?
Are conditions for obtaining the required certificates identified?
Are required certificates obtained?

Open block for additional explanations and information

Please add additional explanations and information regarding permits and certifications in the context of the adoption of drones for public value purposes.

Annex 4 - Societal embeddedness assessment questionnaire for *Market & Resources* dimension

The current questionnaire is one out of four questionnaires that are used in the CITYAM project to evaluate the project's impact on municipalities in the context of adopting drones by municipalities or other entities for public value purposes in urban environments. More specifically, the questionnaires evaluate the societal embeddedness level (SEL) of your municipality based on four dimensions: *Environment*, *Stakeholder involvement*, *Policy & Regulations*, and *Market & Resources*.

This questionnaire focuses on the *Market & Resources* dimension and evaluates the readiness of your municipality to adopt drones from the perspective of market readiness and availability of resources. The questions are divided into subsections focusing on the dynamics of the drone market, financial resources, and business development.

From the analysis perspective, the questions under these three subsections ask about identifying and assessing users, suppliers, and market prices; financial resources necessary for piloting and deployment; and business development.

The questionnaire uses multiple-choice questions with three answer options: YES, NO, ONGOING. In addition, at the end of every subsection, there is an open box for leaving additional information related to that section.

The survey has separate questions on drones used for services and the support systems. **Support system** refers to other critical components and elements that enable the core technology (drone) to fulfil its function. In the context of drones and the CITYAM project, it can include access to electricity, charging stations, landing areas (e.g., vertiport), communication infrastructure etc that are required for drones to operate.

To answer the questions, we ask you to think in the context of drone-based service pilots that your municipality is planning to run as part of CITYAM and if possible other projects or has already run.

Do not be afraid of answering "NO", even if it happens many times. The purpose of the questionnaire is not only to assess the current SEL, but also to provide guidelines to municipalities on which topics and activities should get more attention to move forward with piloting and future adoption of drones. It is at this moment that many municipalities are starting to think about how drones could be adopted in the context of different services.

More information about the societal embeddedness framework can be found through this LINK.

SUBSECTION 1 – DYNAMICS OF THE DRONE MARKET

Guidelines

The questions under this subsection focus on users, suppliers, and market prices. They are defined in the following way:

- In the context of the CITYAM project, **users** mostly refer to different organisations in the municipality's administrative system that could use drones for service provision. It can also include organisations located in the municipality but not part of the municipality's administrative system that can use drones for the provision of (critical) services for public value purposes;
- **suppliers** refer to companies that develop and/or provide drones;
- **market** prices refer to the prices of drones.

Question block 1 MILESTONE 2 SEL1

Current needs for drones, their potential users, suppliers, and market prices are identified.

Guidelines

Focus on tasks or (public) services that your municipality looks to improve, possibly with drone-based substitutes.

Are the organisations, units or departments identified that could use drones in their everyday work or could use drones to provide (public) services?
Are drone-based substitutes to current means of carrying out certain tasks or providing (public) services identified?
Are potential suppliers of drones suitable for service provision in urban environments identified?
Are current market prices of drones identified?

Question block 2 MILESTONE 2 SEL2

Current needs for drones, their potential users, suppliers, and market prices are assessed.

Guidelines

Focus on drone-based services that your municipality has thought of piloting.

Question 1 aims to find out whether you now have assessed the different ways how each potential user could use drones in their everyday operations.

Question 4 aims to find out whether you have assessed the previously identified suppliers from the perspective of the functionality of their drones, prices, supply timeline, origin, or any other perspective important for your municipality.

Are the organisations, units or departments that could use drones in their everyday work or could use drones to provide (public) services assessed?
Are their actual needs for drones assessed?
Are drone-based substitutes to current means of carrying out certain tasks or providing (public) services assessed?
Are potential suppliers of drones suitable for service provision in urban environments assessed?
Are current market prices of drones assessed?
Is the contribution of organisations, units, or departments in the development of drone-based services assessed?

Question block 3 MILESTONE 2 SEL4

Market ready for the adoption of drone-based services.

Guidelines

Question 4 aims to find out whether the needs of the organisations that use drones in their everyday work or use drones to provide (public) services are taken into account by the providers of drones and drone support systems.

Is there a good market position for drone-based services (e.g., from the public image point of view)?

Is there a competitive advantage for drone-based services compared to other methods?

Is value for the public created?

Are the demands of organisations, units or departments that use drones in their everyday work or use drones to provide (public) services integrated into the whole drone-based service system?

Question block 4 MILESTONE 4 SEL4

The whole system meets the needs of organisations, units or departments that use drones in their everyday work or use drones to provide different (public) services. Regarding the latter, the system also meets the needs of residents who use drone-based (public) services.

Guidelines

Demonstration phase refers to the demonstration of specific drone use cases.

The whole system refers to the entire drone-based service system which also includes its support system.

Are the needs of organisations, units or departments using drones in their everyday work or using drones to provide different (public) services which emerged from the demonstration phase integrated?

Are the needs of residents who use drone-based (public) services which emerged from the demonstration phase integrated?

Does the whole system meet the needs of organisations, units or departments that use drones in their everyday work or use drones to provide different (public) services?

Does the whole system meet the needs of residents who use drone-based (public) services?

Open block for additional explanations and information

Please add additional explanations and information regarding the work you have done on identifying and analysing the drone market in the context of the adoption of drones for public value purposes.

SUBSECTION 2 – FINANCIAL RESOURCES
Guidelines

The questions under this subsection focus on the availability of financial resources necessary for the exploration of ideas related to drone-based services, their piloting, and the deployment and development of drone technology.

Question block 5 MILESTONE 1 SEL1

Financial resources are sufficient for the exploration of ideas of using drone-based services for civilian purposes in urban environments.

Guidelines

Focus on drone-based services that your municipality has thought of piloting.

Is it estimated what the needed budget for funding ideas of using drone-based services for civilian purposes in urban environments is?

Is there a sufficient budget for the exploration of ideas for using drone-based services for civilian purposes in urban environments?

Is there a sufficient budget for necessary research and development activities?

Question block 6 MILESTONE 1 SEL2
Financial resources are sufficient for the development of drone-based services.
Are there public or private funds for drone-based services?
Is the financing for fundamental research sufficient for drone-based services?
Is the budget for the research and development activities in the development phase sufficient for drone-based services?

Question block 7 MILESTONE 1 SEL3
Financial resources are sufficient for the demonstration of drone-based services and their support systems.
Guidelines
Focus on drone-based services that your municipality has thought of piloting, is planning to pilot, or has already piloted.
Is the budget for the research in the demonstration phase sufficient?
Are financial resources for the demonstration of the drone-based services and their support systems sufficient?

Question block 8 MILESTONE 1 SEL4
Financial resources sufficient for the deployment of drone-based services and their support systems.
Guidelines
Focus on drone-based services that your municipality is planning to deploy.
Are financial resources sufficient for the deployment of drone-based services and their support systems?

Open block for additional explanations and information
Please add additional explanations and information regarding financial resources in the context of the development, demonstration, and adoption of drones for public value purposes.

SUBSECTION 3 – BUSINESS DEVELOPMENT
Guidelines
The questions under this subsection focus on aspects related to business development in the context of drone-based services.

Question block 9 MILESTONE 4 SEL2
A first business case for drone-based services is made.
Guidelines
Focus on drone-based services that your municipality has thought of piloting, is going to pilot, or has already piloted.
Has a feasibility study been done for drone-based services?
Are the costs and benefits in monetary value for drone-based services assessed?
Is the potential customer value for drone-based services assessed?

Question block 10 MILESTONE 2 SEL3
Municipality's drone adoption strategy adapted to market dynamics.
Guidelines
Focus on drone-based services your municipality is planning to pilot or has already piloted.
Is the adoption strategy taking into account the needs of organisations, units or departments that could use drones in their everyday work or could use drones to provide different (public) services?
Is the adoption strategy taking into account the current supply limits of drones?

Is the adoption strategy taking into account the market prices of drones?

Question block 11 MILESTONE 3 SEL3
Business cases adapted to findings from drone-based service demonstrations.
Guidelines
Focus on drone-based services that your municipality has already piloted.
Are (private) financers identified and are they involved?
Is there a business plan for drone-based services?
Are costs of drone-based services assessed after the demonstration?
Are the benefits of drone-based services assessed after the demonstration?

Question block 12 MILESTONE 4 SEL3
Drone-based services and their support systems are adapted to the needs of organisations, units or departments that are piloting them and residents using the drone-based services.
Guidelines
Demonstration phase refers to the demonstration of specific drone use cases.
The aim of question 1 is to find out whether user needs were taken into account during the installation of the service demonstration.
Are the demands of organisations, units, or departments that pilot drones integrated in the whole drone-based service system?
Are the demands of organisations, units, or departments that pilot drones which emerge from the demonstration phase of drone-based services assessed?
Are the demands of residents who use drone-based services which emerge from the demonstration phase of drone-based services assessed?

Question block 13 MILESTONE 3 SEL4
Solid business cases for the deployment of a whole drone-based service system.
Guidelines
Focus on drone-based services that your municipality is planning to deploy.
Is there a financial model for drone-based services?
Is there a business plan for drone-based services?
Are (private) financers identified and are they involved?
Is customer value created?

Open block for additional explanations and information
Please add additional explanations and information regarding business development in the context of the adoption of drones for public value purposes.