Digital Twin Strategy for Slovakia

Stage 3: Stakeholder Engagement - Summary | 10 Oct 2022

Executive Summary

In view of the 2030 digital transformation strategy that necessitates the alignment of all stakeholders to a common vision, a stakeholder engagement exercise with the 'four spheres of influence' *(state, industry, academía, and civilsocíety)* was conducted to envision a national digital twin for Slovakia. The ultimate goal of this engagement was to understand different stakeholders' perceptions toward the implementation of a digital twin platform, as well as how it would overcome barriers in existing work processes to provide them with a more integrated approach for cross-sectoral and cross-regional collaborations. Six questions were posed to engage the participants and provide prompts for thinking:

1. *Why do we need digital twins? Is there a business case/benefít to civil socíety, academía, state & industry?*
2. *What would the digital twin be like? What level of data is to be collated and integrated into the digital twin platform? (A collaborativeplatform to co-create a better-built environment)*
3. *How willit benefityou?*
4. *Who doyou think the key stakeholders should be in the digital twin platform?*
5. *Where should we locate the test bed within the city district/city and what is the optimal size of the test bed?*
6. *How are we to deliver the digital twin platform and what are the barriers to change?*

The engagement was conducted via a roundtable discussion format, where participants from the 4 spheres were organised into groups to exchange their ideas on the implementation of a digital twin in their country. This allowed for the understanding of different perspectives to ultimately create a collaborative digital twin. A total of 30 participants from the four spheres of influence partook in the engagement.

State | Stakeholder Roundtable Summary

Facilitator: Prof. Jason Pomeroy

Attendees:

Organisation	Pax
Regional capitals (Združenie K8)	1
Association of Towns and Communities of Slovakia (Združenie miest a obcí Slovenska)	1
Association of Towns of Slovakia (Únia miest Slovenska)	2
Metropolitan Institute of Bratislava (Metropolitný inštitút Bratislavy)	2
Creative Industry Košice	1
City of Bratislava	1

Key Takeaways:

Q11 *Why do we need digital twins? Is there a business case/benefít to civilsociety, academía, state & industry?*
Stakeholder Responses:
- *"We need to have a single platform forall cities and municipalities, so that the data is the same (its structure, etc.) everywhere."*
- *""t can help e.g. utility companies to know where they need to strengthen theirnetworks."*
- *"Currently, we have a hugeproblem with access to data, so even if it onlyprovided data, it would begood."*
- *"It wouldgive municipalities a direct channel with the national levelaccess to data"*

Key Takeaways:
- Having a central platform with a common data structure to integrate data across different regions, will allow for greater data accessibility and interoperability. This will facilitate cross-sectoral and cross-regional collaborations and communications.
- There is a need for greater data availability across Slovakia.

Q2 *What would the digital twín be líke? What level of data is to be collated and integrated into the digital twín platform? (A collaborativeplatform to co-create a better-built environment)*
Stakeholder Responses:
- *"Will be different in big cities vs villages, e.g. in Bratislava, there might be data on the economícperformance of different city districts, but this might not be the case in smaller municipalities"*
- *"Allspadal data as accurate ("official" data in Slovakia (e.g. from the Census) is often inaccurate) and up-to-date as possible - someone will have to ensure the updating of data"*
- *"For the city, demographic data could be interestíng - e.g, the age structure of a given city district - but summarised data collected with respect to individuals privacy"*
- *"We need to start with basicspadal data, followed by socio-demographic data, data on institudons (hospital, school..), stadstícaldata..."*

Key Takeaways:
- The digital twin should respond effectively and efficiently to changing operations in the physical twin in all aspects, with up-to-date and high-fidelity geospatial data serving as the foundation, accompanied by aggregated socio-demographic and geodemographic data in consideration of data protection and privacy.
- Different levels of data availability and variances in data granularity are inevitable between areas or regions (e.g. cities vs villages).

Q3 | *How willítbenefityou?*
Stakeholder Responses:
- *"Faster work"*
- *"Lower cost"*
- *"Municipalities mightbenefit from creatíng "clusters" andbeingmore connected"*
- *"Data, if it'sgood, can help us do long-term planníng"*

Key Takeaways:
- The digital twin is envisioned as a tool to establish a connected ecosystem of collaborations amongst municipalities, enabling proactive long-term planning with high-quality data and improved efficiency at a lower cost.

Q4 | *Who doyou think the keystakeholdersshouldbe in the digital twin platform?*
Stakeholder Responses:
- *"State; municipalities; IT administrators; statístícal office; academia; private sector; developers; 3rd sector (NGO); IS suppliers"*

Key Takeaways:
- The digital twin is perceived as a cross-sectoral collaboration effort with key stakeholders involving the four spheres of influence - different levels of government (state, municipalities), academia, industries, and civil society like NGOs and information systems suppliers.

Q5 | *Where should we locate the test bed within the city district/city and what is the optimal size of the test bed?*
Stakeholder Responses:
- *"rural structure"*
- *"urban structure"*
- *"in cluding 6 areas "*

Key Takeaways:
- The testbedding of the digital twin could be implemented in both urban and rural areas, taking into account the six pillars - spatial, economic, technological, environmental, social, and spatial

Q6 | *How are we to deliver the digital twin platform and what are the barriers to change?*
Stakeholder Responses:
- *"data quality"*
- *"system - standard"*
- *"accuracy rate"*
- *"capacity"*
- *"There is a need forgreater data availability across Slovakia "*

Key Takeaways:
- Considering the need for greater data availability across Slovakia and cross-sectoral collaborations, a standardised system and sufficient capacity are imperative to be adopted by stakeholders who are wishing to

be part of the digital twin platform in order to ensure data quality and fidelity.

Industry | Stakeholder Roundtable Summary

Facilitator: Milota Sidorová

Attendees:

Organisation	Pax
Association of Construction Entrepreneurs of Slovakia (Zväz stavebných podnikateľov Slovenska)	1
Slovak Chamber of Civil Engineers (Slovenská komora stavebných inžinierov)	1
Institute of Urban Development (Inštitút urbánneho rozvoja)	1
Real Estate	1
Slovak Chamber of Architects (Slovenská komora architektov)	2
Energy Distributor for the Western Slovakia (Západoslovenská distribučná)	1
Slovenský plynárenský priemysel SPP (major energy supplier in Slovakia)	1
Telecommunication Industry	1

Key Takeaways:

Q11 *Why do we need digital twins? Is there a business case/benefít to civilsociety, academía, state & industry?*
Stakeholder Responses:
- *"a clearsummary of data andneeds in the country"*
- *"better, more economicalplanning, use in tíme"*
- *"data unification from varioussources"*
- *"response to market trends from the urban planning and urban growth point of view"*
- *"open information"*
- *"we do not need it. We shall be thinking whether ít is doable, whether its costs do not exceed benefits, whether it is actually doable and whether the technology can predict (bc from current research we know about limits). Overall technosketpicism "*
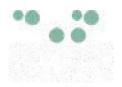- *"shortening the tíme"*
- *"data sharíng"*

Key Takeaways:
- A digital twin platform is seen as a centralised, open portal for unifying heterogeneous data sources across Slovakia. It allows for data sharing and improved efficiency.
- As an integrated system, it is possible to understand urban growth and develop urban planning strategies that respond to market trends, making informed courses of action for better economical planning for the cities.
- However, there are skepticisms about the feasibility of implementing the digital twin, considering the costs required and the benefits (bound by research limitations) it could offer.

Q2 *What would the digital twin be líke? What level of data is to be collated and integrated into the digital twin platform? (A collaborativeplatform to co-create a better-built environment)*
Stakeholder Responses:
- *"howaccurate is the data?"*
- *"above-ground and undergroundstructures, especially undergroundstructures have limits in mapping"*
- *"transitionalperiod for otherparties to provide them, e.g. one provider of electricity said they only mapped 40 percent of its own infrastructure. For providing the data to state they would expect reasonable tíme so they couldprepare"*
- *"data depending on the purpose of use and target group (spatial planning or social). The interface mušt be structured in accordance of the user and his-her own ríghts to access the data"*

- *"priority data from the state point of view must be specified. Basic dataset aimed at spatialplanning and constructíon along with statístíc data about society wíth such level o f detaíl it could be applied spatially"*
- *"Hne orpoints (data)"*
- *"data according to goals (are they f or download, f or preview, what scale?) "*
- *"data must be visualized in the best UX form "*
- *"data securíty, cyber securíty must be applied"*

Key Takeaways:
- A clear and strong leadership is needed from the state to specify the data priority, as well as requirements for
  format and goals of the data (e.g. scale, purposes, line or point data), data fidelity, level of detail (for spatial, social, statistical data).
- Reasonable timeline should be plotted for mapping of instructure data (both above- and underground), noting there are limitations and challenges in mapping underground structures.
- It is of utmost importance to ensure user-friendly UI UX, data security, and cybersecurity. Another key consideration is a structured way of granting access rights to user types and target groups, which should be

Q3 | *How willitbenefityou?*
Stakeholder Responses:
- *"available data that we do nothave today as architects"*
- *"shorter, more efficient processes for planning and constructíon"*
- *"we will be glad to be part of, better for the future forposteríty"*

Key Takeaways:
- Stakeholders from industry welcome the digital twin and would like to be part of the platform, as it will provide them access to data that they do not own currently as architects. Having such a platform with a wealth of data will allow for improved efficiency in the planning and construction processes.

Q4 | *Who do you think the key stakeholders should be in the digital twin platform?*
Stakeholder Responses:
- *"owners, investors, builders, users ofbuildingproductíon"*
- *"data owners"*
- *"financialadministration, data"*
- *"Nationalsecurítyauthoríty (NBU), cybersecurity"*
- *"supplier, administration"*
- *"CSU/Urbion"*
- *"Designers"*
- *"Municipalities - state"*
- *"networks, utility"*
- *"IT"*
- *"researchers, scientísts"*
- *"NGO"*
- *"Slovak hydrometeorological institute (SHMU), cadaster"*

Key Takeaways:
- While the four spheres of influence are seen to play a vital part in the digital twin, there is a wide range of stakeholders from the industry that should be included: investors, builders, users of building production, city service providers and suppliers (e.g. utility, networks), and designers.
- From the technological perspective, the role of Spatial Planning and Construction Authority (CSU) is key in bringing in the technical team of the Urbion system for system integration and compatibility, as well as to ensure the cybersecurity system of the digital twin platform by engaging the National Security Authority (NBU).
- Other data contributors include the government agencies (both state and municipalities; Slovak Hydrometeorological Institute; Geodesy, Cartography and Cadastre Authority; Financial Administrator), researchers and scientists from academia, and NGO from civil society.

Q5 | *Where should we locate the test bed within the city district/city and what is the optimal size of the test bed?*
Stakeholder Responses:
- *"regional cities, all types of buildings, urban structures"*
- *"Trnava/Nitra"*
- *"Bratislava?/Kosice"*

- *"Level of detail (what is needed?) "*
- *"underground collection"*
- *"sprawl, suburbia couldbe interestíngcomparison"*

Key Takeaways:
- The testbedding of the digital twin would be ideal in regional cities with different types of urban structures and buildings. This will include the underground infrastructure of the cities, keeping in mind the level of detail needed. On the other hand, sprawl suburbia is worth considering so comparison of the testbedding outcomes can be drawn between cities and suburbia.

Q6 | *How are we to deliver the digital twin platform and what are the barriers to change?*
Stakeholder Responses:
- *"competency of the state - the authority mušt absolutely push the other partíes into providing HQ data "*
- *"it mušt be clear who is the owner (of the data, of the system?)"*
- *"underground structures HQ data - as this is seen as crucial (optical fibers/how to separate from the ground?), this should be tested as POC"*
- *"the procurement of the twin and the system mušt be agile, as you can never get one final product in IT. Public Procurement Office has started with education how to make state ITprocurements more agile"*
- *"gradual build up of the system, implementation of the system (follows the previous point)"*
- *"financial support"*
- *"political discontínuity, the twin mušt be made priority as it will stem across severalgovernments"*
- *"architects, planners will have to be reeducated in order to be able to desígn in the future (from CAD to GIS,*
  B i M)"
- *"Slovakia is the last country in Europe usingpaper for submitting constructíon plans and masterplans"*
- *"the system and DT mušt be communicated long term to multítude of stakeholders so it is accepted and used"*
- *"user fríendly"*
- *"data mušt be separated - as the data about the present and the future projections (in data architecture) "*
- *"updating data/experts, for maintaining šuch a system you will need robust team of data experts, data curators, specialists on programmíng, methods, clearing u p the data"*
- *"project management of the whole system is crucial"*

Key Takeaways:
- The success of the digital twin platform starts from the competency of the state to foster a culture of collaboration amongst different parties with full commitment to provide high-quality data in all aspects (including those underground structures, which should be tested as PoC). This is accompanied with proactive
  coordination and alignment where a multitude of stakeholders, data owners, and investors (financial support) are engaged on a long-term basis.
- The digital twin project should be a long-term commitment that is supported and maintained by high-performing data and tech experts, with a consensus amongst different stakeholders to sustain it through government changes. The digital twin should be phased in gradual stages with gradual build up of the system that allows for agile procurement.
- User-friendliness of UI/ UX is a key consideration; special attention should be paid on the system architecture
  of the digital twin, particularly on data segregation, to ensure usability experience - where to investigate historical and existing datasets as opposed to where to acquire datasets for predictive modelling.
- Digital education initiatives are required to re-educate different professions to adapt and adjust to the digital

Academia | Stakeholder Roundtable Summary

Facilitator: Daniela Hilčíková

Attendees:

Organisation	Pax
Slovak University of Technology in Bratislava (Slovenská technická univerzita v Bratislave):	
o Faculty of Architecture and Design	3
o Spatial Planning Department	1
Technical University of Košice (Technická Univerzita v Košiciach):	
o Faculty of Civil Engineering	2
o Department of Architecture	*1*
University of Žilina:	
o Faculty of Civil Engineering	*1*
Slovak University of Agriculture, Nitra:	
o Faculty of Horticulture and Landscape Engineering	*2*

Key Takeaways:

Q11 *Why do we need digital twins? Is there a business case/benefít to civilsociety, academia, state & industry?*
Stakeholder Responses:
- *"data availability, publicly available data"*
- *"up-to-date data"*
- *"da ta unifica tion"*
- *"Interoperability (across different sectors)"*
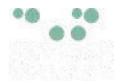- *"accessible to everyone"*

Key Takeaways:
- The need for a digital twin is mutually agreed upon owing to its great potential and benefit as a data unification platform, allowing different users and even the public to access up-to-date data. Data interoperability is key to ensuring large datasets are compliant with quality requirements for sharing across different sectors.

Q2 | *What would the digital twin be Hke? What level of data is to be collated and integrated into the digital twin*

platform? (A collaborativeplatform to co-create a better-built environment)

Stakeholder ReSponses:
- *"clear hierarchy (of data)"*
- *"clearly defined competencies"*
- *"roles o f respective users customised (per their function, responsibilities,...)"*
- *"user-friendly" "user levels (meaningconnectivity andaccessibility through PC, tablet, phone,...)"*
- *"forms-outcomes"*
- *"balanced data"*
- *"should not be completely open (accessibility)"*
- *"centralised - everythingat oneplace"*
- *"interoperability of databases"*
- *"stratification of terrain"*
- *"spadal data"*
- *"under surface infrastructure"*
- *"scanning of data"*
- *"physical m ea s u ring/ physical data"*
- *"statistic data"*
- *"social data"*

- *"geographic data"*
- *"climate data"*

Key Takeaways:
- The digital twin is recognized as a central platform with a clear hierarchy of data involving contributions from different stakeholders and users who should be identified with clearly defined competencies. The stakeholders and users' accessibility to the digital twin is customised and granted in response to their respective roles, responsibilities, and the functions required to carry out their respective tasks.
- Taking a user-friendliness perspective, a digital twin with responsive design will provide an optimal viewing and interaction experience across different devices (e.g. PC, tablet, smart phone).
- As a central data lake with different levels and types of data (e.g. geospatial data, climate data, stratification of terrain, social data, climate data) and different user accessibility, the digital twin should aim to increase the interoperability of databases, as well as the level of detail of BIM models - both above- and underground infrastructure through data scanning.

Q3 | *How willitbenefityou?*
Stakeholder Responses:
- *"prediction (e.g. greenery)"*
- *"base for experíments"*
- *"experíments without consequences"*
- *"base forstrategic planníng"*
- *"what-if simulations"*
- *"cost optimisation "*
- *"safety (people, socíety,...)"*
- *"urban planníng usage "*
- *"education"*
- *"tax collection"*

Key Takeaways:
- The digital twin provides a safe and cost-saving environment for testbedding new innovations without consequences on the physical twin, simulating what-if scenarios for proactive strategic and urban planning. Other application domains that would benefit from a digital are education and tax collection.

Q4 | *Who do you think the key stakeholders should be in the digital twin platform?*
Stakeholder Responses:
- **Stakeholders - who would create DT/ popu late it with data:** *"academía; industry/ business,; state sector (legislation); IT sector; public,; experts; architects; urban planners"*
- **Stakeholders - active users:** *"public; state and public administration sector; associatíons and chambers; experts/ professionals; client/customercentres; agriculture; healthcare; operation/maintenance of strategic infrastructure; developers; investors"*
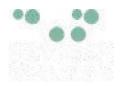
Key Takeaways:
- While the key stakeholders involve the four spheres of influence - state, academia, industry, and civil society - it is important to identify the creators and data contributors (mainly are state sectors, academia, professionals from the IT sector and the field of planning and design, and public) of the digital twin from the active users (an expanded list from the former, which also includes city operators, investors, and professionals from different domains)

Q5 | *Where should we locate the test bed within the city dístríct/city and what is the optimal size of the test bed?*
Stakeholder Responses:
- *"whole c?tíes without city dístrícts"*
- *"max population of the city: 30- thousand people"*
- *"good transport connectivity (outsíde city, highways, trains,...)"*
- *"complex social infrastructure "*
- *"water element (ríver)"*
- *"diversity of social layers (e.g. ethníc minorities) "*
- *"industrialzone (complex, not only one type of industry)"*
- *"diversified industry"*
- *"morphology (fiatland, forests, agrícultural fields)"*
- *"demography of city reflecting an average demography of the country"*

- *"compact city"*
- *"public transport"*
- *"historica l cen tre "*
- *"willingness (of citizens andallrelevantparties) to participate to shape the future of the country"*
- *"good examples o f citíes suitable f or testíng: Žiar nad Hronom, Ružomberok, Liptovský Mikuláš, Kežmarok, Topo/čany, Krupíná, Nové Mesto nad Váhom"*
- *comment: depending if we have only one test bed (then fully complex city) or more testbeds (than going for other "extremes"such as "dyingout" city, newly developedcity, fastly growingcity,...)*

Key Takeaways:
- Testbedding and validation of the digital twin technology can be conducted based on the site selection approach - a fully complex city or multiple sites.
- The former requires a city that can potentially reflect an average demography of the country, as well as the complex interdependence between the hardware of the (inner- and outer-city) physical and social infrastructure, climate and environmental conditions, diversified socio-demographic (including the ethnic minority communities), and historical assets. The latter can be different cities with each characterised by different qualities, ranging from rapidly developing city, newly developed city to undeveloped city.
- Regardless of the site selection approach, getting ground support and participation from citizens and all relevant parties is one of the most critical factors in ensuring the success in digital twinning.

Q6 | *How are we to deliver the digital twin platform and what are the barriers to change?*
Stakeholder Responses:
- **Key to success:** *"raising public awareness; clear methodology; sustainability of project from a political perspective (regardless who is elected, the continuation of project); education; financing; collaborative approach of state institutions;stakeholders'participation; ITinfrastructure"*
- **Barriers:** *"if all the above fails; GDPR; data protection; absence of raising public awareness; decision making*
  mechanism - rightbalance between AI andhuman input"

Key Takeaways:
- The success of digital twin is premised on a clear national framework and methodology, as well as a strong boundary spanning collaboration across sectors and organisations, empowered to work together for project sustainability, in terms of securing stakeholders' participation and finances, enhancing IT infrastructure, and raising public awareness and education regardless of government changes.
- Having a GDPR in place is key to gain trust and support from the public.
- It is crucial to see the digital twin as a decision-making mechanism that balances human input and AI technology.

Civil Society | Stakeholder Roundtable Summary

Facilitator: Katarína Brestovanská

Attendees:

Organisation	Pax
Office of the Plenipotentiary of the Government of the Slovak Republic for the Development of Civil Society	I
Buildings for the Future	I
Office of the Plenipotentiary of the Slovak Government for National Minorities	I

Key Takeaways:

Q11 *Why do we need digital twins? Is there a business case/benefít to civil society, academía, state & industry?*
Stakeholder Responses:
- *"Systematisation of existingand unintegrated data."*
- *"We have data available at different locatíons in the state, yet we do not have them available and do not work*
  with them in the long run."
- *"The State does not share, integrate, analyse the data, and the data is not in machine readable format. "*
- *"Databases e.g. on demographics (statistícal office), economícs (tax offíce), civil evidence (matriky) and the Ministry of Education (school information) all possess complete data but do not integrate ít, do not share ít in any way."*
- *"Data integration will also expand the outlook ofprofessions - allprofessions will be able to visualise other areas of expertise much better (given the visual character of the DT) - which will lead to better consideration of needs of all areas (urbanísts, ecologists, economists, etc. - a common platform for all of them to discuss and come to conclusions will help fill all needs in the best possible way)."*

Key Takeaways:
- The digital twin will serve as a central platform to store and integrate multi-source datasets, which are currently siloed, in a machine readable format that is publicly accessible.
- There is a need for a common platform to expand outlook and improve transparency across different sectors
  and organisations, allowing different stakeholders to communicate ideas and develop holistic solutions that solicit inputs from all possible relevant professions.
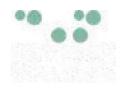
Q2 *What would the digital twin be líke? What level of data is to be collated and integrated into the digital twin platform? (A collaborativeplatform to co-create a better-built environment)*
Stakeholder Responses:
- *"All six areas as presented in the model are necessary."*
- *"It is important to include/integrate the data we already have (as mentionedin QI)."*
- *"Each area should be highly relevant: Example of "demographics" - it is not sufficient to simply state how manypeople live here, we mušt consider (e.g. in BA) how manypeople commute here daily, how many visitors, what kinds of minorities (there are many we do not even know of), etc."*
- *"Culture and history - currently not sufficiently interconnected with other existing data."*
- *"Needs of minorities - not to be forgotten about."*
- *"Social behaviour - is influenceable by development of the living environment - people like to gather in nice places, the way we develop different areas directly impacts social behaviour and the development of the CS."*

Key Takeaways:
- On top of integrating the existing data, having a digital twin encompassing datasets from the six pillars is necessary. This is especially true for the socio-cultural practices and socio-spatial behaviours. These elements are important to inform social development and societal needs (including those of the minorities)

Question 3 | *How willítbenefityou?*
Stakeholder Responses:
- *"The creatíon of the DTítself willalready support the civilsociety (CS), provided the data willbe avaiiabie."*
- *"Opportunity to make more qualified decisions based on real data, rather than on assumptíons."*
- *"Decisions taken based on data enhance the credibility of the decision-making body and increase trust in them as well as general trust within the society - as at this point we are at the lowest possible levels of trust in the country (the lowest trust in government as well as the lowest trust among citizens themselves)."*
- *"The opportunity to scrutínise and control the decisions that are being taken."*
- *"Opportunity to prepare ideas andprojects with consideration of our roots (history, culture) as well as with the perspective of our future direction (development, innovation, sustainability)."*
- *"The access to this data - from the perspective of the CS - means that citizen participation in a meaningful form can increase; citizens and NGOs can provide higher quality and better-informed initiatives, suggestíons and projects."*
- *"The quality of pilot projects by NGOs can increase."*

Key Takeaways:
- Having a digital twin platform that is publicly accessible will greatly support civil society to craft better-informed initiatives and engage in pilot projects in a more meaningful way. This can be done by taking different aspects (history, culture) into account to contribute towards the nation's future plans (e.g. development, innovation, sustainability).
- There is a need for such a data-enabled, decision-making mechanism that allows for transparency and enhances the credibility of the decision-making body, helping to build trust in the state and amongst the society.

Q4 | *Who doyou think the key stakeholders should be in the digital twin platform?*
Stakeholder Responses:
- *"Representatives of all 6 presented areas mušt participate."*
- *"If related to CS - <u>The Chamber of NGOs (Komora MVO)</u> - is the key partner o f the state in supporting the NGO*
  sector. The Chamber has representatíon o f all NGO areas working in the country and should be the prímary
  body to nominate key NGO representatives to work on the DT. "
- *"Representatives of local governments - cities - mušt be stakeholders, especially such that support the CS and work with NGOs."*

Key Takeaways:
- To build a digital twin that encompasses the six pillars, it is crucial to engage the participation of representatives from the six pillars.
- There is a need to identify local government representatives, i.e. The Chamber of NGOs (Komora MVO), that
  can nominate NGO representatives, support civil society, and see the value in working with NGOs.

Q5 | *Where should we locate the test bed within the city district/city and what is the optimal size of the test bed?*
Stakeholder Responses:
- *"If the reason for testíng is to test the compiete concept of the DT, then is should be a city like Bratislava or Trnava. Trnava for the following reasons: optimal size of the city, close to BA, relatively simple regional setting, progressive local government open to visionary projects."*
- *"If the reason for testíng is to soive a particularproblem using the DT, then it should be an area that is developing quickly or is in important/arge transforma ton such as Horná Nitra. "*

Key Takeaways:
- The site selection for testbedding of the digital twin highly depends on the purpose(s) of testing. For comprehensive concept testing, regional cities (e.g. Bratislava, Trnaca) with optimal size and progressive local government would be ideal. On the other hand, to test the problem-solving capability of a digital twin

Q6 | *How are we to deliver the digital twin platform and what are the barriers to change?*
Stakeholder Responses:
- **All the defined areas are either keys to success or barriers - if in oppo**site: *"Cooperatíon and good communicatíon of all involved parties; Cooperatíng local governments; Access to data; An open platform; Visionary authors - unafraid to do things in new and better way; A realistíc definition of the vision; Motivation and faith in the result; Support of the central government to the Authority (Úradu); Enough financing; A working technological environment (a well-operatingsystem); Willingness of people to share data*

Key Takeaways:
- The key to success for the digital twin, as an open platform for data acquisition, depends on a robust technological infrastructure to share data securely amongst relevant parties, who see the purposes of the digital twin and are persuaded of its benefits. This necessitates great coordination and communications between all involved stakeholders, as well as public-private collaborations led by visionary authorities that are supported by the central government (Úradu).
- The digital twin should be defined with realistic vision that can be financed so as to cultivate motivation and faith in the outcome amongst the stakeholders and citizens

Observations & Onwards Prompts for Thinking

It is recognised amongst the four spheres of influence that a digital twin would serve as a centralised platform for data unification, increasing data accessibility and interoperability across Slovakia. Made publicly accessible, the integrated approach of a digital twin enables collaborations and communications across different sectors, organisations, and even regions with improved efficiency. It is also important to note the great potential of a digital twin to provide a safe and cost-saving environment for testbedding of new innovations and simulating what-if scenarios without consequences on the physical twin.

Despite the touted potential of a digital twin, the entire idea of the technology itself can bring in doubt, in terms of the costs, stakeholders, and the amount and level of data involved, as well as the overall accuracy of the simulations and future projections. Concerns also arise in relation to the IT infrastructure required and the feasibility of committing to such a large and long-term project that would potentially experience government changes.

The implementation of a digital twin may seem daunting, but can be achieved with collaborative national interventions and a national socio-technical change programme, given the multitude of stakeholders involved and the scale of the changes required. This necessitates a strong leadership to develop a national implementation plan with clear vision, as well as precise methodology in coordination, goals prioritisation, and resources optimisation.

Proactive coordination and continuous engagement with cross-sectoral and cross-regional stakeholders should be guided with the core values of creating a digital twin for public benefit in perpetuity regardless of government changes. This will facilitate the conversation between stakeholders in finding alignments and ensuring that efforts are channelled in the right direction. There is also a need for a common national framework for information management to serve as a guide for data collection effort, in terms of data format and the level of detail required.

Goals prioritisation and resources optimisation should go hand in hand while planning how the digital twin could be phased to ensure immediate and long-term benefits. Ratherthan aimingforan all-encompassing digital twin atthestart, it might be more feasible to work in small incremental steps based on goals prioritisation and resource availability, and allowfor expansion overtime. Goals prioritisation and resources optimisation can be evaluated based on data availability, accuracy of simulations or forecasting models, and the nation's planning priority areas. This will subsequently define the proof of concepts (PoCs) for the digital twin. It is imperatíve to note that the PoCs should not be tied to a particular pillar but equal for all - spatial, economic, technological, environmental, social, and cultural - owing to the complex interdependence of all the pillars in reflecting the ecosystem of the physical twin.

It further appears that there is no one-size-fits-all approach to identify an optimal site for testbedding ofthe digital twin. This will require conversations between stakeholders to identify the specific purpose(s) ofthe testbedding - whether it is to test the comprehensive concepts of the digital twin or to test its capacity in solving real-world problems of any particular areas in Slovakia.

From the technological standpoint, the accuracy of simulations and future projections highly depends on the amount of data the digital twin has accumulated from the physical twin, as well as the model creation. This requires more thought on optimising data collection effort at scale, as well as the significant role of academia in developing and validating simulation models forthe digital twin given their expertise in this area, backed by thorough literature review. By enriching the digital twin with more data, the capabilities of AI technology embedded in the digital twin will increase the accuracy of the simulations and forecasting models over time.