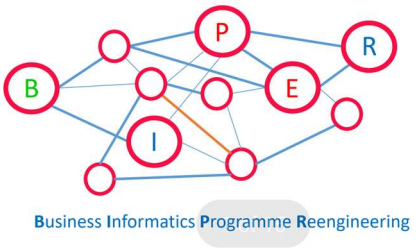

BIPER - Business Informatics Programme Reengineering

Erasmus+ Call KA226, Duration 18 months (2021.03.01-2022.08.31)

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List Abbreviations

Term / Abbreviation	Definition
T&L	Teaching & Learning
AI	Artificial intelligence
BPM	Business Process Modelling
EA	Enterprise Architecture
EAM	Enterprise Architecture Modelling or Management
ADM	Architecture Development Method
TOGAF	The Open Group Architecture Framework
CS	Case Study

List of Definitions

Term	Definition
Goal	A goal is a short statement of a desired outcome to be accomplished over a long-time frame, usually three to five years. It is a broad statement that focuses on the desired results and does not describe the methods used to get the intended outcome.
Aim	What you hope to get and you want to do this.
Objective	Objectives are specific, actionable targets that need to be achieved within a smaller time frame, such as a year or less, to reach a certain goal. Objectives describe the actions or activities involved in achieving a goal
Target	The exact result of what you want to get.
Purpose	… of something is the reason for which it is made or done

Document History

Date	Name	Description
2021.05.20	Gábor A	Document initiation,
2021.05.25	Matteo	Revision, amendment of Chapter 4
2021.06.06	András	Document restructuring, adding Chapter 2,3 & 6
2021.07.07	András	Adding Output subsections to each ADM step
2021.07.09.	Ildikó Szabó	Adding competences to each step
2021.08.26	Andras	Case study metamodel (Ch5)
2021.09.30	Andras	Mapping knowledge structure to edoer.eu
2021.10.26	Keshav, Marco, Shakil	Crannogh Museum CS
2022.02.18	Andras	Urban development CS update with evaluation

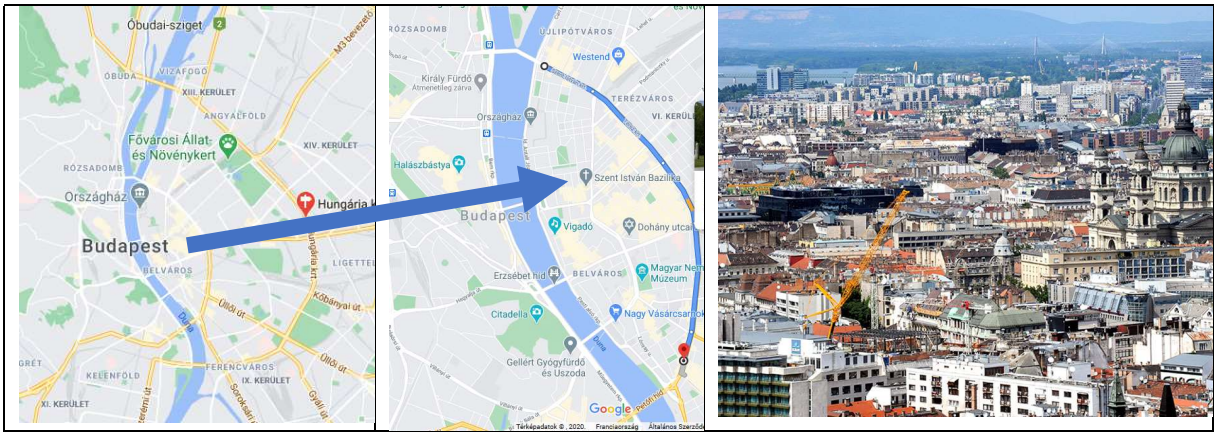
Tartalom

List of figures

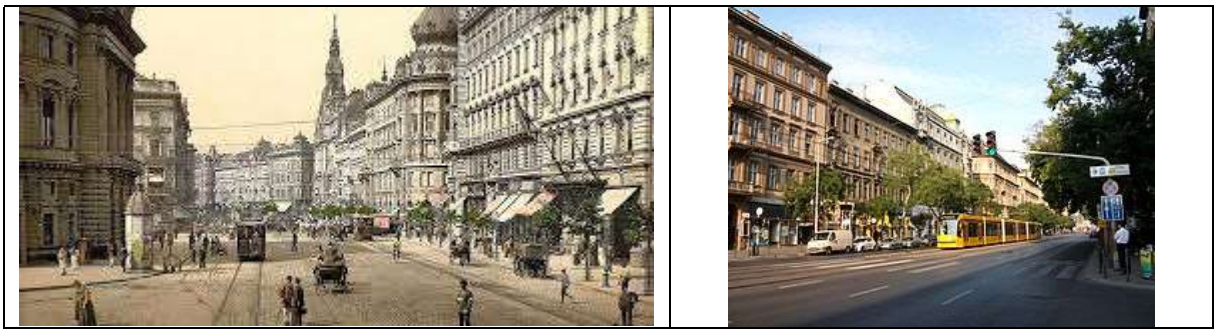
1 URBAN DEVELOPMENT – SMART CITY

1.1 Introduction

The delimited part of the historical part of Budapest, the Hungária-Róbert Károly boulevard from the Danube to the Danube, is considered.



This area was built at the same time at the end of the 18th century, at the beginning of the 19th century, when Budapest became a sizeable European city on a large scale. Architecturally decisive was the growing number of merchant-industrial citizens enriched by the economic prosperity of the Monarchy and Budapest's central place in the economic and financial world of the Monarchy. The urban topography of Paris (e.g. the Grand Boulevard), mixed with Vienna's unforgettable classicist, neoclassical influences, served as a precedent.



Art Nouveau further developed this, i.e. Bauhaus, and the palette was coloured by the architectural trend of the Bauhaus, the latter being actual mainly in Buda, and traces can be found in Újlipótváros.

Two things characterised the apartment buildings in Pest. One, built as tenement houses, an investor built a house or houses for the purpose of renting out flats, e.g. the house, all the infrastructure including the landlord, e.g. the owner took care, it was in his best interest to keep it at a good standard to always find tenants. The other resulted from the sociological composition of the townspeople, usually on the street front nice, comfortable bourgeois dwellings were built, in the back tract smaller, more modestly designed and equipped dwellings were built for administrators, teachers, and other lower-income occupants.

The construction boom completely replaced the previous settlement structure, but it could no longer modernise all the buildings.

The war intervened, and post-war recovery based on the Trianon Treaty had already created a different geopolitical situation. The Second World War properly eroded the building stock. After the war, the restoration and housing policy in the new social system was characterised by industrialisation, the significant increase in the population and size of Budapest and, in an international context, the confinement. The almost complete nationalisation of houses and apartments has created a large stock of rental housing but without the rental housing market. A need-based allocation system has come into force. Maintenance has also become a state task, cleverly combining helpless and oppressive bureaucracy with technological unpreparedness and shortcomings. Only the low-level but effective corruption of the time helped this.

A new turning point came at a time of regime change. Between 1990 and 1994, the state wanted to get rid of the unwanted housing stock due to the insufficient financial and human resources for maintenance, and the rental housing market was not a priority, partly due to the underdevelopment of the market (lack of purchasing power). Social rental housing was not to be dealt with for ideological reasons in addition to the lack of financial resources. Based on their very bad memories and experiences gained during the exercise of the tenant status of the district or city council rental apartment, inhabitants wanted everything, just not to remain tenants. In addition to the very favourable loan schemes and low prices, everyone voted to purchase the apartment on their own property. As a result, most of the rental dwellings in Pest became privately owned, and the house in which the dwelling was located was in joint ownership. The joint ownership was dominated by a very loose regulation, which ambiguously regulated rights and obligations and was often unenforceable. If

one walks through Erzsébetváros or Terézváros, one can also see the traces and all the consequences from the street.

1.2 Facts and Figures

Facts & figures

- Number of apartments in Budapest - cca. 900.000
- Inhabitants / 100 apartment – 249
- Bachelor (one bedroom) flats 40%
- Flats without bathroom – 30%
- Traditional apartment houses – 50%
  - flats built in the 19th century – 80.000
  - need to renew – 50.000
  - need for renewal in the inner districts – 50-55%
- Residential estates
  - number of flats – cca 200.000
  - block houses were designed for 50 years lifetime in the ‘70s.
- Individual houses
  - mainly in Buda or outer districts
  - infrastruce development has priority
- Industrial buildings
  - 10% of total industrial buildings is located in Budapest
  - most of them are outdated – areas are free for new investment, developments (offices, residental buildings)Fac

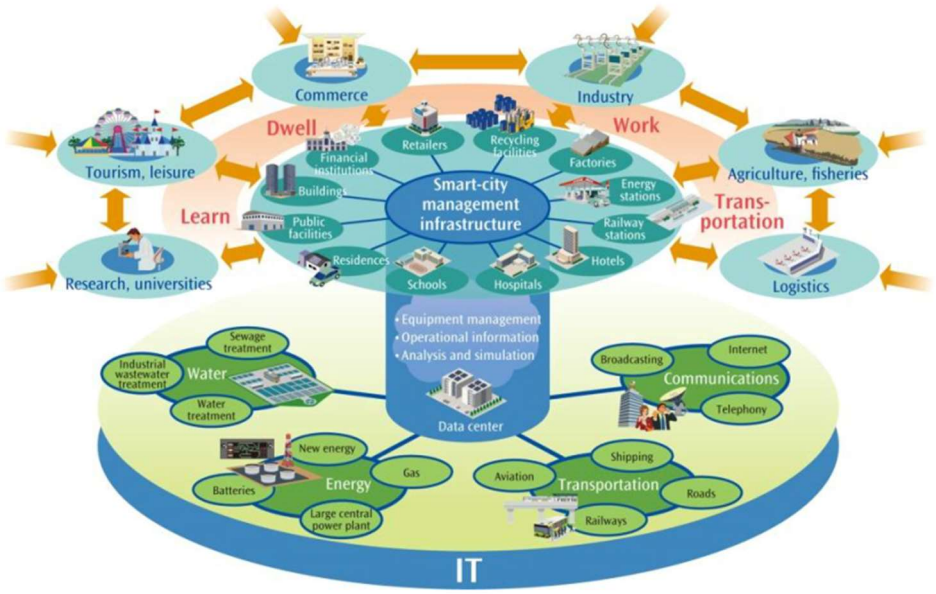
We cannot go back to the past; what happened, it happened. But how next?

1.3 Requirement Analysis

1.3.1 Stakeholders[1]

1. Figure Stakeholders

1.3.2 Functional requirements[2]

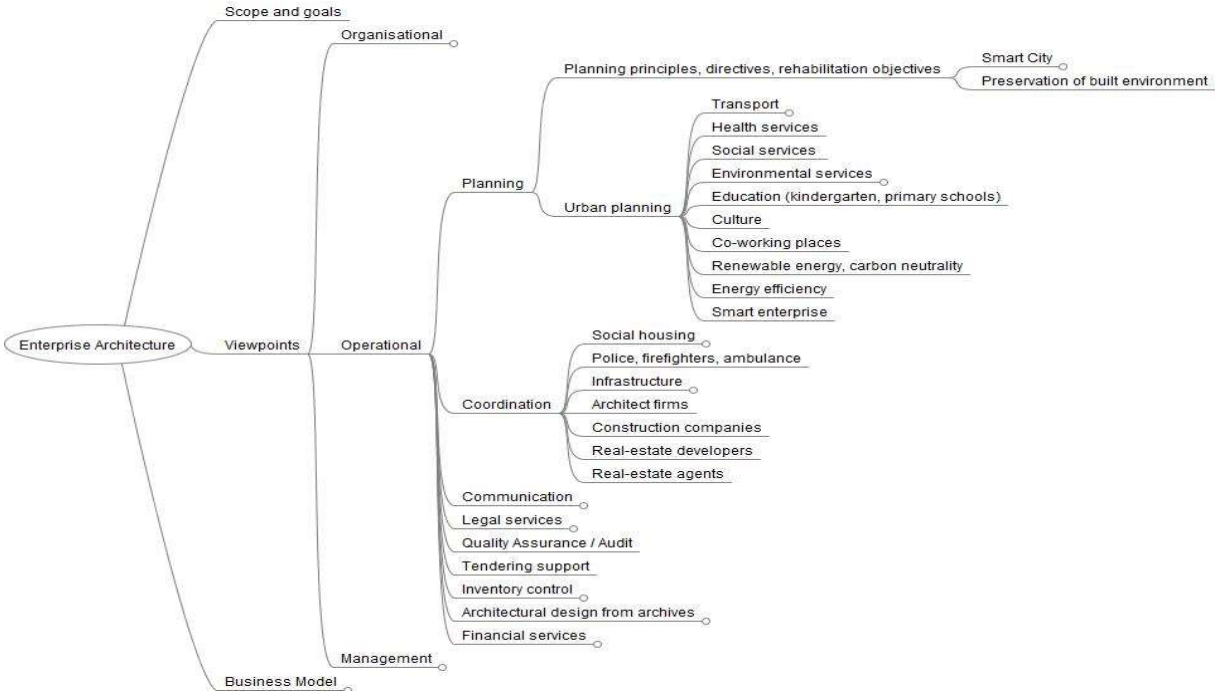


2. Figure Smart City DIagram

[1] Erika Prokop, Hamidreza Tabatabaienia and Madeline Jolk

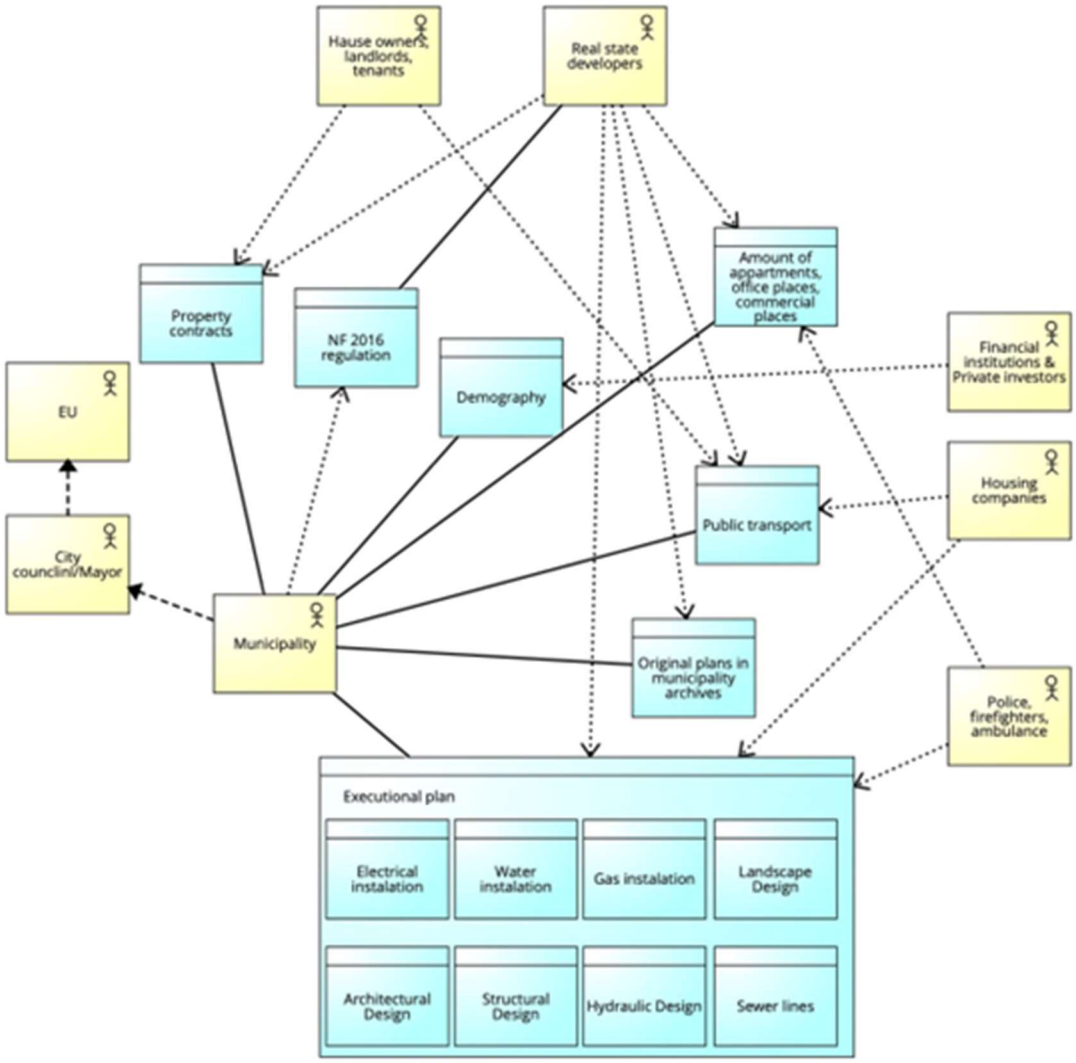
[2] Marvin (2017): Urban Operating Systems: Diagramming the City, International Journal of Urban and Regional Research – Wiley Online Library, https://onlinelibrary.wiley.com/doi/full/10.1111/1468-2427.12479

1.4 Vision, target architecture



3. Figure Urban development Target Architecture

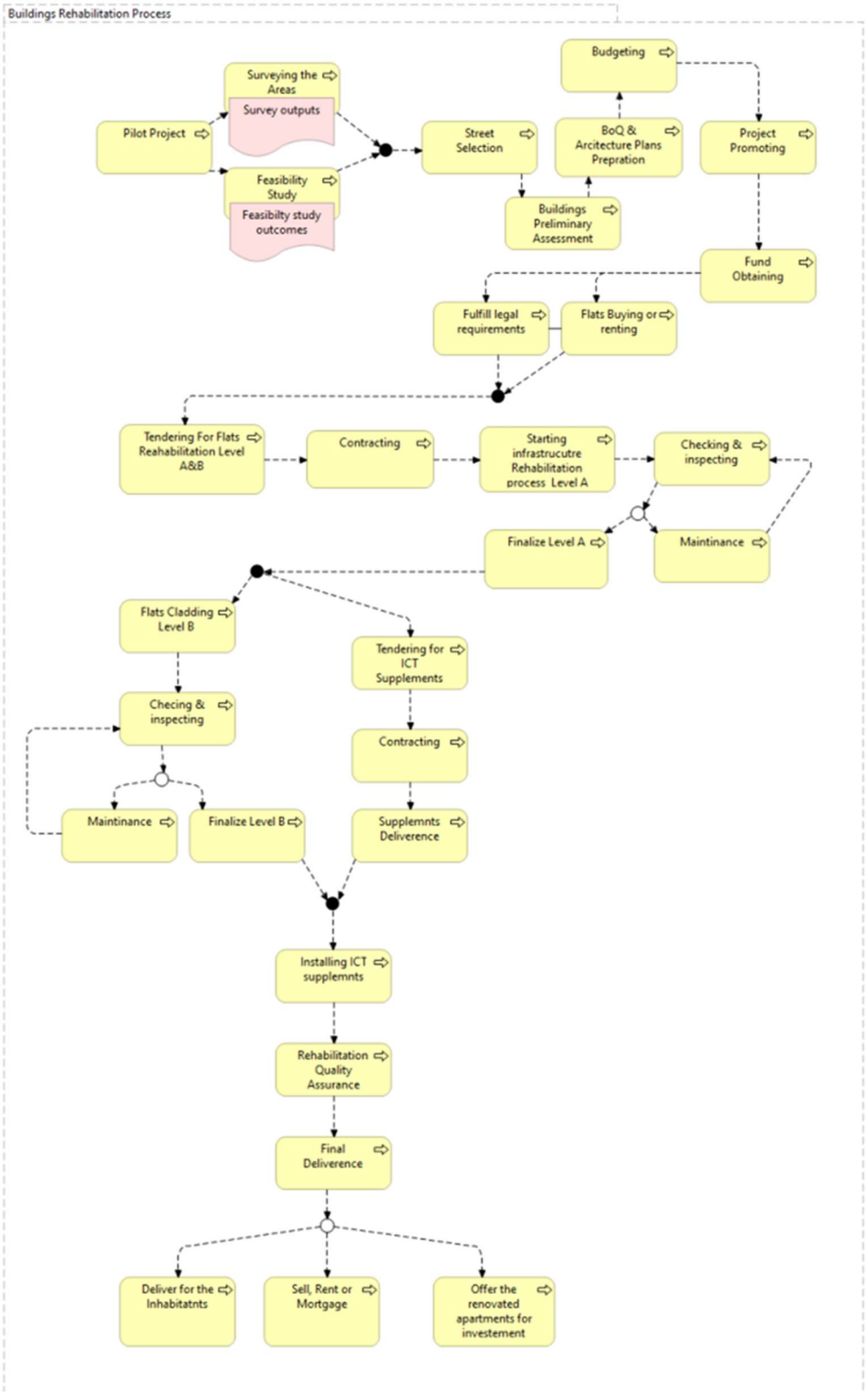
1.5 Business Architecture[3]



4. Figure Business Architecture

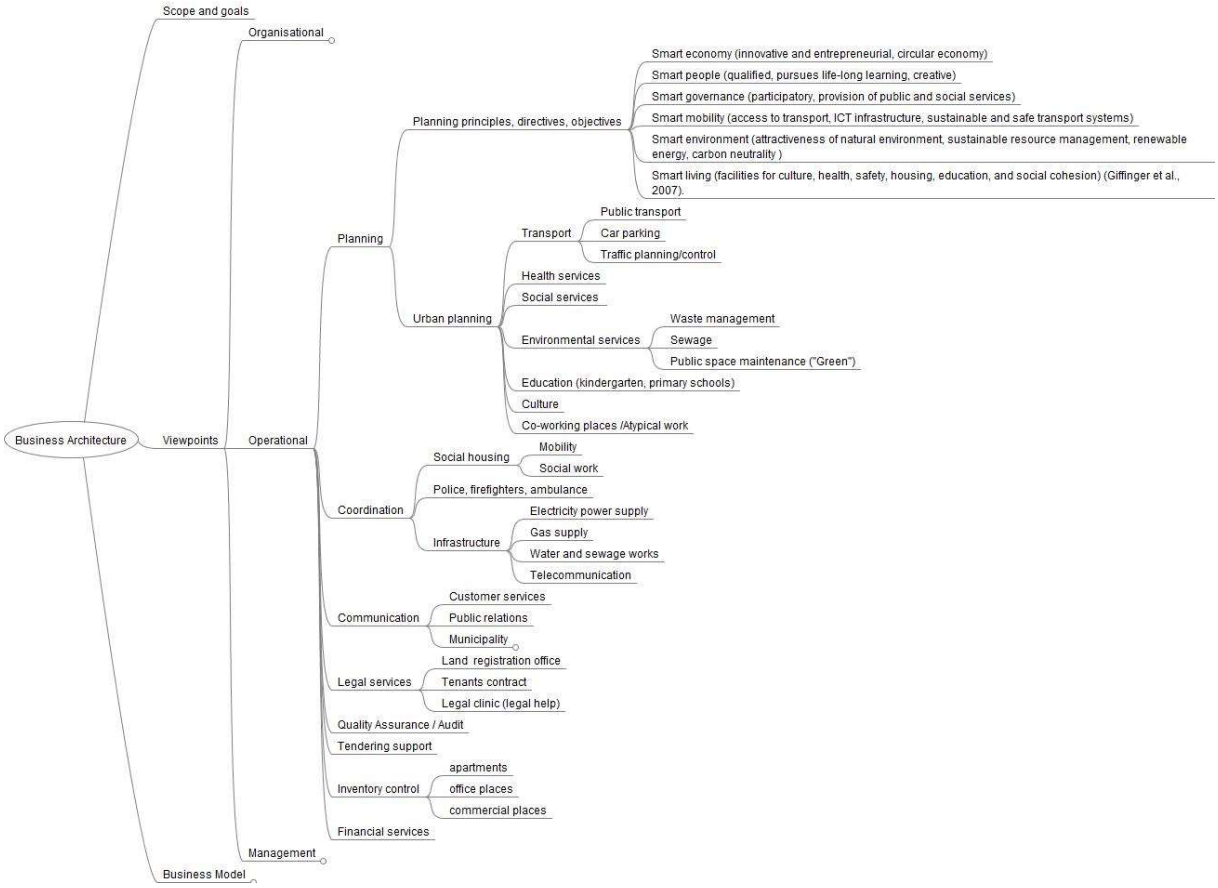
[3] Erika Prokop, Hamidreza Tabatabaienia and Madeline Jolk

1.5.1 Process View[4]

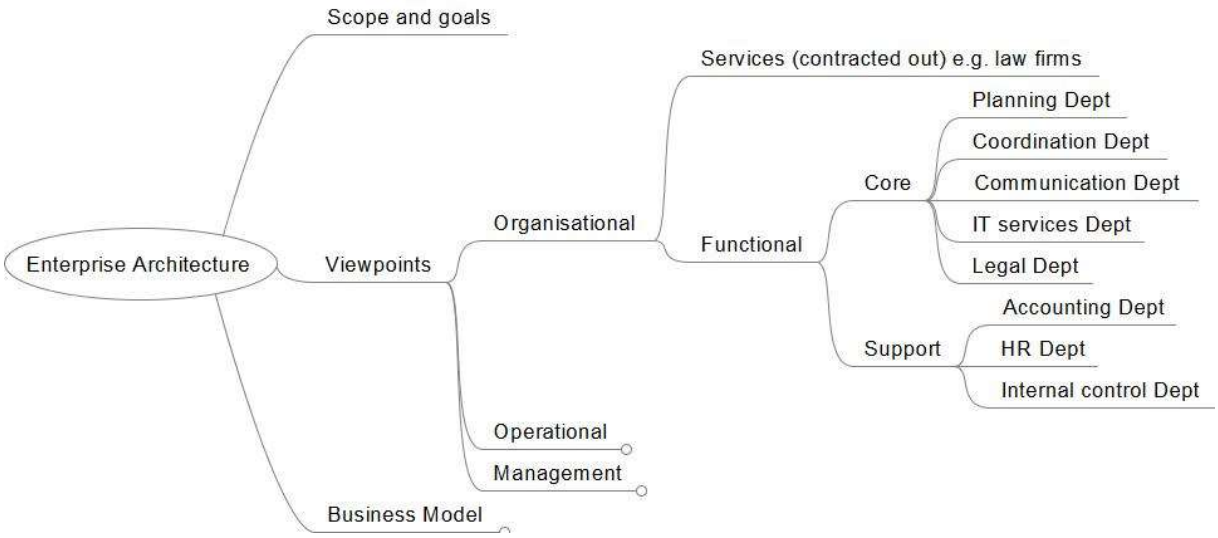


5. Figure Process view

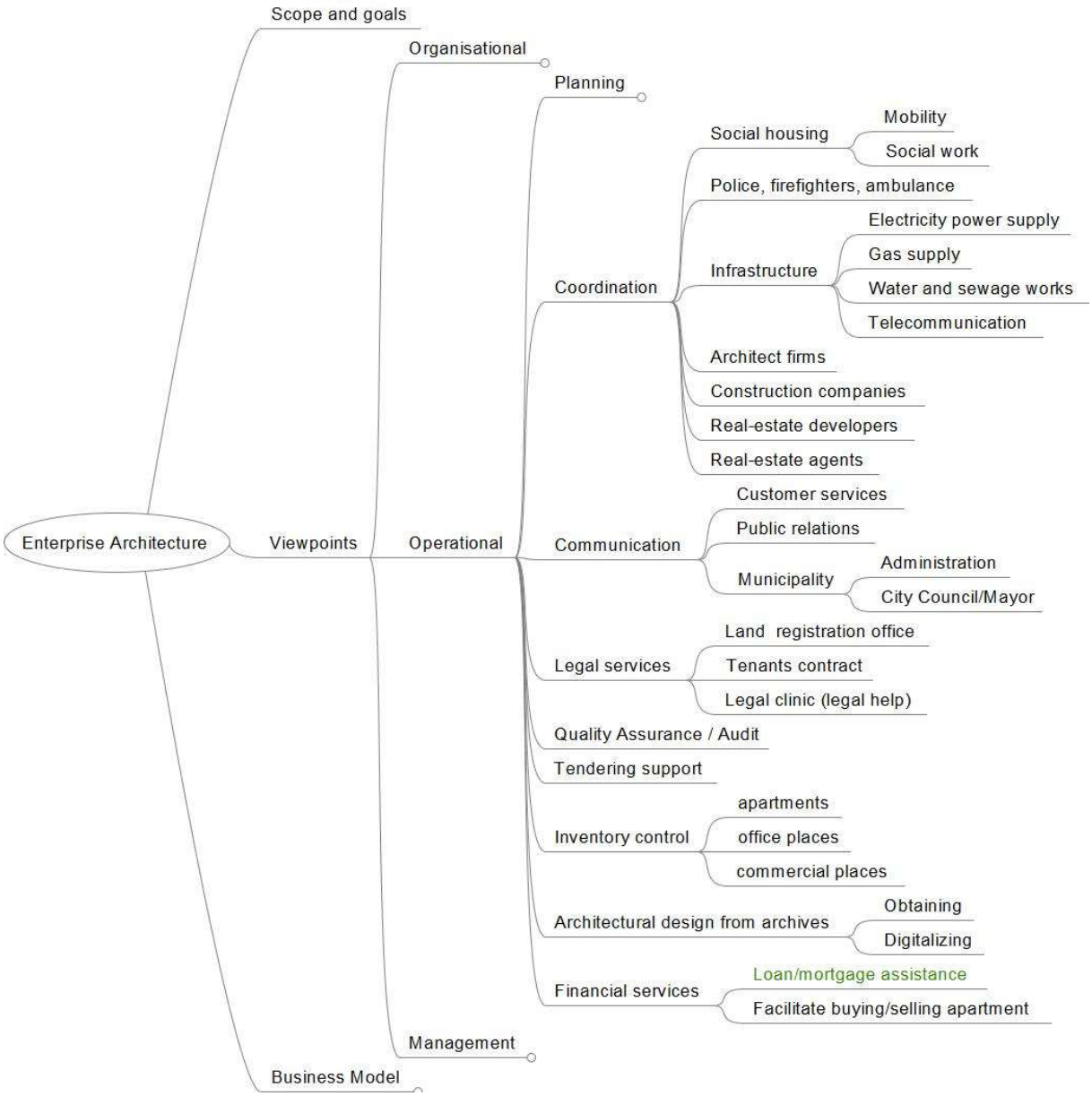
[4] Irah Mariey Sitchon, Sayyora Orazbaeva, Saisugathri Narasingu, and Mohammad Wael Dahman



6. Figure Urban Development Business Architecture



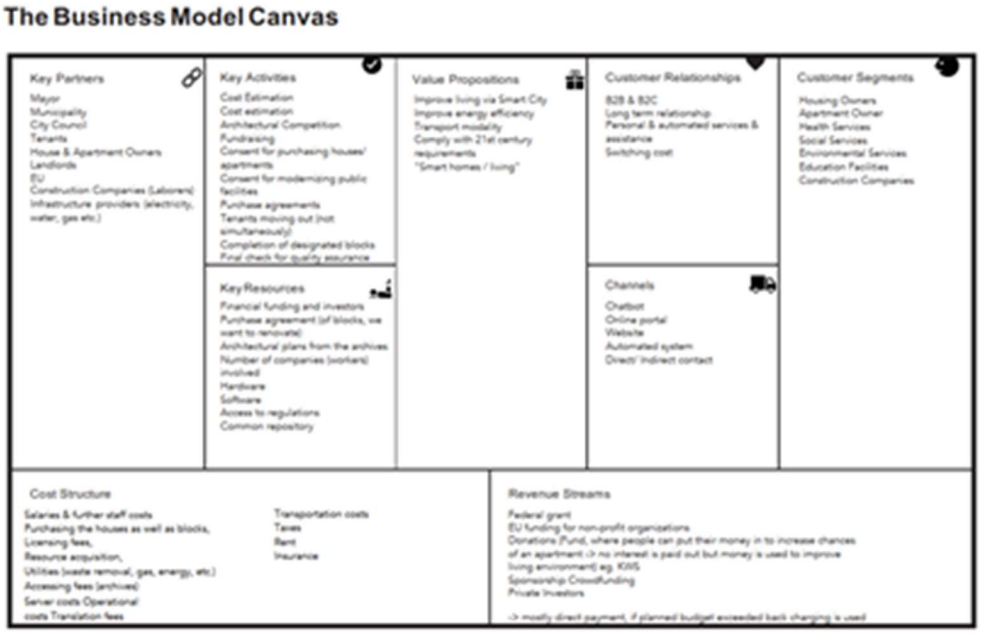
7. Figure Organisational viewpoint



8. Figure Operational viewpoint

9. Figure Management viewpoint and business modell

1.5.2 Business Modelling[5]



10. Figure Business Model Canvas

1.6 Information System Architecture[6]

1.6.1 Data Principles (tbd)

1.6.2 Data Architecture

Data Sources

- Households' data: number of inhabitants per apartment, number of apartments in building, construction material used in buildings...

[5] Erika Prokop, Hamidreza Tabatabaienia and Madeline Jolk

[6] Riadh Bouakez, Farman Garibov and Khurelbaatar Buyantogtokh

- Finance and Accounting data: estimation of revenues to be collected, costs related with salary of employees, purchase invoices data...
- Demographic data: number of citizens per district, average value of m2 per area
- Infrastructure data: Cables architecture plans, number of IOT devices installed...
- Communication data: emails, social media posts, meetings' reports...

Data Capture

- Market research: already existing documentation containing relevant information about
- Budapest demographics, number of buildings present in each area, valuation of the m2, etc...
- Surveys performed on habitants of buildings that may be selected for renovation: measuring willingness of habitants of each building to move out and how much they value their property
- Internet of things devices: Newly placed sensors: give an accurate and real-time indication of energy consumption inside every household/building.
- Newly placed cameras: give traffic information (rush hours), better visual control over the streets, important data for the police.
- Stakeholder interviews: Giving the opportunity for every part to express its opinion about the matter, understand the interests it is aiming to preserve/achieve.
- Data collected from the internet, press, social media

Data store

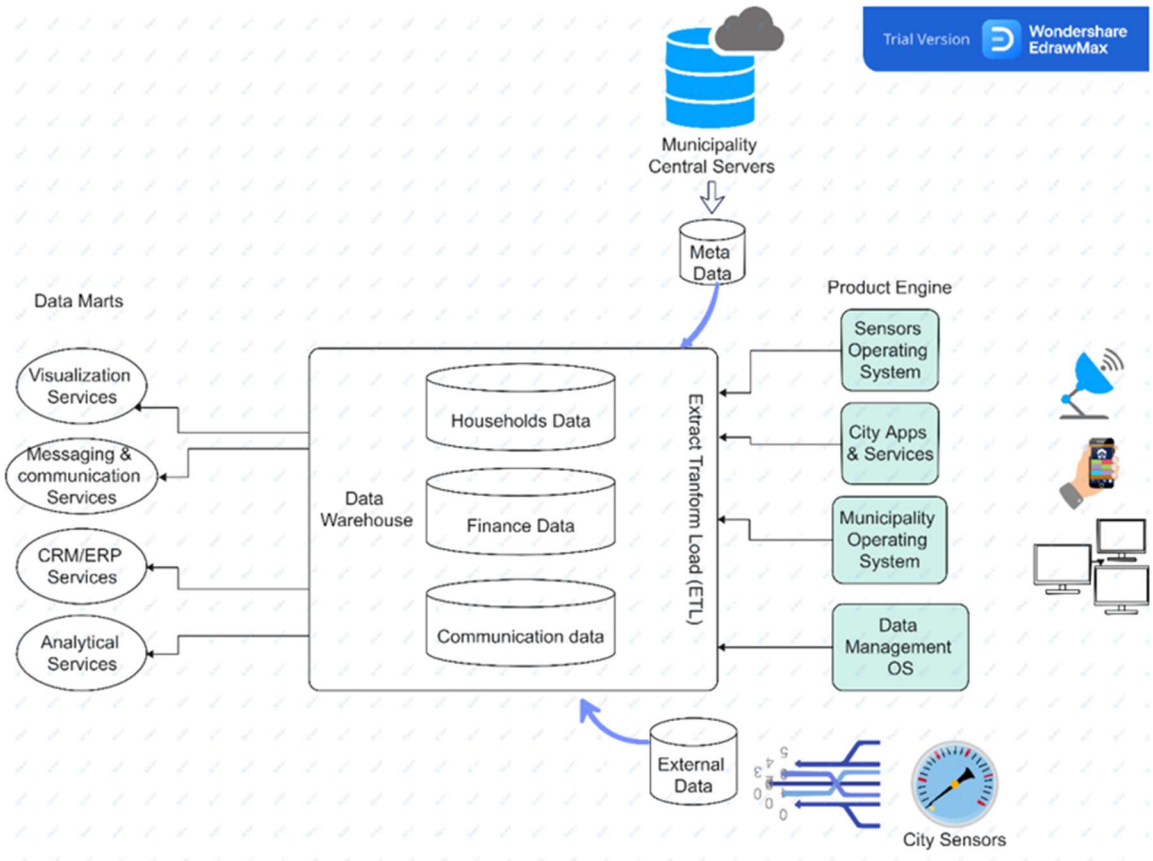
All the data will be stored in a central database related to the municipality cloud repository. Multiple communication channels connected to every data extractor/sensor will guarantee the flow of information to the central municipal repository.

Data Access

The central container will take in charge the role of a gatekeeper for the flow of information. It will guarantee giving access of the data to only some predetermined parties that are eligible to receive and collect it from the central repository.

Data Distribution

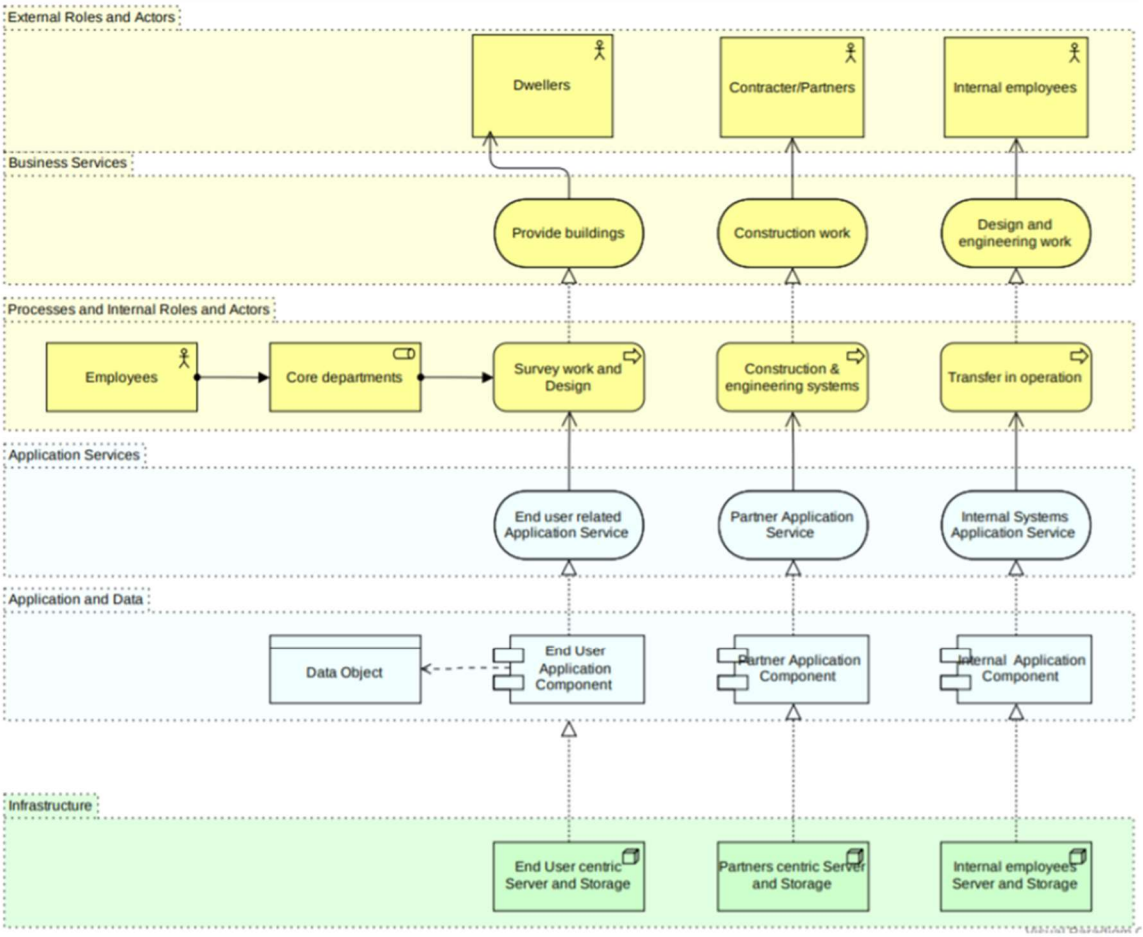
All the relevant data to the urban system planning system is collected and stored in one central repository to which all other applications are connected (see figure below). The meta data is stored securely in the Municipality servers and only can be accessed through the central data warehouse. This indirect connection between the different business applications and the meta data guarantees the protection of the archives of the original information. The different installed sensors over the city are the enablers of the extraction of external data that will be transformed and loaded to the main repository through each specific system. The resulting output are the different services that generated from the collection of all these sorts of data.



11. Figure Data Architecture Overview

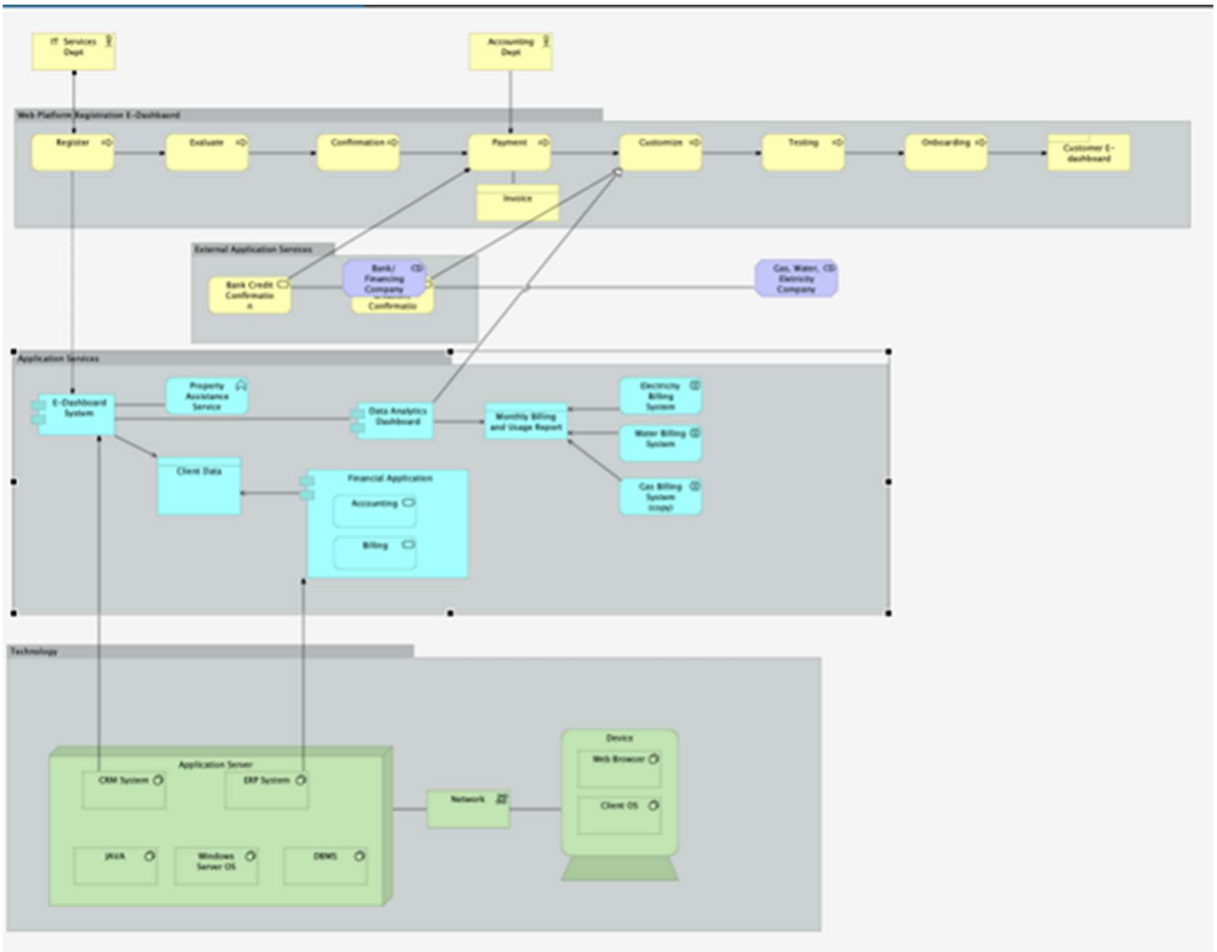
1.6.3 Application Architecture (tbd)

1.7 Technology Architecture[7,8]



12. Figure Technology Architecture

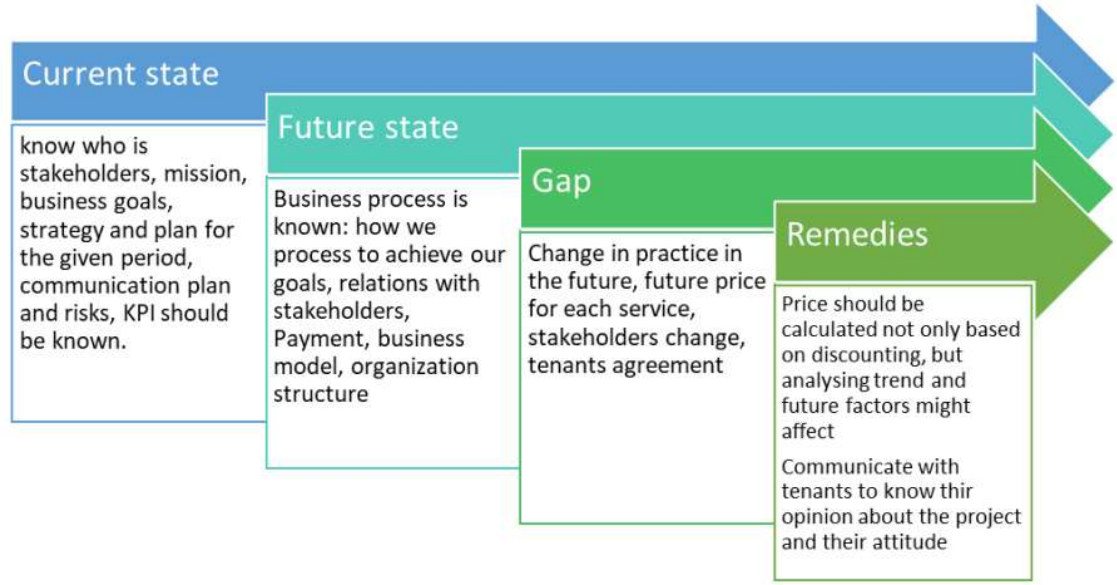
[7] Riadh Bouakez, Farman Garibov and Khurelbaatar Buyantogtokh
[8] Irah Mariey Sitchon, Sayyora Orazbaeva, Saisugathri Narasingu, and Mohammad Wael Dahman



13. Figure Deatled Technology Architecture

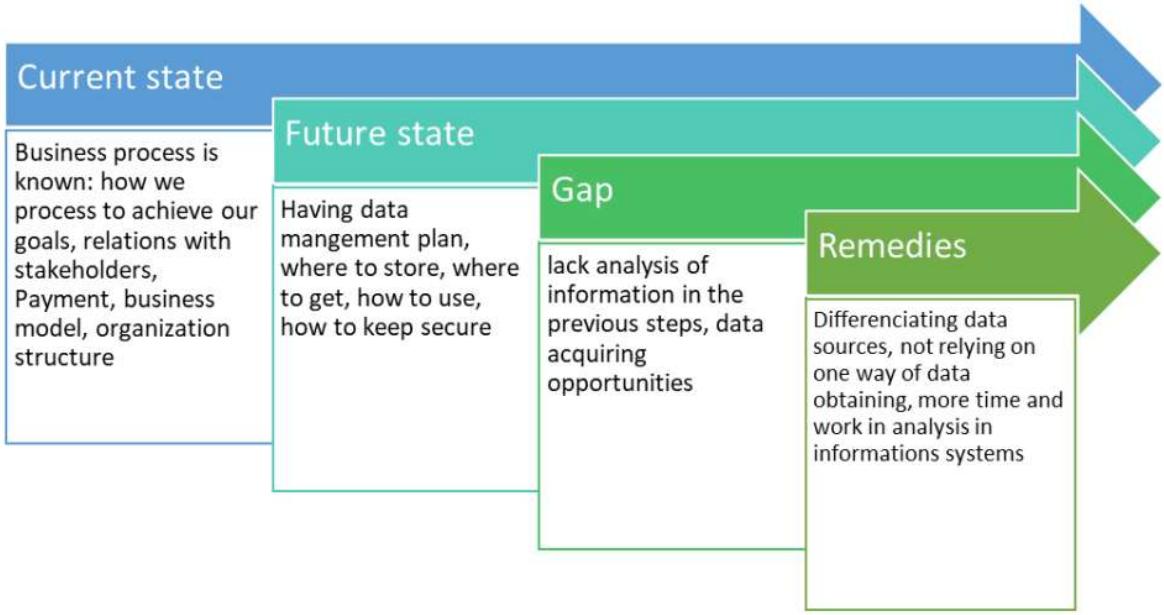
1.8 Opportunities and Solutions – Gap Analysis[9]

Phase A (Architecture Vision) to B (Business Architecture)

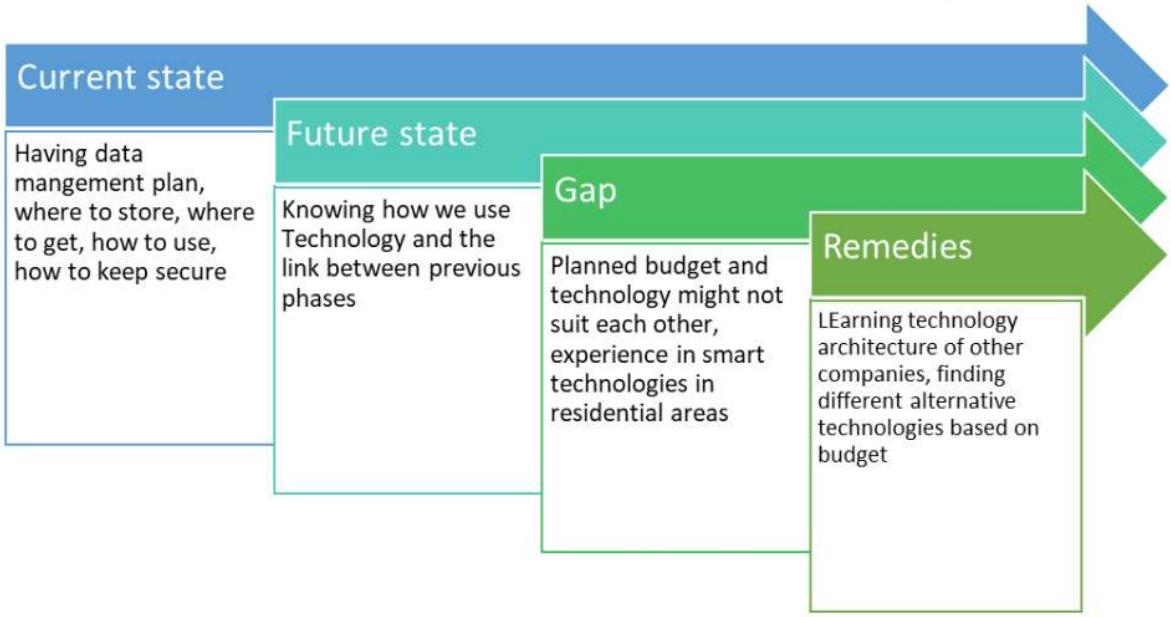


[9] Irah Mariey Sitchon, Sayyora Orazbaeva, Saisugathri Narasingu, and Mohammad Wael Dahman

Phase B (Business Architecture) to C (Information System Architecture)



Phase C (Information System Architecture) to D (Technology Architecture)



1.9 Teaching Experiences and Conclusions

1.9.1 Experimenting

The “Urban Development” case study has been taught in master, doctoral and postgraduate courses

	2020/21	2021/22
Business Informatics Master (HU)	25 students / 7 teams	21 students / 6 teams
Business Informatics Master (EN)	13 students / 5 teams	18 students / 5 teams

Information Manager (postgrad.)	16 students / 5 teams	21 students / 7 teams
Data Analyst (postgrad.)	27 students / 10 teams	32/ 9 teams
Business Informatics (PhD)	5 students	5 students
Total	86 students / 32 teams	97 students/ 32 teams
Grandtotal	183 students / 64 teams	

Hungarian students worked on the case study in Hungarian, foreign students (from very different countries with different background (a.o. Azerbaijan, China, Germany, India, Jordan, Philippines, Mongolia, Syria, Tunisia, Uzbekistan) worked on the case in English. In the latter case, not only the language difficulties, but the lack of the proper knowledge of Budapest geography and history might have been a barrier.

Teaching method. Each course had been divided into four parts. The first part was devoted to (a) introduction into business information systems, (b) enterprise architecture concept, (c) TOGAF and (d) ADM. During the first part the "story" of the case study was introduced, as well.

The second part delt with requirements (smart city as medium for contextualisation), architecture vision, baseline and target architecture, business architecture. By the end of the first part, teams presented their initial solution, that we thoroughly discussed in the class. After presentation and discussion students continued working on the case.

The third part addressed the information system architecture, more focus was given to the application, than the data architecture. In this phase the technology architecture was also introduced, and it depended on the teams how far they go with the case. At the end, the presented second time their solutions, they were discussed again in details.

In the fourth section of the course opportunities and solutions, implementation, governance, and change management issues were shortly presented, and student teams presented their final solutions.

1.9.2 Experiences

The **first milestone**, the creating the business architecture, was usually the time for frustration and disappointment. First, they realized the difference between solving a toy-problem and working on a e real-life case is huge. T & L objectives of this part (a.o.) are to make explicit the importance of the contextualization of a real-life case, separating different actions that may lead to the partial solution of the global problem, the need for handling conflicting particular objectives in the context of the case, to understand the role of priorization, to cope with enablers and barriers. This is why they have to remember other knowledge, sometimes experiences than what they learn during the enterprise architecture course.

As an initial step they started to decompose of the problem, but through this step always lost several other important dimensions and the end-result looked like solving a tiny particular problem. Discussions of the first draft of case study solution were rather psychological treatment than talking about architectural details.

> At the end of one of the postgraduate courses I asked the students how they felt about the case. The spokesman of the best team told, they felt awful, first they did not understand what the problem is, then they spent hours with searching and investigating the background context, they had to read plenty of different publications while they could put together the complex approach. This is what I exactly wanted.

The **second milestone** meant composing the information system architecture. After the discussion and reviewing, orientating the business architecture, this phase was much easier for most of them. The reason may come from the fact they enrolled in BIS courses, they have more motivation in information system context, but also this part of development is more concrete, more technical, there are more methodological, technological "stepstones" where they might feel more comfortable, confident themselves. As a course outcome, the good feeling gives back the motivation. The discussion focused on partly the narrow professional BIS related questions (data sources, data management, application development, technological considerations). Another part of the discussion addressed feedback to the target and business architecture. s at this phase the granularity of architecture design was deeper, it provided a sound basis for fine-tuning the output of the previous phases.

> To my surprise, many of the students were reluctant to go back a previous "homework", as they felt some unfairness, or dishonesty to change something in an already submitted work. Took some time to understand this untold feeling, but then we could overcome this barrier.

The **third milestone**: coming up and presenting the final solution meant the real revelation. In majority the team efforts resulted nice and relatively complete deliverables.

1.9.3 Conclusions

Nevertheless, running *10* courses with *183* more or less interested students in *64* teams provided a sound basis for drawing some conclusions.

The *course structure* was the first constraint that we could not overcome. The architecture-based BIS curriculum assumes overcoming the fragmented course logic of teaching, and instead of the collection of more or less fragmented course portfolio teaching and learning is centred around the problem-solving. Obviously, students must be able to master a basic toolset, but above the minimal BIS skillset, the rest of the "art of information systems design" can be and should be absorbed during the work on solving problem(s). This approach neglects the traditional course logic (which rather mirrors the staff's academic interest than the actual T & L needs), and finally, opens a wide channel for practising soft skills (presentation, team working, comparative competences and others).

Under the mentioned circumstances the assumption of the knowledge obtained during the students' earlier studies remained the only option. Because of the slightly or very different approaches of the

different courses, students (independently of their age, background, position) are willing to focus only on the ongoing course, to recall earlier learnt material needs special efforts (a kind of psychological barrier). After a strong cognitive massage students realized recalling knowledge and skills from the “past” is not a weakness, but on the other way around, it is a serious advantage for them.

In the previous section (“Experiences”) we could observed the *specific learning curve*: from the frustration to the revelation. Although the learning curve specifics was observed through “learning by doing”, it is worthwhile to be prepared explicitly in advance.

We earned several proofs of the advantages of the architectural approach. Combining IT, business economics, information management helped them to cope with the complexity of the case. The complexity needs to be enhanced in the direction of *social sciences*, especially the smart city context lighted out the lack of social, and partly economic viewpoints, sensitivity.

Future developments might aim to integrate more domains into one larger course in order to give time teaching and learning connecting but necessarily case relevant pieces of knowledge. Another breaking up with the tradition, instead of one course instructor, a *team of instructors* (of different disciplines, background and/or experiences) would guide through the students.

2 SCOTTISH CRANNOG MUSEUM – SMART MUSEUM

2.1 Smart Museum in the Smart City

Museums are traditionally thought of as "all for the eye, nothing for the hand". The primary role of museums is to present the documents, art pieces or other artefacts of history, fine arts and other professions, and to make their collections accessible to the general public. Recently museums, while retaining their original functions, have been interestingly integrated into the modern, or if you prefer smart world, and have become a primary site for **non-formal learning** (see museum pedagogy), in addition to collection enrichment. Viewing is replaced or at least complemented by interactivity, and museums are becoming a kind of knowledge centre in the general process of digital transformation. This transformation goes hand in hand, of course, with the expansion of functions, the expansion and change of relations with the wider environment. Observing the trend of change, we can safely interpret the transformed museum as an integral part of the smart city concept, an entity that is an important site for education and training, for improving the cultural environment and, more generally, wellbeing of citizens.

2.2 Purpose of the case study

The purpose of this case study is to develop a framework for Business Information Systems (BIS) keeping in mind the challenges imposed by the COVID19 pandemic and the increase of online learning and hybrid delivery. The subject matter in this case is to incorporate the 'Technology Architecture' as part of an undergraduate module in 'Business and Information Systems (BIS)'. The Enterprise Architecture (model, management, development) was chosen in the BIPER project proposal as the theoretical foundation of the BIS Teaching and Learning (T&L) process. As such, the case study must reflect the minimum complexity and detailed levels (domains) of EAM.

2.3 Relevance of the case study from UWS perspective

Relevance of this case study with the existing undergraduate course in UWS. The Business Technology program in UWS has been designed to reflect the importance of how and why businesses adopt and make use of new approaches and new technologies and to instill graduates with core IT and business skills. This program is distinct from traditional computing programs in that it does not focus on programming or other specialist technical skills. Rather, it recognizes that there is a need for good general technical practitioners working in SMEs out with the technology sector who have been educated in the key aspects of business technology and who can provide organizations with an exemplary technical support and maintenance skillset as well as being able to function in a key business role.

The program delivers a combination of technology and business- related modules in every year, some of which are designed around accredited material from organizations such as Microsoft, Cisco and the British Computer Society, affording students the opportunity to supplement academic studies with professional certification, if they so desire. Typical roles from this program includes Business Systems Analyst; Data Analyst; Project Manager; Technical Support Specialist; Systems Administrator; Business Intelligence Analyst; Data Analytics Specialist; Business Technology Consultant; Technology Trainer; and Teacher. Students who graduate with an honors degree will be eligible to proceed to a variety of business and/or technology focused Masters' programs.

2.4 The Scottish Crannog Centre

The Scottish Crannog Centre is a museum that was established to preserve prehistoric underwater heritage in Scotland. One of the heritages that the museums preserves is the Scottish Crannog, a stilt house built on a Scottish Loch that was used as dwelling during the Iron Ages. Archaeologists from the museum have been exploring 1500 years Crannog's dwellings since 1980 and reconstructed one of such dwellings based on excavation results. This museum runs from funds collected from varied sources. The long-term sustainability for this museum in the perspective of potential business model, technological modernization to draw more audiences and continued support for potential archaeologists and researchers are the goals for this document.

2.5 Vision

The museum is looking to move on another location and to digitally transform itself into a smart museum, where technology is seamlessly integrated within the exhibitions and galleries to enhance the visitor experience, help manage the collection and preserve the artefacts. The museum relocation involves real estate development, such as new Crannog reconstructions, cafe, restaurant, gallery, and re-enactment areas. The digital transformation covers the IT services and ~~hardware~~ infrastructure necessary to deliver services such as web hosting of images of the pre-historic dwelling site, online booking system for the visitors, an on-line networking facility for the archeologists working in this location so that they can exchange the gained knowledge with other researchers. Moreover, the IT and hardware infrastructure need to support immersive technologies, such as web hosting of augmented reality and virtual reality applications, kiosks, interactive walls, and a CAVE system.

The museum will be **relocated** in a new area with modern architectural design and IT infrastructure to draw the attention of visitors and researchers.

The management from museum decided to go ahead with the concept and started the procurement process for the construction / development companies. However, during the preparation of the technical requirements, it emerged that a background service company would be hired to coordinate the work of the selected companies and to better articulate the aspects of museum management. This service company will primarily help developers through IT services.

2.6 Museum Planning Context – Preliminary Requirements Analysis

Taking into account of the stakeholders, several different requirements were enlisted during the preliminary requirement analysis. The museum intended to give full access to archaeological research beside the usual museum services. Due to the limitation of space, they prefer the scheduled visits. Also, the museum intended opening the formal education, to schools, local communities. Another request was to provide a platform for smart entertainment, connecting on-site and remote

activities via mobile apps. From a technology development point of view the following features are highlighted, as basically required from developer companies

2.7 Technology principles of the digital transformation of the museum

Connectivity	What types of data connectivity will be incorporated (fibre-optics, cable, wireless etc)
IT Infrastructure	What are the network infrastructures (Network switches, Routers, Firewall devices, Data Servers, Application Servers)
Web Development	What are the contexts to be added in web development process?
Secured Networks for the researchers	Weather security is paramount for the researchers' net? Why and how?
Online Bookings	How the online booking system could be simplified for the general audiences?
App Development	Importance of Apps development for the museum for better ubiquity.
Data Visualisations	To monitor the continuous performances of the museum activities, how the data visualization could be incorporated on the website or internal network pages
Image Processing	The technical representations or visualisation of data or images using technologies such as machine learning /AI to meet the requirements for the audience.
Renewable Energy	To reduce the operating cost, how the renewable energy system (solar/ wind, charging points for the electric cars) could be utilised in the complex.
Smart lighting system	How the solar lighting system could be utilised in a smart way in line with the electric light to conserve the energy? This is also true for the heating or cooling systems for the complex.

~~Expectations for real estate developers can be formulated along the following principles:~~

Museum management expect the following deliverables from the coordinating company

RfP based on the Requirement Analysis	How to develop the requirements for the developer companies?
Archaeological representations in the complex	Important of gathering the views or recommendations from the prominent archaeologists.
Smart City Concept	How is the smart city concept added in the design?
Project Initiation Document (PID)	Development of project management document.
Risk Analysis and Mitigation	What are the risks, if the project is not progressing well, time schedules etc.
Architectural Design	Third-party architectural design for the museum complex and finalising the design in-line with the decision makers.
Architectural Work Approval	What are the processes involved in design approval?
Transitioning Infrastructure Development	What might be the consequences on existing infrastructure for the new site and remedial actions?

Impact Analysis	What might be the consequences on the surrounding people living in the new site and compensation methods?
Revenue generation	E.g., Café, Cinema studio with immersive technology etc. How?
Sustainability	Is it possible to rent some parts of the complex (such as café, gymnasium) for fund generation towards self-sustenance?

2.8 Narrow Problem 1 - The Virtual Crannog

2.8.1 Brief

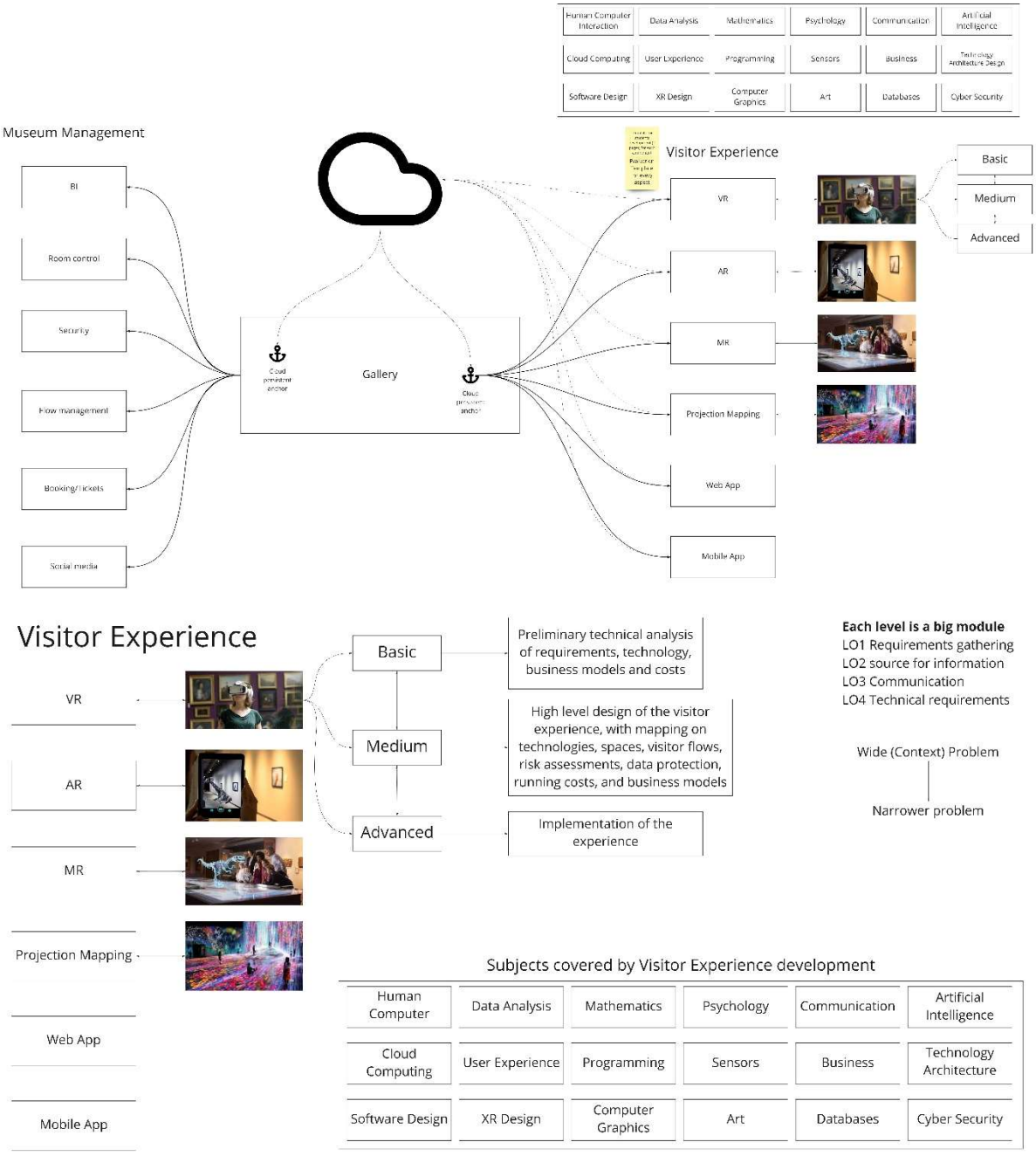
In July 2021 the Crannog reconstruction burned down, within 6 minutes nothing was left, other than a bunch of burned poles sticking out of the loch (Figures 1 and 2)

The Scottish Crannog Centre will re-build the stilt roundhouse, but it will take time.

In the meantime, they would like to let the visitors see the Crannog on the Loch again as it was before it burned down (see 3D model here https://skfb.ly/6tqzv) using immersive technologies.

Your task is to analyse this problem, identify possible solutions, what it would be needed to implement them, and study the feasibility of the identified solutions, providing overall costs of the solution, limitations, and requirements for their implementation. You should provide an ideal solution and at least two alternatives from which the museum management can choose.

The solution should be accessible by a large number of visitors, easy to maintain and provide a high fidelity three-dimensional visual representation of the Crannog before the fire.



It is recommended that a double diamond process [1] is followed to design the solutions.

2.8.2 Tasks

Task 1 - Problem analysis (Basic)

- Aim and Objectives
- Environment
- Discover Phase
    - Stakeholders
    - Stakeholders' Needs

- Resources needed
- Timeframe
- Risk assessment
    - Project
    - H&S

Task 2 - Solutions identifications (Basic/Medium)

- Define Phase
    - Brainstorming
    - Vision
- Ideal Solution
    - Experience design document
        - Goals
        - Story
        - Environmental Storytelling
        - User Experience
            - Emotions
            - Agency
            - 3D Interactions
            - 3D UI
        - Multisensory stimuli
            - Visuals
            - Sounds
            - Haptics
            - Smell & Taste
        - Visitors Flow
            - Flow paths
            - Flow rate
        - Risk assessment
            - Project
            - H&S

    - Technical design document
        - Hardware Requirements
        - Software Requirements
        - Assets Requirements
            - Digital
            - Physical
        - Operation Requirements
        - Maintenance Requirements

- Alternative 1 (same structure)

- Alternative 2 (same structure)

Task 3 - Solutions Feasibility (Medium

- Main Solution
    - Costs
        - Upfront Costs

        - Running Costs
        - Maintenance Costs
    - Accessibility
    - Requirements Assessment
        - Software
        - Technical
        - Human
        - Business
    - Limitations
- Alternative 1 (same structure)

- Alternative 2 (same structure)

Task 4 – Prototyping of selected solution (Medium/Advanced)

- Iterative prototyping
- Documentation
- Version control
- User testing
- User feedback
- Business testing
- Business feedback

Task 5 – Final implementation & integration (Advanced)

- Final Implementation
- Documentation
- Version control
- Business evaluation
- User evaluation
- Integration within business

References

[1] https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond

3 KRANJ AS A SMART CITY

3.1 About the city

The Municipality of Kranj is the economic, commercial, traffic, educational, and cultural center of Gorenjska region and provides home for 60.000 citizens. It covers an area of 148 km2 and lies at the crossroads of important traffic routes leading from northern Europe to the Adriatic and from western Europe to the east. Its population is 58.527 inhabitants, with average age of 37 years.

In the last years, Kranj is gaining recognition for its efforts to improve sustainability of tourism, mobility and overall lives of its inhabitants. In 2020 municipality Kranj accepted updated strategies; Urban sustainable strategy 2030 (Kranj innovative city) and strategy of digital development, smart city and community Kranj (2020-2030) that chart pillars of strategic development and outline future activities. In 2020 Kranj was recognized as a second-best Slovenian city in e-mobility (falling behind the Ljubljana), but took over the race and was awarded first place in 2021.

More information about the city, its history, places of interest, walking areas, tourism and culture, sport, health and traffic is available at the following resources:

https://www.kranj.si/
https://www.kranj.si/en/about-kranj/kranj-in-numbers
https://www.visitkranj.com/

3.2 Recent projects – state of the art

3.2.1 Smart mlaka

There are many projects that are currently ongoing in Kranj, one of key ones being Smart Mlaka. Mlaka is a small community next to Kranj that shares energetics, utilities and public traffic infrastructure with city Kranj. As such it was chosen for pilot smart city project to test innovations before they are being implemented on a larger scale. Mlaka became a sort of a training ground for the introduction of sensors (internet of things) in the energetics and utilities infrastructure, as well as new traffic policy. Municipality is collecting data from Mlaka's infrastructure, this data is being fed into web and mobile applications to inform locals, as well as using it to test different scenarios on Mlaka's digital twin.

3.2.2 Mobility

Kranj's 2020 strategic documents are strongly connected to the goal of sustainable and smart mobility. Municipality Kranj is operating with a clear goal, they want to reduce CO2 emissions, the amount of dust particles and noise. Sustainable mobility projects are not new to Kranj. Municipality is transitioning its business car fleet to electric cars. They are setting up charging stations and ensuring that the energy used by cars will be produced by municipality itself in the most ecologically possible way - with the help of photovoltaic (solar) power installed on the roofs of municipal buildings. From 2017 there is an electric mini bus offering free rides to tourists and locals in and around city centre. Municipality currently operates the largest electrified system for bike sharing in Slovenia (KRsKOLESOM) that is expanding every year, they are also expanding reserved car sharing parking spaces around the city for sharing of electric vehicles (Avant2Go).

In the last years, Kranj invested in updating and adding to its cycling infrastructure, in 2019-2020 alone they built 9km of cycling paths and added several new bike sharing points. In 2020-2021 municipality built Sustainable mobility centre in the middle of its larger neighborhood Planina. Sustainable Mobility centre was open in May 2021 and offers an option to register into all vehicle sharing systems (bike,

electric car, as well as public bus system), they offer workshops on sustainable mobility, they recently even organized cycling flea market. Sustainable Mobility centre employs a professional bike repairman that offers his services from Monday to Saturday, but there is also a publicly available station with tools and pump to allow simple repairs for bikes. In a range of 50m around Sustainable Mobility centre you will find 2 city bus stations, as well as bike sharing station and 3 parking spaces reserved for electric vehicles in Avant2Go car sharing system.

In 2021 bike sharing system spans 28 stations in and around Kranj city. Next to 95 regular bikes it also offers 75 electric bikes and 2 cargo tricycles that are available for inhabitants of city centre to help them transport heavier baggage to their apartments in a city centre that is mostly closed for traffic. In 2020, municipality Kranj joined 4 municipalities in the region (Naklo, Radovljica, Tržic and Jesenice) in an effort to create unified bike sharing system Gorenjska.bike that is currently offering 245 bikes (more than half of them electric) to locals and tourists under single provider and monthly of yearly payment plan.

Apart from that, Kranj is also partnering with Telekom Slovenije as a first Slovenian municipality testing innovative traffic calming technology.

3.2.3 Energetics

In partnership with regional electricity and utilities infrastructure providers, Kranj started energetic renovation of public buildings. One of the buildings that was chosen for renovation is the building of Faculty of organizational sciences, but in the last 2 years several schools and other public buildings were renovated to improve energy efficiency, switch to more sustainable energy sources, improve air ventilation and install solar panels.

As Kranj lies in the mountainous region, it is more prone to heavy snowfall, which affects electric infrastructure. Many areas in the region are also protected as they are a part of the Triglav National Park so the built infrastructure shouldn't stand out from the natural environment and should only use natural materials. Elektro Gorenjska, which is operating electric infrastructure in the region committed to improve the security of electricity infrastructure against natural disasters by laying cables in the ground instead of providing electricity by air which is otherwise common in Slovenia.

As was mentioned before, municipality is changing the fleet of their business vehicles and installing solar panels on public buildings, so that in a few years, public employees will only be using electric vehicles and electric energy that was produced on public buildings.

As a part of Smart Mlaka project, electric infrastructure was equipped with sensors. The final solution of the project will enable collection, display and analysis of data from smart meters (for electricity, gas and water), as well as smart sensors for the environment and traffic. This will provide an insight into the management and challenges of energetics. Project partners are aiming to create a model that will be suitable for implementation in the rest of the municipality and beyond. The goal is to raise the quality of life of local inhabitants with the use of digital solutions.

3.2.4 Environment

E-environment in Smart city Kranj encompasses environmental changes through technological development and services that helps citizens to live in a cleaner, greener and less noisy environment. The aim is to create more data and information supported environment that would help to better inform the citizens about the environment and related challenges.

Current state of eEvironment area in Smart city Kranj is slowly progressing towards the aim of more connected and digital environment. Currently, the citizens can obtain some information about the environment through the measurements about the quality of the air on the (https://www.kranj.si/kranj-moje-mesto/kakovost-zraka) website. Notifications about the state of drinking water supply is currently regulated only through the website of communal service Kranj website (https://www.komunala-kranj.si/oskrba-s-pitno-vodo). The eEnvironment informatization is therefore more focused on younger population, which are generally more skilled by using the digital services and technology, than elderly ones. The informatization level of eEnvironment of Smart city Kranj is currently still quite limited.

On the other hand, in 2020 was established a pilot project called Smart Mlaka (https://www.kranj.si/vzpostavili-pametno-sosesko-mlaka-pri-kranju). The final solution of the project will enable the collection, display and analysis of data from smart meters (electricity, gas, and water), smart sensors for the environment and traffic. Citizens will have independent access to air quality data directly from the measuring device and receive warnings about potential dangers (e.g. air pollution). One of the deliverables of the project will be also the implementation of smart lightning, where the lights will be switched on and the lighting power adjusted according to the external conditions and actual needs of people or traffic, so it will be less disruptive for citizens and environment. One of the aims is also to lower the C02 exhaust by using the electric vehicles and enable greener and more sustainable environment. The citizens can rent an electric car through the mobile application and thus contribute to lower environmental pollution. One of the important elements is also waste management system and its optimization. Waste management systems, lighting, water, sewerage, energy is well developed and available on the market, they only need to be implemented in a connected smart community system and constantly upgraded.

Overall, the informatization of the e-Environment in Smart City Kranj is slowly progressing, also with the help of pilot projects like Smart Mlaka, and with the start of the changes of the citizens habits and business entities through the data provided by the smart sensors integrated in eEnvironment.

3.2.5 E-democracy

E-democracy in Smart city Kranj encompasses government, organization and formulation of proposals related to citizens that are settled in urban area of Kranj municipality. The aim is to promote citizens' participation in different areas that impact their quality of life (transportation (smart mobility), politics, governance, education, public transparency and citizens' rights, among others). By using the digital smart phones and other devices citizens can find all relevant information on-line and submit ideas (initiatives) for development and improvement of life in Kranj. Those who are not ICT fluent (e.g elderly) can gain information by reading the local newspaper and by contacting the municipality via phone. They can also submit ideas by filling in the paper form. As Municipality Kranj expect that with the time this way will become completely obsolete they plan to provide all services for participation in social decisions on-line.

Currently, the citizens can find all the necessary information on-line (mobile application iKranj, websites and social media). They can also search and submit ideas concerning the quality of life in Kranj by using KrPovej (krpovej.si) website. Other e-democracy processes that enable citizens participation in social decisions are not supported jet. Particularly, they plan to support by digital technology the following:

- Manage submitted ideas:
    - Rang submitted ideas (initiatives) by relevance and importance and suggest quick and appropriate response to the proposal.

    - Vote for realization of submitted ideas that are selected as relevant and important.
- Transparent plan and execution of ideas that are voted for realization.
    - Include in the planning and execution all actors with the shared interests. Citizens can provide valuable insights to make more informed plan and less issues can arise during the execution of the project.

3.2.6 E-administration

E-administration in Smart city Kranj is quite obsolete. For citizens they are available during official hours (personally or by phone) and via e-mail. Applications and forms are available on their website. Citizens can download and print application or form. The filled and signed application or form can be sent via regular mail or citizen can bring it personally during office hours. More electronical way is to send them via e-mail but the form needs to be digitally signed by using a certificate-based digital ID. They offer more advanced electronical submission (https://dovolilnice.kranj.si/) only for permits (e.g. permit for parking, deliver in the pedestrian area, …) but without the use of digital certificate as the registration into their system is sufficient for this kind of forms. Still for the electronical submission of other application and forms where the use of digital certificate is needed, the solutions is not available yet.

Their internal administration processes are not supported by digital technology yet. They are not using a document management system, so the applications and forms submitted electronically are printed out. Also, the response to the submitted document is send via regular mail. Thus, they are dealing with a lot of paper and have unnecessary costs. Based on the current state of e-administration they have two digitalization objectives:

- Submission of applications and forms completely electronically.
- Management of the received documentation by using document management system and electronic archive.

3.3 Strategy for Kranj smart city digital development 2020-2023

3.3.1 Overview

The Municipality of Kranj has adopted the Sustainable Urban Strategy of the Municipality until the year 2030, which defines the key development challenges of the Municipality of Kranj as the center of the Gorenjska region. The document also identifies priority thematic areas and strategic objectives, to the achievement of which digitalization can make an important contribution.

Kranj wants to become a city of opportunities, a sustainable, progressive and vibrant urban center of the Gorenjska region, and this overall goal cannot ignore an orderly, modern and powerful information technology environment. Digitalization is already taking a strong role today and will have a much greater impact on practically all areas of life and work in the future. Therefore, its development, based on well-thought-out strategic planning, is necessary for the integrated development of Kranj.

We see an easily understandable digital development strategy as the most effective foundation for planning and accelerated implementation of digitalization. Digital development strategy defines key development concepts, areas and solutions. The strategy is open to new services, solutions and technologies that will prove to be relevant in the future, so it is a robust foundation for future development.

The goal of implementation of a digital strategy for smart city development is a comprehensive information and communication environment with clear coordination, connected processes and

platforms, understandable and accessible data and sufficiently powerful communications. In such an environment, existing and new solutions form a connected whole with well-utilized information resources for the needs of citizens, the economy and city management.

A preliminary analysis of the situation in the field of digitalization in the Municipality of Kranj showed that all key functions of the city administration are supported by information technology solutions. There is also a number of specific solutions supporting work of the city administration and the needs of citizens. In addition, the analysis also shows that solutions are poorly connected, often installed and managed on completely unconnected systems and often poorly known and used by target groups. The strategy presents the development concept that will connect the existing solutions and accelerate the development of new services in the connected/integrated information environment of the Municipality of Kranj.

More information about the strategy:

https://www.kranj.si/mestna-obcina/strategija-digitalnega-razvoja-pametnega-mesta-in-skupnosti-kranj-2020-2023
https://www.kranj.si/files/06_mestna_obcina/strateski-dokumenti/strategija-pametno-mesto-gradivo-za-mestni-svet-14102020.pdf

3.3.2 Smart city digital strategy

The strategy consists of the following content and key areas, which are shortly presented in the next paragraphs:

ASSESMENT OF ICT ROLE IN KEY CHALLENGES AND GOALS DEFINED IN SUSTAINABLE URBAN DEVELOPMENT STRATEGY OF KRANJ

- Image of the city and development energy with the aim of accelerated industry development and job openings after crisis
- Collaboration and communication between all stakeholders in the municipality (e.g. open data for trust building)
- Regional role of Kranj (development of solutions and sharing them with other municipalities in the region)
- Co-existence between city and rural environment (digital infrastructure, availability of services)
- Job openings, growth of enterprises and investments (restructured market, from large to many SMEs, digital infrastructure, open data, flexible employment, work from home, industry collaboration)
- Concentration of ICT enterprises and technologies in Kranj (many ICT enterprises in Kranj, Development center ICT, smart city strategy, implementation of robust integrated information environment for coordinated management, integration of processes, data sharing and ICT infrastructure for processing, sharing and archiving of data, services for citizens, increasing of productivity and development opportunities for industry and sustainable development of the city.
- Young people and families (infrastructure, opening for new developments, encouraging of talents, employment, new services and contents, digital services, learning environment, employment, integration of younger population in the society by the use of ICT)
- Traffic system and infrastructure (traffic management, new (e)mobility models)

- Management of natural resources and climate changes (waste management optimization, energy efficiency, public lighting, water management, the need for integrated system, use of ICT for information sharing, awareness and knowledge building
- Spatial policy (information sharing, mobility)
- Revitalization of the old town of Kranj (tourism, events, cultural heritage, …tourism platform, search engine, shopping platform, design of new services for visitors)
- Changes of life style (new services and platforms for citizens encouraging active free time, self care and health care, culture, integration of different stakeholders and service providers, gamification)
- Cooperation with Ljubljana and other European cities (best practice, knowledge sharing, education, logistics, … integration of information systems)

Details are available in the Strategy (https://www.kranj.si/files/06_mestna_obcina/strateski-dokumenti/strategija-pametno-mesto-gradivo-za-mestni-svet-14102020.pdf)**.**

MANAGEMENT OF INFORMATION TECHNOLOGY ENVIRONMENT

Extreme technological complexity, fast changes and unpredictable future have to be taken into account for successful management of IT environment. Having these challenges in mind, the following perspectives have to be addressed:

- Organizational management (central, integrated, management bodies defined)
- Process based management (analyses, overview, definition of key processes, input data, resources, process owners, decisions to be taken, optimization of processes)
- Data management (overview of key assets, definition of content, meaning and unified understanding of data, key responsible employees for different data and databases, definition of data status related to security, availability, storage, design of data glossary for data sharing, new services design, definition of requirements and implementation of the technology for digital platform for data lake)
- IT infrastructure management (desktop applications, servers, other HW, communication infrastructure – LAN, WIFI, IoT – LoraWan, Narrowband, 3G – 5G, sensors for air, water quality, measurement of energy and water consumption, traffic and parking management, …)

Details are available in the Strategy (https://www.kranj.si/files/06_mestna_obcina/strateski-dokumenti/strategija-pametno-mesto-gradivo-za-mestni-svet-14102020.pdf)**.**

DEFINITION OF COMMON SEGMENTS AND ARCHITECTURE OF IT INFRASTRUCTURE

Integration of systems, data and services is needed for development of smart city. For that purpose, it is important to define and implement:

- the content manager of the common infrastructure, who is also the coordinator of the various stakeholders and their subsystems and data,
- data storage space (data lake),
- data management system

- a common communication platform that provides access to data and services from different stakeholders in one place, payment systems, user involvement (citizen involvement) and governance with a loyalty system.

The strategy defines in details the technological and content wise requirements, processes and managerial perspectives of building and implementation such an infrastructure.

Functional requirements for integrated digital infrastructure are the following:

- Meta data catalogue
- Architecture and implementation of data repository in central data lake
- Integrated data orchestration
- Open API concept
- Dynamic, on demand Business analytics in reporting
- Central management with algorithms of artificial intelligence
- Definition of KPI based o ISO 37120:2018

National portal for open data should be used as a priority (https://podatki.gov.si/).

Details are available in the Strategy (https://www.kranj.si/files/06_mestna_obcina/strateski-dokumenti/strategija-pametno-mesto-gradivo-za-mestni-svet-14102020.pdf)**.**

KEY PRIORITY AREAS

Common IT infrastructure for integration of systems, data collection and communication between different systems and environment enable fast, manageable and rational development of different solutions. Priority areas emphasized so far are the following:

- Energy management
- Automatic remote meter reading
- Traffic management
- Building of supporting environment for autonomous driving
- Control and security
- Waste management
- Control of environmental parameters
- Public lighting management

These areas were set up by solution providers and by representatives of the City municipality of Kranj and serve as priority areas for the establishment of concrete solutions integrated within a common platform. Local pilot project Smart Mlaka has already realized some of the above mentioned initiatives.

More information about Smart Mlaka project is available on the following links:

https://www.kranj.si/vzpostavili-pametno-sosesko-mlaka-pri-kranju
https://www.youtube.com/watch?v=dM4O8qt9zzA
https://vimeo.com/502615338

Another focusing area is food-self supply. For that purpose, the pilot project group was already defined. The aim of the project is to connect local food producers and their customers, especially public institutions. The solution will enable joint public procurement and the collection of needs adapted to

the current offer and on the other hand a solution for a comprehensive overview of currently local available quantities of different agricultural products. The system will include local growers and customers in order to shorten supply chains, reduce the carbon footprint, promote local self-sufficiency in food and raising the quality of food in (public) institutions.

The overall aim of smart city is wider and covers the areas presented in 14. Figure.

14. Figure Smart City Kranj (Source: Strategija digitalnega razvoja Pametnega mesta in skupnosti Kranj za obdobje 2020 do 2023)

Details are available in the Strategy
(https://www.kranj.si/files/06_mestna_obcina/strateski-dokumenti/strategija-pametno-mesto-gradivo-za-mestni-svet-14102020.pdf)**.**

DIGITAL SKILLS

Smart cities and communities projects are only successful, if the citizens have sufficient digital skills and knowledge. Currently there are no systematic activities in the wider region of Kranj in this area.

However, the Municipality of Kranj committed to become a model municipality for activating talents and promoting innovation and entrepreneurship, which will be based on digital skills and knowledge. These solutions and culture is expected to have regional and wider impact. Activities in this area must deliver measurable results for all target groups, with a special focus on young people and teachers.

The first step will be preparation of »Action plan for Knowledge« and setting up of concrete measures. Co-creation approach, open innovation and design thinking will be used in the workshops with various key stakeholders.

Key activities of action plan are defined in the Strategy
(https://www.kranj.si/files/06_mestna_obcina/strateski-dokumenti/strategija-pametno-mesto-gradivo-za-mestni-svet-14102020.pdf)**.**

DEFINITION OF ACTIVITIES, SOLUTIONS AND FUNCTIONALITIES

In the strategy, the needed activities for step-by-step implementation of smart city solutions are described. In addition, there is an overview of currently available services, which were described in prior chapters. These services present a starting point for integration and new service design.

Some of the further solutions that will have to be designed are the following:

- Remote meter reading for water and gas consumption
- Remote meter reading for electricity consumption
- Data exchange between different providers will enable consumers monitoring and control
- Implementation of city card for citizen ID and payments
- Integration of current services
- Monitoring of citizens and tourists in the city center
- Upgrade of mobile application iKranj
- Establishing of data leak

3.4 Course assignments

The case will be conducted in the Digital business class, which is a part of MIS study program in the 3rd (last) year of undergraduate program.

3.4.1 Smart city challenge in 2018/2019

During the Digital business class, students are either working on the common class challenge, presented by the stakeholders and professors or they design their own innovative digital ideas and are supervised by professors and assistants. In the year 2018/2019, the students were engaged in the challenge Kranj as a smart city. At that time, the representative of the Municipality, responsible for smart city solutions presented current situation and challenges for future development. The presentation was done at the end of the lectures (39 teaching hours), before students started with exercises (24 teaching hours). During the lectures, students were introduced by wide area of digital transformation, digital technologies, digital business and solutions, as well as digital business models. During their studies, the students also gained knowledge from other program specific courses: ICT, Databases, System analysis, Development of business applications, Business information systems, Business models design, Modelling and simulation of systems, Security and Programming.

Students were assigned to the groups. Each group addressed one presented challenge, with the aim to provide the most suitable proposal of the solution (prototype solution). During their work on the assignment (challenge), they were engaged in design thinking process. They were also using several tools that enable critical thinking, problem analysis, design of solution etc. (e.g. rich picture – CATWOE, business model canvas, value proposition canvas, personas, wireframe diagrams, UX, web app prototype, mobile app prototype, different tools for prototyping, etc.). Seven groups of students presented their results in a seminar paper as well as a prototype solution presentation. Seminar works were related to:

- redesign of Kranj city website,
- redesign of mobile application iKranj,
- e-business of municipality,
- digitalization of sustainable mobility,
- digitalization of utility services, e-democracy and e-participation,
- digitalization of Kranj old part of the city.

One of the seminar works is presented in Appendix. At the final day, seminar works were presented by students to the representative of the Municipality, responsible for smart city, which provided feedback information about the feasibility of each proposal.

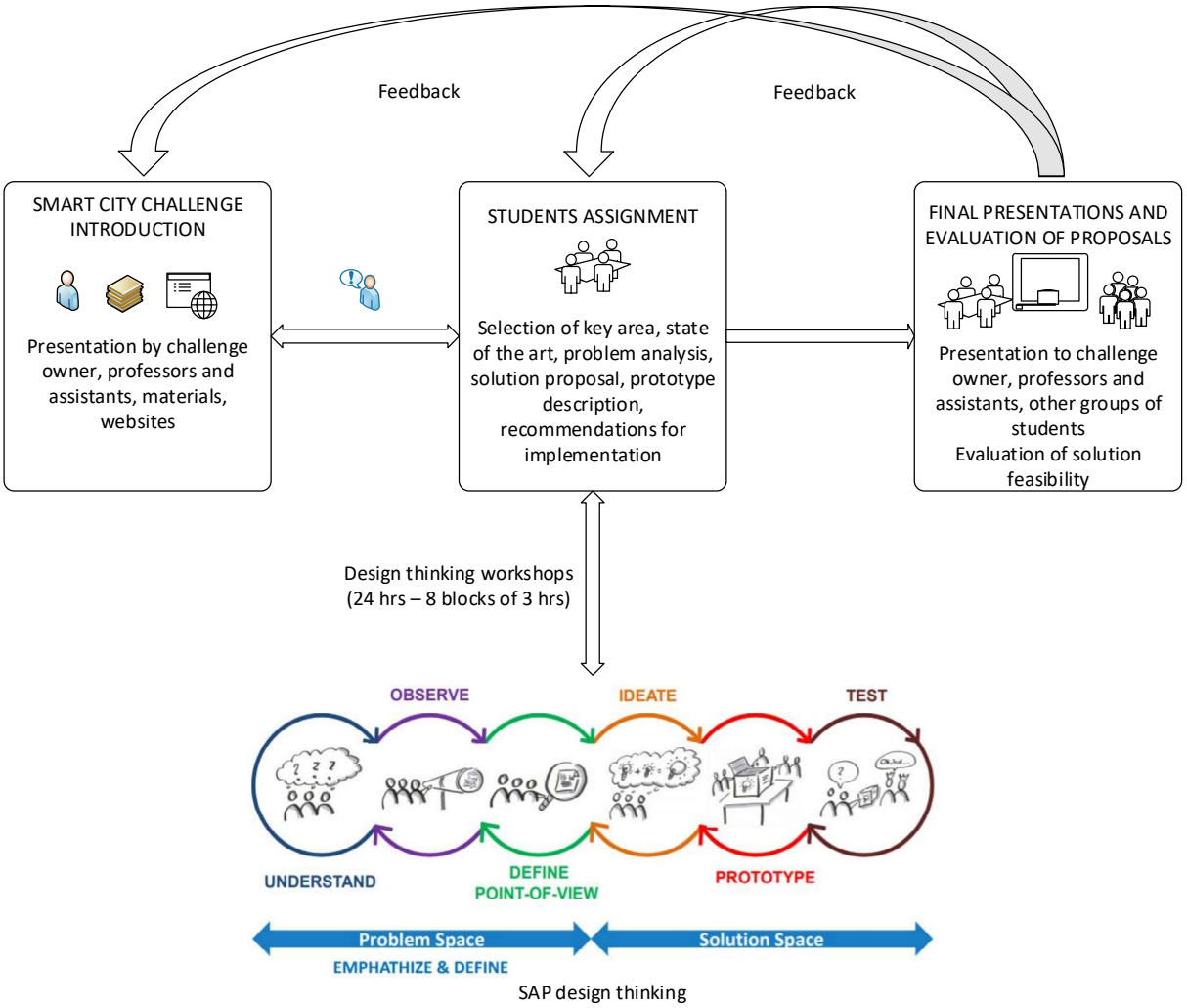
3.4.2 Smart city challenge in 2021/2022

Again this year, the students will work on a common challenge – Kranj as a smart city. The representative of the Municipality, responsible for smart city already provided a number of materials, including presentations from recent smart city related projects presented at various conferences and other events, publications in media as well as formal, strategic documents, which are the basis for future smart city development. The materials are presented in the Appendixes. The main foundation for the challenge is the Strategy for smart city digital development, which is shortly presented in chapter 3.3. of this document.

The challenge will be organized in similar way as in previous years. Students will be introduced with smart city strategy, recent developments and projects, challenges and opportunities for future smart city solutions. They will be working in groups. Each group will address different key priority – challenge.

During the class, again design thinking will be used to engaged students into innovative thinking, problem solving and solutions design activities. For that purpose they will use several tools as for example rich picture – CATWOE, business model canvas, value proposition canvas, personas, wireframe diagrams, UX, web app prototype, mobile app prototype, different tools for prototyping, etc.).

15. Figure present the methodological framework for challenge smart city challenge-based learning



15. Figure Methodological framework for challenge smart city / challenge-based learning

3.5 Digital Business course evaluation

Students' reflections

Course evaluations from students are in general very positive. Although students might feel that more effort has to be put in this kind of approach, they feel that they are very independent in their design process. At the end, they identify their selves with their work and are proud of achievements. The motivational factor is also the way of grading, where there is no classical writing exam. They document their problem solving and design process in the seminar work (according to template), which is (after it is accepted by the teachers) presented in the classroom to the other groups of students.

Some groups of students emphasized that this kind of approach enables them to express their innovation potential, which is not a common case at all other courses.

Teachers' reflections

Digital business course is based on problem (challenge) based learning and is run by design thinking. Students are given a problem (a challenge) or they choose the problem, which they will address during the course. Students are assigned to teams of 3 members. The aim of the course is to stimulate students to combine knowledge of digital technologies potential in addressing the real life problems – challenges. In addition, with this kind of approach we aim to support students' critical thinking, system approach to problem solving and in addition entrepreneurship and innovation potential.

Compared to classical teaching approach, this kind of teaching requires more dynamics and effort from the teachers, especially from the perspective of mentoring, motivating and supporting of students during the design cycle. This is very important in the phase of problem definition, where students has to achieve deep understanding of the problem, its causes and consequences. Understanding of the problem presents underlying foundations for problem solving and next phases of the solution design. The role of teacher is changed from lecturers to mentor, motivator and challenger.

This kind of approach equips students with skills for critical thinking, problem solving, design process, entrepreneurship and collaboration. Cooperation with enterprises, who provide initial problem, enables students to relate with real life problems during their studies.

COVID-19 reflections

During the COVID -19 situation, most of the teaching was done online, using MS Teams for communication and collaboration, while Moodle was used as a repository for teaching materials and assignments. In discussion, students noted that the efficiency of online teaching and learning was higher. They also emphasized the advantage of being able to complete assignments at a time that best suits them, while still meeting the deadline. Only the students from abroad indicated that they preferred teaching in classroom so that they could better overcome language barriers and integrate.