Business Informatics Programme Reengineering

BIPER - *Business Informatics Programme Reengineering*

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Editor(s)	A. Gábor, M. Arru, C. Csáki, Z. Szabó, I. Szabó
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List Abbreviations

Term/Abbreviation	Definition
ADM	Architecture Development Method
AI	Artificial intelligence
API	Application Programming Interface
AWS	Amazon Web Services
BA/BSc	Bachelor of Administration / Bachelor of Science
BI	Business Intelligence
BIS	Business Information Systems
BPM	Business Process Modelling
CAPEX	Capital Expenditure
CS	Case Study
CIO	Chief Information Officer
CRM	Customer Relationship Management
CTO	Chief Technology officer
CUB, Corvinus	Corvinus University of Budapest, Hungary
DB	Database
DBMS	Database Management System
DEXi	Digital Commerce Intelligence (company, software)
DNS	Domain Name Server (Internet Server type)
DSS	Decision Support System
DT	Design Thinking (method)
EA	Enterprise Architecture
EAM	Enterprise Architecture Modelling or Management
EC2	Elastic Computing v2 (Amazon Web Services)
ECTS	European Credit Transfer System
EIS	Executive Information System
ERP	Enterprise Resource Planning (System)
GIS	Geographical Information System
ICT	Information and Communication Technologies
IS	Information Systems
IoT	Internet of Things
IO	Intellectual Output
IT	Information Technology
MA/MSc	Master of Administration / Master of Science
MIS	Management Information System
MS	Microsoft (software)
OMIS	Object Maintenance Information System
OPEX	Operational Expenditure
PL	Programming/Procedural Language
S3	Simple Storage Service (Amazon Web Services)
SCM	Supply Chain Management
SDN	Software-Defined Networking
SKIMA	Software, Knowledge, Information Management and Applications Conference
SQL	Structured Query Language (for DB)
TOGAF	The Open Group Architecture Framework
T&L	Teaching & Learning
TCO	Total Cost of Ownership
TPS	Transaction Processing System

UM, Maribor	University of Maribor, Slovenia
UX	User eXperience
UWS, Scotland	University of the West of Scotland
VPN	Virtual Private Network

List of Definitions

Term	Definition
Goal	A goal is a short statement of the 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 particular 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

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24.03.2021	Matteo Arru	Created TOGAF sections
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23.06.2021	Matteo Arru	Technology level
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22.04.2022	Csaba Csáki	Small corrections and refinements from all partners
25.04.2022	Marco Gilardi	Small corrections
26.04.2022	Zoltán Szabó	Final touches

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1. PURPOSE OF THIS DOCUMENT

The BIPER project aims to develop a blended-learning compatible BIS curriculum, based on shared values, e-Learning experiences and sound pedagogical principles.

While eLearning has been around for over two decades now, the recent global challenge invoked by the COVID-19 pandemic has put online education into the forefront of academic attention - both as a technological opportunity to maintain the continuity of teaching (at all levels of education) and as a challenge to innovate and apply new methodological approaches. While online courses had become popular at the higher education level, the option to use eLearning for most courses appeared to be too much of a financial as well as methodological challenge for most typical institutions in this arena. Also, ever since the birth of digital training, there were areas facing difficulties due to the nature of the skills and abilities to be learnt. One of such areas is software engineering and systems development (beyond mere coding).

The current pandemic put extra strain and challenge on most universities to retain the quality of their education. It has become clear that innovative approaches are needed - and needed fast: approaches that can help to deliver high-quality education in distance learning format in areas traditionally not well suited for digital training. The challenge concerns not only teaching methods and material but also the teachers and trainers themselves. We need best practices that can ready lecturers to reach out to students for distance teaching and learning in this new era.

The academic field of Business Information Systems is a complex area bridging business and organisational topics with questions of applied information technology. Teaching such a multidisciplinary domain which assumes not only knowledge of theoretical concepts and technical skills to use tools but also a problem centred mindset and related problem-solving abilities is a challenge in itself. However, with the heightened need for high-quality online education (offering both distance or blended learning options in the wake of the COVID-19 pandemic) educators of this area face increased difficulties to find appropriate methods and create new content and teaching material. Higher education institutions facing this challenge have followed various approaches and come up with varying solutions - typically depending on cultural context and organisational traditions. Sharing ideas and experiences regarding what worked and what was less successful could enhance our knowledge of BIS distance education. It would also allow for creating a collection of best practices with examples. Fostering communication and information sharing in teaching BIS online could further the teaching of this field at the third and fourth level in light of a potentially longer battle with social distancing rules.

BIS education in a classroom context may be characterised by what the literature calls 'active learning', which refers to pedagogies that increase and enhance student interaction. This is required by the project-oriented, and teamwork-based reality of developing, implementing and managing IT/IS solutions in an organisational context. Beyond the obvious basics of the trade, interpersonal skills, team building and the ability to combine individual efforts with group work are an essential part of training BIS professionals. While 'traditional' classroom settings may allow for fostering discussions especially with smaller class sizes, teaching and learning through eLearning platforms (such as MS Teams, Google classroom or other tools) makes it challenging to form groups, to work in teams or even exchange ideas and comments freely. While video and audio solutions are usually augmented with less synchronous means such as text messages or sharing files, this still does not make up for lost personal proximity. Using document sharing options and working on the same file together raises new challenges just as much as offering new opportunities. To be successful in this setting of increased complexity and expectations lecturers could use any help they could get - let it be experiences, best practices, successful methodologies or even ready-made materials.

Methodological innovations are needed that can deliver soft skills along with best practices for teaching and learning such skills. This implies digital education that goes beyond the simple demonstration of how to use some software tools but instead could allow the transfer of complex skills and capabilities required by developing and managing modern computer and data systems. Sharing best practices and experiences between institutions of differing cultures is essential in this regard. Furthermore, new methods, methodologies, and techniques need to be explored as well - solutions that could be used both in a fully online setting and could be successful in the context of hybrid and mixed approach educational settings as well.

The BIPER project aims at allowing consortiums partners to share their knowledge and expertise concerning the above situation and develop a shared pool of shared resources benefiting both its members as well as the wider BIS education community.

In this document as the basic document for delivering Intellectual Output 1 we intend to give a sound basis for introducing Enterprise Architecture modelling approach and using it as a context for teaching BIS rather as specialisation than just curriculum.

2. ENTERPRISE ARCHITECTURE MODELLING IN BRIEF

2.1. Introduction

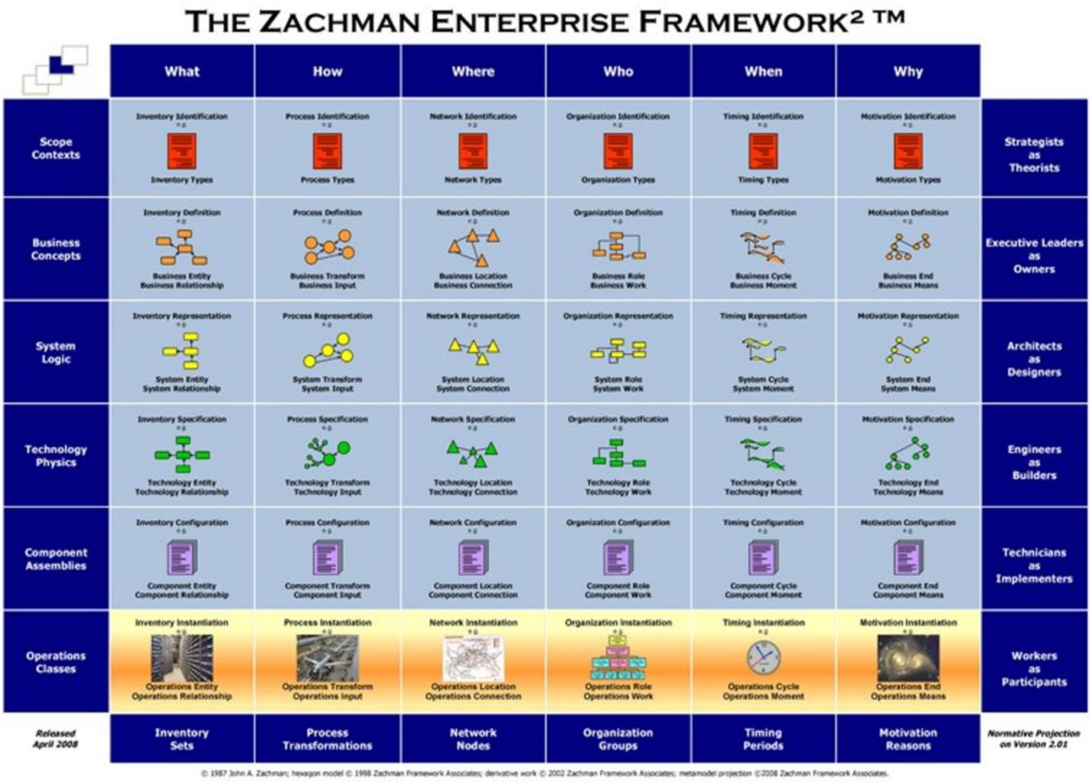
ICT, the world of information systems, is changing very fast, sometimes rapidly. Therefore, everything we say about systems design IS education is somewhat relative and needs to be put into historical context to understand why changes happen and the expected lifetime of a paradigm shift. There are many examples, how Al Gore's Information Highway evolved into a knowledge society until the data-driven economy has replaced it, or nowadays the metamorphoses of industrial revolutions ending up in Industry 5.0 for the time being.

These rapid changes put a strain not only on social change, but also challenges the higher education sector trying to prepare its students for jobs, that might not even exist yet. To provide the solid backbone for a comprehensive BIS education, the BIPER project offers an approach based on the generalized architecture concept, also known as Enterprise Architecture Modelling (EAM).

Enterprise Architecture is a discipline that manages conflicting approaches to success within large-scale organizations. It is partly rooted in organizational science partly in IT management. In times of digitalization, more organizational units than ever before are beginning to push IT infrastructures to their limits in order to solve dynamic business challenges, meet requirements and remain globally competitive. This document lays done the groundwork for an EAM-based BIS curriculum – that can be used by BIS program and teachers to develop their own solution. Further details are provided in the documents describing IO2 (Architecture delivery) and IO3 (Architecture transition and governance) as well as a specific case study as demonstrative example.

2.2. Why Enterprise Architecture?

In 1987 John Zachman, then IBM Chief System Analyst, published an article about the architectural view of business information systems [1]. Zachman realised that due to the development in data processing, the traditional design and implementation approaches of IT-supported business functions result in rather isolated solutions. Instead of being an accelerator of adaptivity, the competitiveness of the enterprises, the costly IT solutions often freeze them on the given technological and application level. Using the computer architecture analogy, he suggested applying a more complex approach. The Neumann computer is built on one physical layer which executes only a very limited set of operations (but does it very fast), and everything that we consider as an integrated part of the computer is a set of superior layers, always using the services of the layer below (machine code, assembler, native, interpreter languages, etc). From a system analysis and design point of view, the following questions need to be answered: who(people/organisation), what (data), where (network), when (schedule), why (motivation/strategy), and how (function) is doing or happening. Zachman suggested splitting the



1. Figure Zachman framework (source: Zachman, 1987)

information systems into different layers: scope (contextual), business functions (conceptual), logical design (system), physical implementation, technology platform, components, and operation, and try to get answers to the above-listed questions at every level. The result will be obvious, especially if contradictions become explicit, e.g. doing something but nobody knows with what or where… [2].

2.3. TOGAF Enterprise Architecture

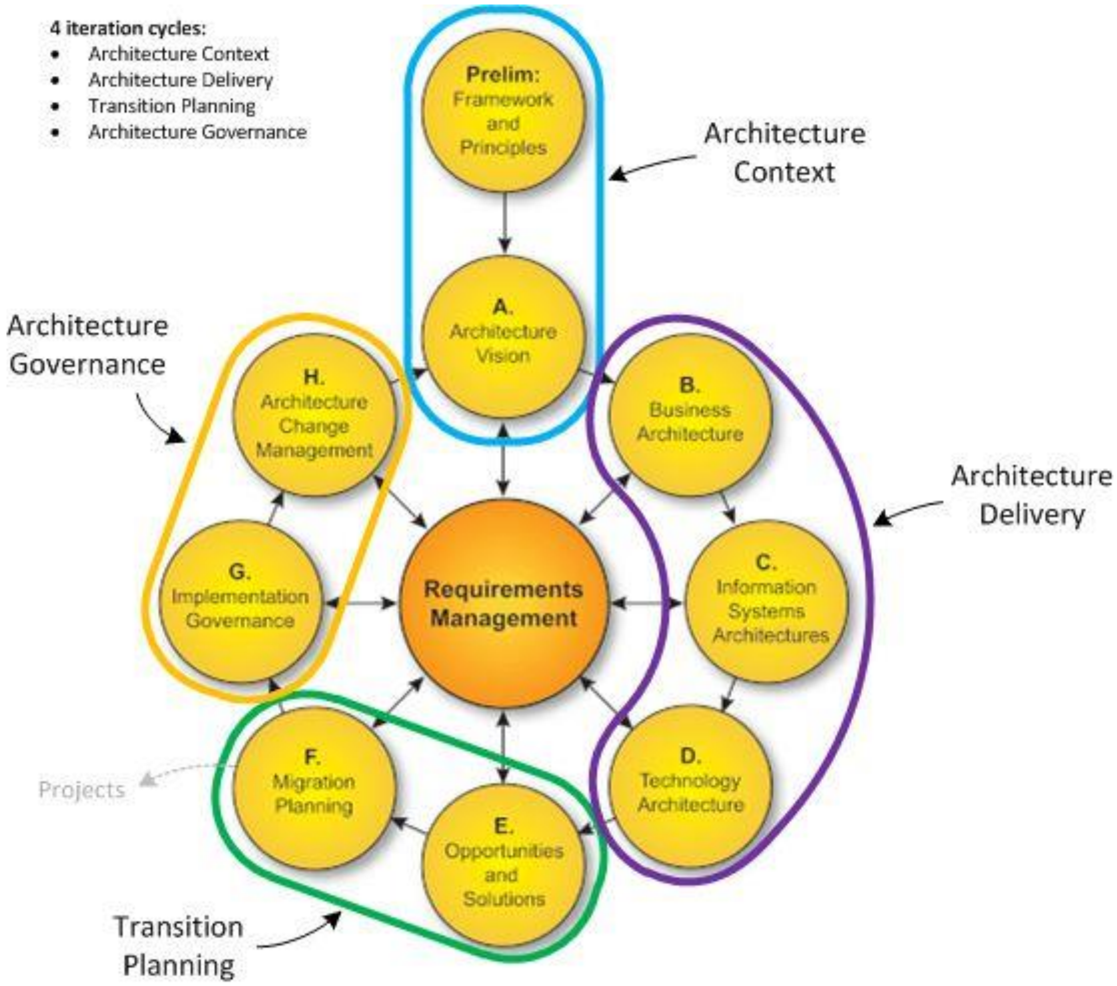
The enterprise architecture concept slowly overruled the former methods. When the Open Group, a non-profit association comprising almost all the big ICT players, announced the TOGAF Enterprise Architecture model and the associated development method, it became an industrial standard [3].

Although there are other models (e.g. FEA), the underlying logic is very similar [4]. The logic behind the TOGAF is the following in a nutshell.

1. TOGAF differentiates among several architecture domains: business architecture, information systems (data and application) architecture and technology architecture.
2. Every architecture domain distinguishes between baseline and target architecture; doing this to explore the gap between the two, and based on gap analysis can be a roadmap, a project plan created. Considering the maturity level, human, technological and financial resources, one or more transition architecture can be outlined; this way, the organisation and the IT management will follow a well-controlled and coherent development scenario.
3. The suggested architecture development method (ADM) is split into four phases: creating the architecture context (requirement analysis, stakeholder analysis architecture vision); architecture delivery; in this phase, the different architecture domains are drafted, worked out; transition planning phase deals with the realisation, implementation, while the architecture governance phase is devoted to the implementation governance, change management.

Because the definition of an enterprise depends on the organisation's strategic objectives, the enterprise is not necessarily the same as the one at the Court of Registration. Due to the architecture work's scope definition, the enterprise may mean only a part of the legal enterprise. On the other way around, we consider the enterprise vertically or horizontally connected with customers and/or vendors. The latter mentioned is called extended enterprise. Hence, depending on the scope definition, the concept and development method is a framework that needs to be customised and adapted to the actual requirements and conditions. We might say customisation often happens, but this feature gives an extra opportunity in the case of ADM, namely the generalisation and customisation back and forth. This is called the enterprise continuum.

Why enterprise architecture is popular, what are the drivers behind this methodology? Looking back, many big or not so big companies invested a lot in information technology and information systems during the last few decades, and many of them run quite old legacy systems; due to the long history of developments, many island solutions are still working. Because the systems are old but still working well, the replacement, moving toward the newest technology, platforms, and solutions, is complex, not to mention how costly they are. The question is, where is the point where a CIO/CTO, the board (including the treasurer), comes out from the comfort zone and is willing to take a step forward? The breakeven points are the following. A development decision is justified if it results in better competitiveness, more efficient and effective business operations and IT services, savings in OPEX and CAPEX, better-planned procurement, and further development. It is also expected that the new system should be adaptive considering the internal and external conditions, circumstances. Internally, among many others, the process maturity, available resources, and the level of staff's cognitive absorption play an essential role. The place in the global value change and compliance to the sustainability goals may have importance. The architecture development should respect the organisation's typical behaviour in terms of changes; after radical changes, always a consolidation period follows (theoretically), the architecture work cannot break into the overall behavioural lifecycle.



2. Figure ADM cycle (source: Pinecrest)

The circumstances mentioned above lead to the formulation of main drivers of enterprise architecture building: customisable framework, repeatable architecture development – meaning stepping further towards the more advanced, integrated solution; considering the reusability, standardisation, interoperability seriously, and portability. We saw, the TOGAF Enterprise Architecture model applying the concept of enterprise continuum complies with the customisation and re-customisation requirement. The introduction of transition architectures enables the phased, well-controlled development, the scoping of enterprise, extended enterprise gives enough flexibility to stay within the resource constraints.

Again, we may see back to TOGAF EAM a few years later, as BISAD lives in (some of our) memory. Nevertheless, it is still a valuable asset for system analysis and design domain at present and in the foreseeable future.

2.4. BIS Curriculum and the Enterprise Architecture

Traditional teaching and learning (T&L) assume students follow a linear knowledge building trajectory. Learning basic concepts, knowledge, and skills will be acquired bottom-up, putting details together. It is often said, first have the toolbox, then use it. This approach has deep historical roots since up to the recent decades, the only places for T&L were the academic institutions, the sources of knowledge were the distinguished professors.

However, many advanced T&L theories offer some different approaches to show there are more efficient methods; to mention a few: spiral, problem-based, challenge-based T&L. Reasons are probably multifold, the mass production in the higher education, closer connection to the world of labour, availability of multiple sources of knowledge, penetration of internet, and advanced digital literacy very likely plays a significant role. The changing learning specifics of incoming students push academia to change the T&L approach; hence the curricula need to be adapted to the new situation. This is the case in the case of IS, MIS programmes, too. The question is how to apply the concept structure embedded in the suggested model curriculum of many leading professional associations (ACM, IEEE, AIS, ISACA)?

First, the curriculum is a set of concepts, or it is better to consider as a set of requirements that need to be met during the implementation, in the realisation phase, that is T&L. Keeping in mind the dichotomy is essential. The requirements may change by time, place, type of audience, level of education, and the way of implementation. Nevertheless, each part has relative autonomy; the requirements might refer to professional viewpoints, or short-term interest of the labour market (in this case, it geographically shows diversity), or long-term, future demand of the world of labour. In the EU practice, the requirements are frequently called competences split into knowledge, skill, attitude and responsibility/autonomy categories. (In practice, skill and knowledge are fuzzy concepts and, in the literature, one replaces the other very often.) The Bologna process introduced the learning outcome-based curriculum design. Apart from the official-pedagogical justification, the need to comply with the labour market demand is definitely one of the strongest drivers. Whatever is the approach (in the case of IS education, the learning outcome approach is fully justified, in the case of medicine, one may remain a bit more conservative), separating the requirements (competences) from the implementation is a must. If one likes in a manner of object-oriented modelling, class objects and instances.

Second, there is no reason to object to the validity of IS concept hierarchy. In a very rough resolution, it covers IT foundations (computers, peripherals, data, network, programming), system analysis and design (functional requirements, as TPS, MIS, DSS, EIS, Collaboration/Workflow; and non-functional requirements, as authentication/authorisation, UX design, security); implementation (coding, testing); infrastructure management; project management; IT strategy, IT governance, IT audit. In business informatics, it is essential to confront IT services at every level with the business objectives, independently of what side has a primary role: business line will need IT support or IT technology offers business opportunities to be harnessed. What it means, IT and application domain cannot be discussed and taught separately, but just in a complex organic context.

Third, the Enterprise Architecture model offers an excellent T&L framework since, by definition, the EAM is built on the strong correlation between IT technology and business management. As we saw earlier, the architecture development method in every stage has the developers contrast the information technology solution with the business objectives, processes and maturity. This feature can be very efficiently utilised in MIS programmes. Because of the minimum complexity of EAM, it is ideal for introducing problem-based T&L; this approach fits best with the idea of EAM.

Once we reach the instance level, we enter into designing the course outline. First, we will skip the traditional course design since we put in the centre problem-solving. The general idea is to start with a very complex, almost unsolvable problem, e.g. urban development in a city area of half a million inhabitants, over 200.000 real estate objects, meeting with XXI century requirements, like smart city, sustainable environment, etc.

After breaking down into smaller problems according to the nature of solution providers, students will rather study than learn about the business, environmental, societal features, characteristics, and hopefully will conclude to smaller but feasible subproblems.

The students will then learn the scientific approach to business problems solving, including the basics of Taylorism, Lean thinking, Six Sigma, and other business analysis approaches. They will learn to adopt the right decision-making approach in the different business contexts.

They will learn about business economics, including firm theory, sociology, regulations relevant to addressing the relevant business challenges. The expected outcome is to outline a working model, e.g. setting up a modernisation company.

In the next phase, once they work out the business architecture, they will be moving towards the information architecture.

The process is continuing as the ADM requires. At every stage, they will need to learn the corresponding IT technology part. The problem-solving process under the case framework will indicate where and when to introduce system design principles, procedures, database design, business intelligence methods, or governance issues. Depending on the training timeframe, but at least two iterations are necessary, as the audience must confront the barriers of the (suggested) solution. This is how they will understand what the role of maturity models is, transitioning and audit.

The authors had the opportunity to participate in several meetings with executives of big or smaller IT companies in the past. One of the returning questions was what features of graduates they request most, whom they wish to employ? All the time, the recurring answer split in half-half: they are looking for smart, able to learn, intelligent graduates, and on the other way around, well-trained, skilled labour force, whom they can send to the client on the other day.

The fact that summing up the opinions gave considerable freedom in curriculum design draws attention to the importance of soft skills. There are many soft skills, but I believe collaborative working is among the most important ones. Hence the suggested T&L style builds to a large extent on collaborative work. The key issue is how to create groups.

From a realisation point of view, the formation of groups may follow different principles (and at this point, I overlook the difficulties arising from the overall academic schedule, organisational fragmentation).

One option is composing groups from students having different specialisations (IS, management, finance, sociology, …).

Another option is to set up groups of students in different years of their studies – novices can learn from their more experienced fellows, and the problem-solving evolves through a few generations. Of course, the two principles can be combined, too. Good group composition will not fully guarantee success, but the prospects are not bad. Instructors must learn how to facilitate the groups properly, and the key success factor is doing a good job and having fun.

References

Zachman, J. A. “A Framework for Information Systems Architecture". IBM Systems Journal 26, 276-292,” IBM Syst. J., vol. 38, no. September, 1987.

Sowa, J.F. and Zachman, J.A. “Extending and formalising the framework for information systems architecture,” IBM Syst. J., vol. 31, no. 3, pp. 590–616, 2010, doi: 10.1147/sj.313.0590.

Lankhorst, M.M. “Enterprise architecture at work: Modelling, communication and analysis, fourth edition,” in Enterprise Engineering Series, 2017.

Urbaczewski, L. and Mrdalj, S. “A Comparison of Enterprise Architecture Frameworks,” Issues Inf. Syst., vol. VII, no. 2, pp. 18–23, 2006, doi: 10.48009/2_iis_2006_18-23.

Pinecrest (No Date). "Four iteration cycles of The Open Group Architecture Framework. https://www.pinterest.es/pin/734860864167878182/?amp_client_id=CLIENT_ID(_)&mweb_unauth_id={{default.session}}&simplified=true

3. TEACHING & LEARNING IN UNIVERSITY GOVERNANCE CONTEXT

3.1. University Governance

The design and launch of university programmes can only be understood in the context of university governance. Each HEI is fundamentally interested in producing graduates, but there are significant differences among the HEIs according to the relative proportions of teaching and research. It also depends on the ratios between the levels of training (vocational, bachelor, master or doctoral) and what the priorities are for each level of training. Whether the HEI's catchment area is national (possibly international), regional, or specific local is also a differentiating factor.

In general, we can say that in all HEI strategies, we find the ambition to achieve high research performance validated by an international scientific community (this is now based on a misinterpreted science metric of publication + citation).

Another mandatory element of the strategy is the labour market relevance of the output (graduates), i.e. the match with the world of labour's expectations.

The strategy also includes the education of young people for scientific and teaching careers. A fundamental requirement of university governance is to ensure the institution's sustainability, in other words, to ensure resources for operations and necessary developments and control the expenditure. This requires the creation and maintenance of a dynamic balance. The details vary greatly depending on whether the HEI is state-owned, private, or other forms exist. Sustainability requires that the HEI creates and maintains or adapts a portfolio of products.

The product portfolio will be influenced by the variety of courses, the number of students, the revenue generated by each course, or the level of cross-financing. We are not mistaken if we assume that programs providing good career opportunities positively contribute to sustainability and reaching the desired equilibrium. A good career opportunity means a degree that allows them to find a job without delay and that both starting salaries and income levels 5 years after graduation are above average.

Many conclusions can be drawn from the above findings, two of which are now particularly important to us. Preparing for the first, students must meet the requirements of the labour market. To do this, we should add that considering time spent in school; they do not have to meet today and future requirements. In other words, education (programs, curricula) to be almost constantly adapted to the requirements of the catchment area based.

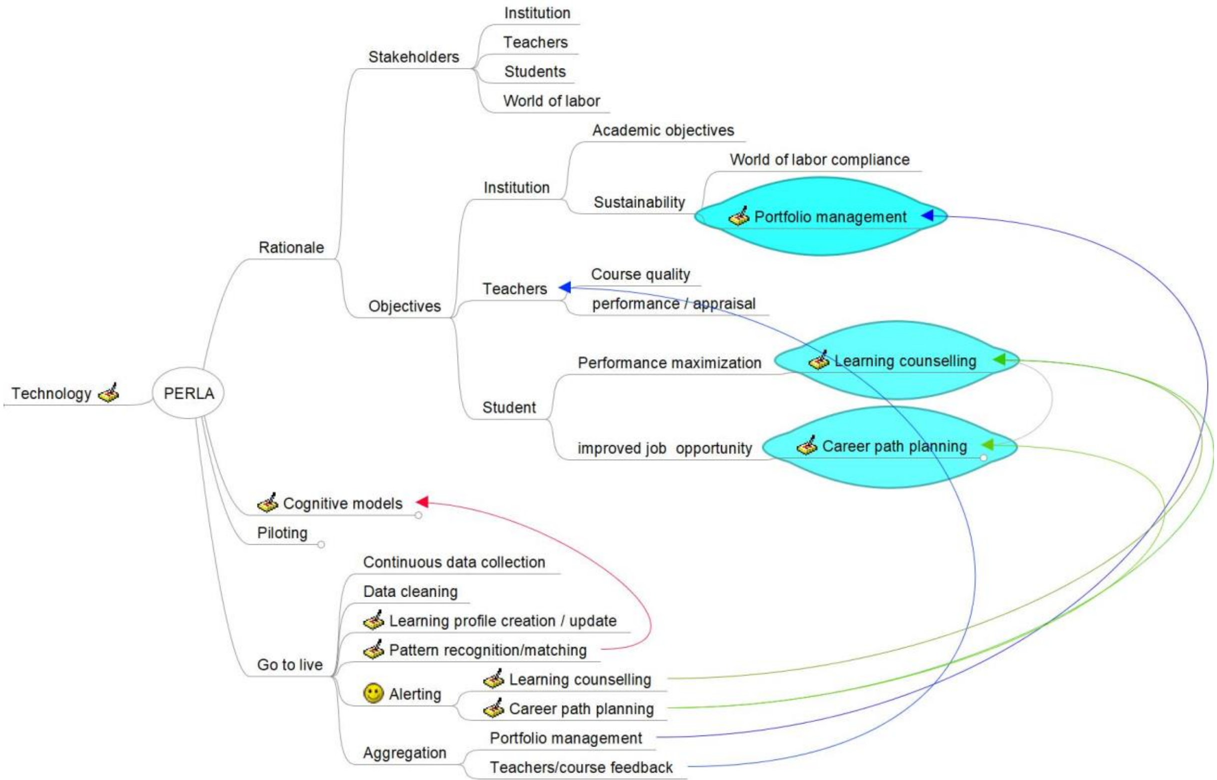
The preparation of students happens not only considering the expected requirements but also by considering what characterises the input in terms of cognitive and learning style, a priori knowledge. Together, these two aspects determine the teaching style and the instructor's attitude to a large extent.

The other conclusion relates to student and faculty performance.

The requirement for instructor performance stems from the instructor's status on the one hand and the nature of the course on the other. The two assessments (student and instructor) should, in a good case, point in the same direction.

By aggregating the micro-level evaluations, conclusions can be drawn about the course and the program, and by summarising them, the portfolio can be managed at the HEI level. From BIPER point of view, the relevance of contextualisation is that curriculum development is closely linked to the development of the pedagogical concept and the methods of selective evaluation.

The appendix includes a detailed description of the implementation and a high-level summary of the solution that was presented at a SKIMA conference in 2013.



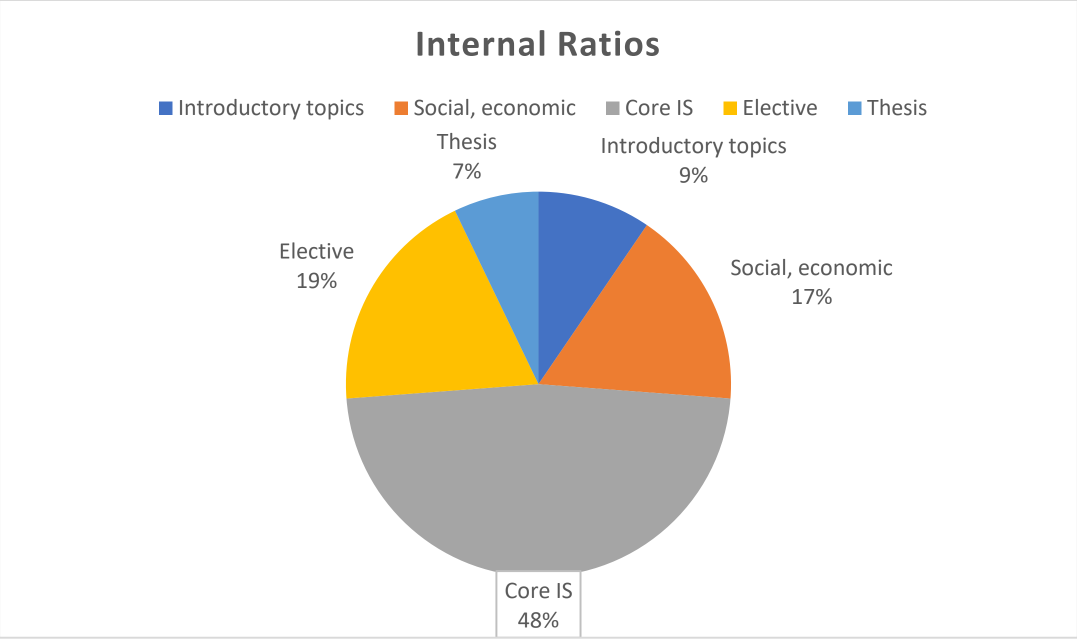
3. Figure University governance complexity (source: Authors)

BIPER priority	Action
Nice to have	Portfolio management – it is out of the scope of the BIPER project
Must have	**Learning counselling – cognitive and/or learning style, interactions based on the selected T&L style**
Nice to have	Career path planning – there are promising and advanced research
Nice to have	Technology: (crawling, data cleaning and interpretation, pattern matching, asynchronous and real-time processing, complex event processing, etc.)

3.2. Selecting the Appropriate Case Study

The general purpose of the case study (CS) is to provide a **framework** to study every aspect of the BIS curriculum. We promised and chose in the project proposal the **Enterprise Architecture** (model, management, development – EAM in the following) as the theoretical foundation of the BIS T&L process; therefore, the case study must reflect the minimum **complexity** and detailed **levels (domains)** of EAM.

What do we know about the BIS curriculum schedule in the frame of Business Informatics specialisation? Assuming 180-210 ECTS credit per BA/BSc and 90-120 ECTS credit for MA/MSc, a rough estimation of the internal ratios is displayed in Figure 4.



4. Figure Knowledge domain structure (Source: Authors)

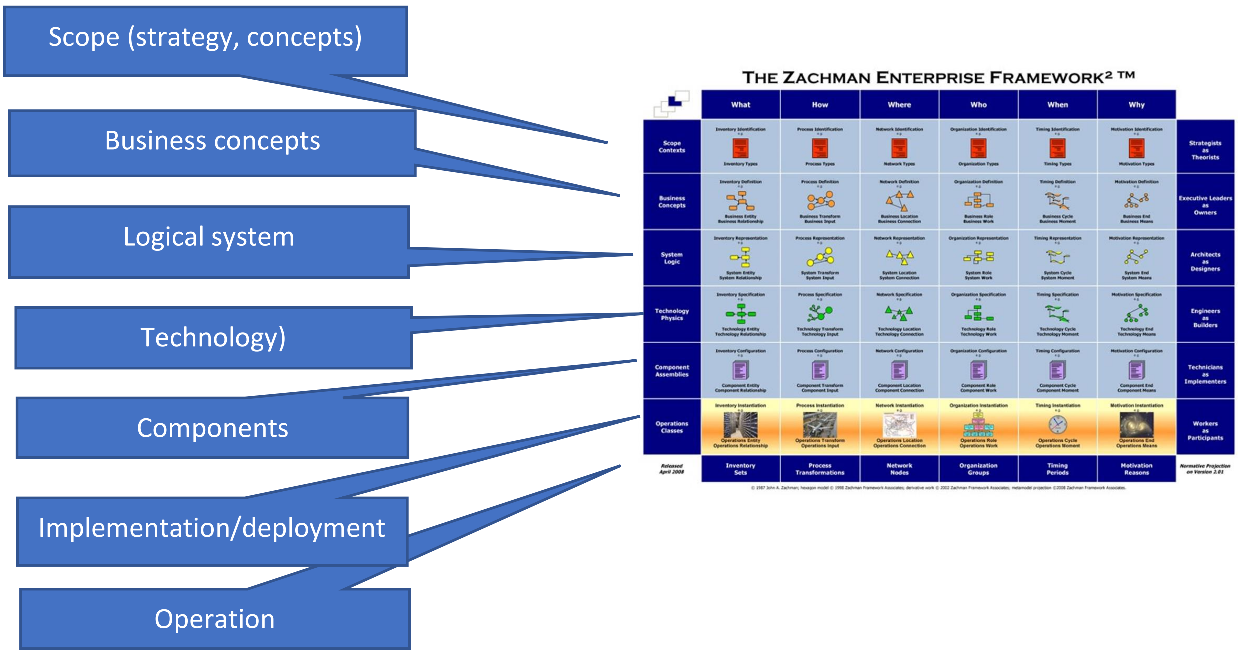
Introductory topics will not be part of T&L, and hence CS will not cover those topics. Introductory topics are computer architecture, network architecture, MS Office, operating systems, programming basics. Also, macro and microeconomics are considered to be introductory.

Students can earn roughly 70- 75% of the total credit during the study period (core IT 48%, social-economic studies 10-12%, elective 5-8%, thesis work 7%) from the distribution of the output and outcome requirements. This amount of credit should be enough.

Complexity means to consider every task equally from a **social**, **economic** and **IT** perspective. The larger the scope, it is better to include more aspects, dimensions. A few examples: in the social dimension, we can address the climate issue (Green Deal, renewable energy, sustainable environment, etc.), social resilience, social inequality, and some more. We will include the atypical work in the economic dimension, global value chain, global supply chain, shared economy, platform economy, no-growth development, etc. The IT dimension can include the role of disruptive technologies and the dance between infrastructure and application development (e.g. 5G and IoT-based applications).

3.3. Levelling

We need to level the cross-domain approach, and we can use the Zachman framework for this purpose. In the Zachman framework, the following levels are distinguished (Source: Authors, based on Zachman, 1987):



3.4. Problem-based Learning

The CS would meet the complexity requirement if it addressed the cross-sections of social, economic, and IT dimensions; of course, it changes according to our work level.

Another question is what will be the primary T&L approach? There are several options to choose from. Our recommendation is problem-based learning. Problem-based learning fits very well with a few questions that are relevant to artificial intelligence (AI) too:

1. How does a human think during problem-solving?
2. Which is the solution to a given problem? (or better, which are the solutions?)
3. How to find a solution for a given problem?

Although the research of the first question is rather far from BIS, it is partly in our interests, as far as selecting an appropriate teaching style based on different cognitive styles of the students is a matter. The second dimension will reflect the complexity. A solution is acceptable if it results in some added value in one or more directions without hurting others (at least according to Pareto). Obviously, the third leg is the more relevant and interesting for IT professionals. This leg includes methodologies, methods (machine learning, big data, and many more). An entire agreement in the mentioned AI approach is crucial because it will affect what IT methods can or should be used (simply speaking, the AI – in contrast to the trendy tabloid interpretation – cannot be simplified only to machine learning).

In our understanding, **problem-based learning**

1. starts from the **articulation** and **understanding** the problem, where
    a. articulation means the ability (this is a soft skill!) to tell, describe, outline a situation in clear, universally accepted and agreed, but at least well defined for "home use" terms (common vocabulary!).
    b. Understanding means to explore different (at least social, economic and ICT) aspects of the problem (e.g., modernisation of healthcare – social security, insurance, - telemedicine - prevention – IoT/5G).
2. Distinguishing between problem (phenomenon) and work to be done. Students need to be able to **decompose** (breaking down) the problem into executable tasks.
   At this point, we assume that students first will understand, learn, and apply strategies, strategic approach, stakeholders, stakeholders' interests, motivation, conflicts, recognising contradictions.
   Second, they will appreciate the organisational and technological boundaries (primarily the organisational boundaries cf. extended enterprise).
   Finally, the students will be able to prioritise and program the work. They will evaluate its impact on the resolution of the given problem and the benefit for the stakeholders and the reference business. The students will learn to handle and compromise expectations by balancing scope, resources, time and quality.
3. **Task specification** – planning, scheduling, resource allocation. These activities show a wide variety, depending on what level they are doing it. TOGAF offers a double approach:
    a. By defining different Architecture levels (vision, target, baseline), the student learns to perform gap analysis and define transition architectures.
    b. Within each architecture phase, the student learns to specify actions encompassing the four **domains**: business, data, application, and technology.

   At each stage and in each domain, **granularity** is a problem variable that the student will learn to address, having the levelling approach from the Zachman framework (see above) as a reference and organically with an iterative and incremental process.
4. **Performing tasks** means
    a. planning the tasks by their priority, constraints, and cost
    b. executing several steps that needed to get the expected result in the given task and
    c. evaluating the results (e.g., OODA cycle[1] or followed any other similar approach)
    d. making decisions about the next iteration(s)

   In the first place, the EAM development method (ADM) provides ample basis for iterations (target/baseline/transitions); second, considering the selected level of granularity also gives the notion of iterations. Finally, on the task level, the OODA or similar cycle will conclude into iterations. These three times embedded into each other's iterations will give a sound basis for T&L schedule, planning.

5. In a problem-based approach, students will have the opportunity not only to **reflect** on the output of their activities but also on the process they applied. In particular, they will reflect on the team dynamics (when teamwork is involved), the appropriate usage of the reference

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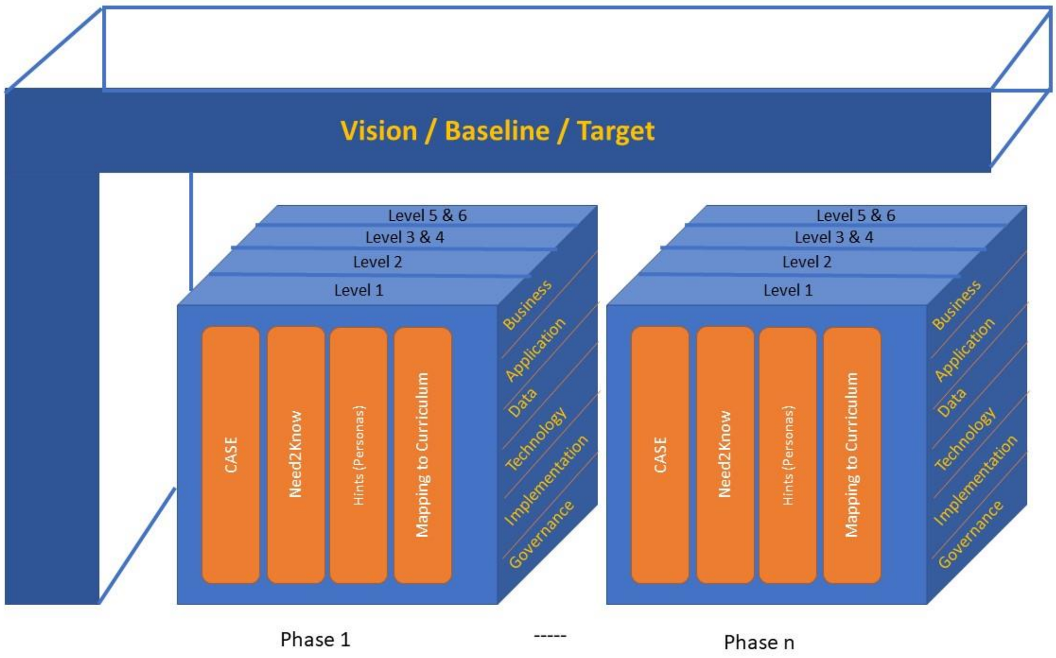
1 observe–orient–decide–act. - Colonel John Boyd US Air Force

frameworks, and the granularity level. They will learn to evaluate their efficiency, business effectiveness, and agility and **improve their problem-solving approach retrospectively**.

Teaching must be rather a **facilitation** than the traditional knowledge transfer. Facilitation means motivating students, orienting, giving help to find the appropriate sources, tools. Motivation might mean both the preparedness of the facilitator and understanding students' difficulties, sometimes demotivation. The latter mentioned assumes the continuous monitoring of students' performance, activities (only in the context of learning).

3.5. Fragmentation through levels, layers, and transition phases



5. Figure Fragmented dimensions (Source: Authors)

The schedule very much depends on the organisation of the teaching period, usually a semester.

For educational purposes, the whole exercise must start with some "warming up" case study for the students to learn the way and culture of groupwork, including communication and reporting. Then an introduction will give a **high-level** overview of enterprise architecture, an introduction to the requirement analysis (preliminary phase), and the role of the architecture repository. This part ends with the architecture vision and target architecture.

The figure above intends to demonstrate how several options are slicing the teaching material. The minimum teaching unit preferably is one "cube". One cube refers to one complete architecture or, in TOGAF terminology, one transition architecture. If it is necessary, one cube can still be split along the levels that are starting with scope and business (level 1&2) and continue with information systems (level 3&4) then implementation and operation (level 5&6). As an educated guess, two 6 credits courses might cover one phase (as one iteration and depth).

Each (of the six) layers then need to be addressed on several **levels**, according to the **degree of granularity**, a potential levelling is the following:

a) Level 1 – scope

b) Level 2 – business
c) Level 3 – logical
d) Level 4 – physical
e) Level 5 – implementation
f) Level 6 – operation, change management, governance & deployment.

3.5.1. Six levels of teaching business architecture are incorporated here on a need-to-know basis

Level-I: *Architecture Level*	Understand major components of Business Architecture (Goals, Process, Stakeholders, Products, Measurement, etc.). Demonstrate a broad, general knowledge of Business Architecture Develop a knowledge that is embedded in the main theories, concepts and principles of Business Architecture. Be aware of the changing nature of Business Architecture. Demonstrate a broad knowledge of the scope, defining features, and main areas of Business Architectures.
Level-II: *Macro Component Level*	Understand major building blocks of Business Architecture. Show detailed knowledge in some areas of Business Architecture such as strategic goals, business process, value chain, organizational units and external stakeholders, products and services, controlling and measurement.
Level-III: *Architecture Element Level*	Understand the role of services provided by the organization in the value creation. Understand the network of services facilitating business services and the interdependencies of business services and the underpinning technology-based services.
Level-IV: *Technology Service Level*	technology services in the context of business performance; role of technology in business process-based value creation; service level management.
Level-V: *Technology Component Level*	information systems that support business processes and activities including ERP, BI, CRM, SCM, …; classification of IT applications based on the main business processes, sub-domains and strategic layers.
Level-VI: *Specific Market Solution Level*	SAP HANA, MS Navision, Tableau, PowerBI, etc.

3.5.2. Six levels of teaching application architecture are incorporated here on a need-to-know basis

Level-I: *Architecture Level*	Demonstrate a critical understanding of the models, metrics and standards for software project and quality management.
Level-II: *Macro Component Level*	Demonstrate knowledge of modern methods regarding the development, introduction and management of IT systems to support and enhance management and business functions. Critically evaluate and advise on the appropriateness of software packages, languages and techniques in the context of a problem situation.

Level-III: *Architecture Element Level*	Critically analyse and evaluate IT techniques, technologies and services as used in modern business developed for IT platforms in the context of the chosen theme of study. Demonstrate a critical and deep understanding when examining current and emerging techniques, standards, methodologies and tools that support the development of IT applications
Level-IV: *Technology Service Level*	software development methods; current methods and technologies of analysis and design; effective design principles; implementation and usability of computer-based systems; ERP and Functional applications, BI solutions, CRM applications; evaluating the system's fitness for purpose.
Level-V: *Technology Component Level*	concepts and techniques of object-oriented modelling; analysis and design of an object-oriented system; the Agilis approach to the production of a software system; function points method; feasibility techniques and
Level-VI: *Specific Market Solution Level*	the four test of feasibility: operational, technical, schedule and economic (TCO, cost-benefit analysis);

3.5.3.Six levels of teaching data architecture are incorporated here on a need-to-know basis

Level-I: *Architecture Level*	Understand the role of data in strategic planning of the modern Enterprise.
Level-II: *Macro Component Level*	Be able to apply a critical awareness of the role of pervasive and persistent database technologies as a platform for developing and deploying centralised and non-centralised IT-based business systems.
Level-III: *Architecture Element Level*	Demonstrate reasonable understanding of relational and object oriented database architecture including the logical and physical structures, memory and processes structures, and data dictionary Demonstrate good understanding of the database approach to data management
Level-IV: *Technology Service Level*	Design and develop fully functional database applications. Demonstrate an extensive understanding of data modelling concepts and methodologies for relational database design. Demonstrate the ability to design and implement relational database systems.
Level-V: *Technology Component Level*	SQL, client environment and commands, sub-programs and database level triggers, PL/SQL languages.
Level-VI: *Specific Market Solution Level*	Designing and developing a database application using the Oracle Object Relational Database Management Systems Use SQL to define and manipulate data stored in a relational database

3.5.4. Six levels of teaching technology architecture are incorporated here on a need-to-know basis

Level-I: *Architecture Level*	Understand the architecture stack: hardware, resources including middleware and system software. Understanding the diverse types of architecture: Stand alone, Server, N-gears, Virtualization, Cloud, Edge. Understand the varied types of Clouds: Private, Public or Global.
Level-II: *Macro Component Level*	Understand requirements for facilities, computer hardware, connectivity and computation delivery, hardware abstraction, operating systems, middleware, API, how data is stored, presentation modalities and platforms, type of cloud services (IaaS, PaaS, SaaS, etc.), logging and auditing.
Level-III: *Architecture Element Level*	Computation services, Computer Networking, Encryption, Storage services, Virtual Machines, Kubernetes, DBMS, Messaging and Queue, Principles of Security, Type of Applications, Service orchestration, Type of presentation (Data, Voice, Video).
Level-IV: *Technology Service Level*	Network Peering, Network switching L2 L3, Service-Aware network management, Proxy, Intrusion detection, VPN, DNS, SDN, Cloud Identity Management services, SQL, No-SQL, Serverless NoSQL.
Level-V: *Technology Component Level*	Firewall, Geo API, GIS.
Level-VI: *Specific Market Solution Level*	Cisco Firepower 4100, Google Cloud Bigtable, Cloud Fire store, AWS S3 buckets, AWS EC2, …

3.6. Evaluation

3.6.1. Typical learning structure

The proposed BIS (or digital business) program is envisioned using problem (challenge) based learning and it may incorporate other special techniques (such design thinking, design science, etc.). Students are given a problem (or a challenge), which they will address during the program (how to prepare and select an appropriate problem, that is often presented in a form of a case study is discussed in Section 3.2 and Chapter 4 of this document). Students are typically assigned to teams of 3-6 members. The aim of this approach is to stimulate students to combine knowledge of digital technologies potential in addressing real life problems. In addition, with this kind of approach the goal is to foster students' critical thinking, system approach to problem solving and in addition entrepreneurship and innovation potential.

Compared to the classic teaching approach, this kind of teaching requires more dynamics and effort from teachers, especially from the perspective of mentoring, motivating and supporting of students during the design cycle – in other words they work more as facilitators. 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.

3.6.2.Course evaluation

Teaching a multidisciplinary domain such as Business Information Systems (BIS) assumes not only knowledge of theoretical concepts and technical skills to use tools but also a problem centred mindset. Related problem-solving abilities is a challenge in itself. Course curriculums are evaluated based on latest principles of Teaching and Learning in Higher Education (such as addressed by the "Teaching for Understanding" (Wiske, 1998), the "Multiple intelligences" (Chen, Moran and Gardner, 2009), or the Universal Design for Learning (Rose and Meyer, 2006) approaches). However, the difficulty arises in the context of the Problem Based Learning (PBL) approach combined with the practice of Flipped Classroom (Lage et al., 2000). The flipped classroom educational process model is a form of blended learning. During the application of this instructional strategy preliminary, individual processing of the material of traditional lectures takes place first (typically online), which is then followed by an active classroom work also incorporating problem-based, cooperative methods. The challenge for teachers is to move away from traditional lectures and related seminars. They should learn how to avoid falling back to the usual ways of teaching. Seminar work focuses on teams progressing with solving the problem and asking question about material they reviewed since the last lecture.

This, however, requires a wide range of learning material to be available for students. This might be traditional means such as books and slide packages made available (typically in the Intranet) but also includes videos, blogs, podcasts, web pages, and other forms. Indeed, material produced by third parties should be considered. In fact, students, while studying outside the classroom may encounter, discover and explore sources freely. The job of the teacher is to help them out how to be selective. They can facilitate quality checks over sources and material brought into class by students. In class, the normal PBL progresses through exploring the problem.

The challenge for teaching BIS – and thus for the evaluation of program and course content and methods – is rooted in the nature of the field. BIS graduates are typically hired to bridge the gap between IT and business. This gap is especially relevant for large and medium sized companies, or for IT service providers, consulting companies. Typical business IT jobs include business analysis, system development, digitization, presale activities, logical and physical design of IT services, database management, data analysis and data mining, IT demand management, IT project management, IT services financial controlling, application and service support, IT risk analysis, automation of business processes, and software testing. Regarding specialized IT-IS areas, the list ranges from artificial intelligence and its application, automation, autonomous systems, and process optimisation, to GDPR, cybersecurity, IT security, but industrial modernisation (Industry 4.0), databases, BI and data visualisation are also strongly emphasised. In IT related areas knowledge of the basics changes quickly. Knowledge gained during institutional training can quickly become obsolete, and technologies learnt can get outdated. It is an important goal for students to be able to learn independently, and be capable of self-driven, self-regulated learning.

All this makes planning and evaluating programs difficult. To understand students' reception of the new content and format a student feedback and experience survey procedure was established including a survey questionnaire.

The student evaluation survey is part of any quality assurance process. There are several types of surveys that may be conducted at different times:

- Overall Course Quality is a mandatory survey conducted prior to the start of the next academic year (every other semester);

- **The Course Quality Survey** is administered at the end of each course. This survey is not mandatory, so it is difficult to motivate students to complete the questionnaire.
- Qualitative feedback in the student council and in the student arena. The latter is an informal meeting of students, tutors (students and lecturers), faculty and head of each programme.

Below are two examples of surveys seeking student feedback as implemented by BIPER partner organizations. The questions used at UWS (called **MEQ “Student Views”)** focuses on student feedback.

The Course Quality Survey, presented below, is the most informative and formal feedback received from students at UM. It provides information on how students perceived the lectures, work assignments, course materials, comprehensibility, time allotted for individual work, etc. Combined with student performance and discussions in the Student Arena forum, we have a comprehensive assessment of the innovative learning approach. The questionnaire is available online in the e-learning environment (Moodle) and is anonymous.

University of Maribor Survey:

Maribor Survey	Do not agree at all	Do not agree	Nor disagree, nor agree	Agree	Fully agree
Assess the extent to which you agree (according to the scale) with the following statements regarding classical lectures					
• The contents of the lectures were understandable					
• The contents of the lectures were demanding					
• The contents of the lectures were interesting					
• The contents of the lectures were related to previous courses					
Assess the extent to which you agree with the statements regarding the lecturer					
• The lecturer encourages students to perform their study obligations continuously / timely (preparation for colloquium or exam, preparation of seminar papers, etc.)					
• The lecturer advises and guides students in performing their study obligations					
• The lecturer takes into account student initiatives					
• The lecturer has correct / respectful attitude towards students					
• I am satisfied with the work of the lecturer					
• The lecturer stimulates critical thinking and intellectual curiosity of the students					
Assess the extent to which you agree with the following statements regarding e-lectures					
• The objectives for e-lectures are clearly defined. E-lectures have clear instructions for completion of assignments					
• E-lectures are related to classic lectures (the subject is upgraded, supplemented)					
• Contemporary literature is included in e-lectures					
• The deadline for submitting e- assignments is appropriate					
Estimate how much time you need on average to work in an e-classroom for one e-lecture.					
• Up to one hour					
• From 1 to 2 hours					
Please provide an overall assessment of the course (from 1 to 5)					
What did you like most about the course? (open end question)					
What did you dislike about the course? (open end question)					
Study programme					
Sex (male / female)					
Type of study (full time / part time)					

UWS mid-term survey (evasys+):

Module Coordinator:

Module name (Module code):

1. Module Experience Questionnaire

1.1 Staff have made the subject interesting

Definitely Disagree Definitely Agree

1 2 3 4 5

1.2 The module has provided me with opportunities to explore ideas or concepts in depth

Definitely Disagree Definitely Agree

1 2 3 4 5

1.3 The criteria used in marking have been clear in advance

Definitely Agree

2 3 4 5

1.4 Feedback on my work (verbal/written) has been provided in a timely manner to enhance my learning

Definitely Agree

2 3 4 5

1.5 I have been able to contact staff when I needed to

Definitely Agree

2 3 4 5

1.6 The module is well organised and running smoothly

Definitely Agree

2 3 4 5

1.7 Any changes in the module or teaching have been communicated effectively

Definitely Agree

2 3 4 5

1.8 I feel part of a community of staff and students

Definitely Agree

2 3 4 5

1.9 Staff value students' views and opinions about the module

Definitely Agree

2 3 4 5

1.10 It is clear how students' feedback on the module has been acted on

Definitely Agree

2 3 4 5

1.11 Overall, I am satisfied with the quality of the module

Definitely Agree

2 3 4 5

1.12 Looking back on the module, are there any particular aspects which worked well?

1.13 Looking back on the module, are there any particular aspects which we could improve?

3.6.3.Students' evaluation

While summative methods are very important, and they have a clear pedagogical foundation with new methods of teaching come new methods of assessment as well (Yorke, 2003). These methods move beyond the traditional approaches and propagate in-process evaluation of students' comprehension and progress. Formative assessments are formal and informal procedures conducted by teachers during the learning process and are aimed for supporting learning. They are supportive and development focused assessment techniques (Pereira et al., 2016) and include for example diagnostic testing, heterogenic assessment, as well as self- and peer assessment. In addition, to treat students in a holistic manner, it is not irrelevant how students feel about themselves and their education. Consequently, student well-being is considered as a fundamental condition of successful teaching (Jones et al., 2021). A clear challenge for BIS is how this philosophy and corresponding techniques may be integrated with the nature of the field as discussed in previous subsections. Some potential solutions may be:

- Ex ante student evaluation

    - assessing students' level of knowledge and skills at the beginning of each semester – and at project milestones. While the former is based on a more extensive review, the latter is self-administered along relevant dimensions according to simple (5 or 10 level) scaling.
- Continuous evaluation
    - In the context of PBL there are challenges related to evaluating students along two dimensions: progress of work (e.g. progress of the project content) and level of skills (e.g. similar to traditional marks and grading). For project progress the difficulty of progress monitoring raises from the fact of individual ideas and lack of predefined deliverables. While using occasional milestones is typical, those milestones are not necessarily preset at the beginning of a term, instead, they might arise depending on individual group progress.
- Ex post student evaluation
    - The other complexity of judging student performance at the individual level is related, of course, to the essentially group-based setup. Judging individuals in such a context is not only difficult, but also time consuming and required extra attention from teacher – but it may improve by experience.
    - Groups are progressing by their own pace and their project evolves depending on members' interest, knowledge, background and experience and influenced by group dynamics. Thus, group results may need to be judged in themselves – not in comparison to some preset goals, nor in comparison to each other.
    - Students may acquire 'extra' marks along the way. Using these additional marks could compensate for other marks. As a different approach, instead of judging students by general marks, groups may be evaluated in themselves – such as compared to their progress in relation to their starting levels. This, of course, presupposes some default assessment at both individual and group level.
    - Peer review is another tool available in the context of PBL (and project based) approaches. The advantage is not only that peers are often able to judge other project in relation to their level and in contrast to their own work, but this way students learn from each other. In addition, they may improve their skill in giving feedback and applying constructive criticism.
    - One effective learning and sharing method is encouraging students to regularly present their work (status) to their peers. This can be used in combination with peer feedback.

Based on the experience of BIPER partners, the first reaction to PBL-based 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 themselves with their work and are proud of their achievements. The way of grading is also a unique motivational factor, as there is no classical exam-writing. They document their problem solving and design process in the seminar work (according to templates), which (after being reviewed by the teacher/facilitator) is presented in the classroom to the other students. Some groups of students emphasized that this kind of approach enables them to exercise their innovation potential, which is not a common case at all under most traditional courses.

3.6.4.Teachers' evaluation

The following dimensions have been identified as relevant for PBL-based teaching: ability to manage groups, ability to read group dynamics, ability to deal with flexible deadlines, ability to monitor individual progress, and ability to provide dedicated feedback. Evaluating the performance of teachers depends on their role and is best done using a multichannel approach.

Stereotypical teacher roles in higher education include Facilitator, Mentor, Expert, Innovator, Community builder, and of course, the traditional Educator. In the context of the BIPER approach the two most important characteristics (role) required from suitable teachers is Facilitator and Innovator – in other words someone who is able to guide students in their exploration of their own individual learning paths while being open to and an expert user of new teaching methods. To help participating teachers in their PBL work, the key performance measures is not the hours taught, but the performance of his/her students based on integrated student feedback (done regularly on an ongoing basis not only at the end of semesters or courses). In addition, peer reviews and class visits are also recommended, especially by experts of pedagogical methods.

3.6.5.COVID challenges and experiences

One of important element of motivation beyond the changing nature and market of BIS education was to understand and reflect on challenges brought on the sudden online rush as a result of the COVID-19 pandemic. There are some general points to discuss here followed by some actual reflections based on BIPER partner experiences.

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 at two of the BIPER partners (UM and CUB), while the third university (UWS) applied VR-based technology. 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.

Numerous difficulties and challenges have been encountered in this process of conducting lectures and tutorials online due to the COVID-19 situation. At the undergraduate level students become acquainted with different work environments and problem-solving practices related to the development, operation, and maintenance of information systems. Here we report observations from three courses in the OMIS study program. The two of them - Business Model Design and Business Information Systems - are taught in the second year and Digital Business in the third year. All three courses are mandatory for the students of the OMIS program. In all three courses, we use teamwork, problem-based learning, and various business modelling tools. There were 12 students enrolled in each of the first two courses, and 25 students in the third course.

In the first course we use a simple business case where students are divided into groups and evaluate different problems and learn different tools while applying them in different phases of Soft System Methodology. Later, they approach a complex case developed based on a real environment - a small manufacturing enterprise. Normally, we often use a blackboard, large posters, markers in different colours, and "post-it" papers during class. Student groups used separate parts of classrooms for discussing and collaborating. This was much more difficult with the MS teams. Sometimes a simple drawing to show how to use a particular tool took a lot of effort to draw using MS Visio or another tool, even if the templates were used. For students to collaborate, we prepared channels in MS Teams, one for each group. However, they used these channels only during lectures. For collaboration on their assignments outside lectures, they used Discord. During the lectures, it was more difficult to engage students in conversation, because it was the first time we met in a virtual environment. They were shy and only participated in the conversation when invited and called by name.

After this course, we met again with the same group of students in the Business Information Systems course. There was less teamwork in the lectures and we did not use any tools, because they were already familiar with the tools from the previous course and they needed these skills only for completing their seminar work later in the exercises. We focused more on the technological perspectives of information systems and discussed the different cases. Student engagement was the same as in the previous course. Only a few students participated in the discussion. The others participated only when called upon by the lecturer.

The Digital Business course is taught in the third, final year of the undergraduate program. We met with this group of students in person before the pandemic. However, half of the students were from the program Business Engineering. And it was with these students that we met for the first time. Surprisingly, these students were also more engaged, even though they were not familiar with the content of Information Systems or Digital Business. This course was more dynamic, with more discussions. This course looks for the innovation potential of digital business models. Students have to apply all the knowledge, skills, and tools they know from previous courses. The result of their assignment and exam must be an innovative digital business model. For this purpose, we use design thinking to stimulate the students in the innovation process. They also presented their ideas to other peers during the course and we had several facilitated discussions as well as brainstorming sessions. In the end, students provided new ideas that were elaborated according to the syllabus.

More technological problems occurred during the tutorials, where students are working with different program solutions (e.g. SAP, Datalab Pantheon X). Before the COVID-19 pandemic access to all the program solutions was provided through computers located in the computer classrooms. As such, students did not need to install program solutions by themselves on their computers. When they needed to install program solutions themselves, many of them had problems because of the different hardware equipment, operating systems, and other settings they are using. When we managed to overcome these first barriers we were able to proceed with tutorials. The next problem that occurred, was related to very slow progress through the assignments. For example, the majority of students did not have an additional screen that would enable them to more easily follow the tutor instructions. Furthermore, some students had issues with the microphone and they reported problems by writing them into chat, which further hindered the progress. To proceed more quickly, tutors had additional sessions with those students who had problems. As the tutors' overload was detected this was just a temporary solution.

At the master's level students develop research, technical, analytical, communication, and management (managerial) competencies that enable them to lead effective groups and manage business activities through information and communication technology. The lecturers were using a PC with two monitors, audio-video equipment for communication, a graphic tablet, etc. Different programs were used, mostly open-source, fully available for students. Here we report educational experiences from two courses on the OMIS program: Decision theory and Data mining. The lecturer was using a PC with two monitors, audio-video equipment for communication, and a graphic tablet (Wacom Cintiq 16). During both courses several programs were used, mostly open source, fully available for students (i.e. Orange data mining, Silver decisions, DEXi, etc).

The decision theory is the first-year obligatory course for the OMIS students and an elective course for the students of the Enterprise engineering programme. Data mining course is an elective course for both the IS and enterprise engineering programmes in the second year (fourth semester) of master level studies. Usually, in the first year of master studies most students (80%) previously finished the bachelors studies of one of the Faculty of Organizational Sciences programmes. The remaining students are from other faculties and fields of studies (i.e. economics, social sciences, computer science, mathematics, etc.). There are usually some international students enrolled as well. There were 29 students enrolled in this course. This is an educational challenge in itself. Students have different previous knowledge, different levels of understanding of complex management problems, they often have no real-life experiences, and during the Decision theory course the lecturer must bring some of those real-life ideas of complexity to them. In previous years we have developed business simulators to sup-port teaching about complex management problems. The experiments that we have conducted from 2003 to 2006 showed that group supported simulation-based learning contributes to a better understanding of the management problems and support learning about decision-making. However, we could not use the business simulator in the online environment, because of the lack of IT support. Also, in the usual classroom environment the lecturer can use the blackboard to present the methods and techniques of decision modelling. The graphic tablet can somewhat replace the blackboard, but this means that the lecturer is working on at least two screens. At the beginning of the course the students were a bit shy, but by the end they started to communicate more freely. They were purposively assigned into working groups, matching those who previously finished the Faculty of Organizational Sciences with those that came from other faculties.

The data mining course is different in the way that the group is smaller (up to 15 students), and by the fourth semester they have already known each other and have worked together before. Based on our experiences from the first wave of the pandemic, we have adjusted the lectures so that the lecturer used the Orange data mining software, while explaining the theory behind the methods and algorithms. This way, the students were more focused on the topic, there was more feedback seeking behaviour present and they were readier for the tutorials and independent work that followed the lectures. However, not all the students have two screens that would enable following lectures and simultaneously working in Orange. The students sought feedback more often compared to the first year's students. There was almost 100% attendance at the lectures, and all the students passed the exam on the first attempt, which was not the case at the Decision Theory course.

When tutorials took place, we encountered a lower level of productivity among students. Although more students were able to attend tutorials, some of them seem to only partly follow them, as they attended them during their work or other obligations. Thus, they were not able to fully focus on assignments and actively participate in the discussion. Consequently, we noticed a decrease in the quality of the submitted assignments. As already mentioned, we have encountered different challenges. Some of them were quickly solved, while some remain even after the second wave of the COVID-19 pandemic. We did not notice essential differences between the experiences at undergraduate and master levels, but we can make some general conclusions based on our observations.

We noticed that many problems related to technological issues were resolved to the extent that the majority of our students can work in the learning environments that are required for each course. Unfortunately, the internet connection and technical equipment issues that students are facing cannot be resolved by the faculty. Therefore, it is important to inform students before the course, what kind of technological equipment they will need to complete it.

Switching from traditional to computer-based learning/teaching is another problem that we noticed. In the first wave, we encountered difficulties to adapt from both sides, teachers, and students, but in the second wave mostly by students in the first year of undergraduate and master studies. We relate this adaptability struggle to unique circumstances, as our students were not able to meet in person at the beginning of the student year. Furthermore, a lack of computer literacy prevented these students to manage their assignments and courseware provided. To overcome this problem, the faculty should offer their students (at least to the first-year students) basic courses in computer literacy.

Teachers have also struggled to motivate students at times. As some of the approaches did not prove successful we tried new ways, including offering them extra credit, adjusting the expectations, and laying out estimated completion times for each assignment. We also tried to motivate them by setting up a collaborative environment. This approach proved to be more effective in smaller groups where students already knew each other. In contrast, the larger groups that had never met in person were more difficult to involve in conversation with the teachers and among students.

References

Wiske, M.S. (ed.) (1998). Teaching for Understanding: Linking Research with Practice, San Francisco: Jossey Bass Publishers.

Chen, J., Moran. S., & Gardner, H. (Eds.) (2009). Multiple Intelligences Around the World. San Francisco: Jossey- Bass.

Rose, D.H. & Meyer, A. (2006). A practical reader in universal design for learning. Harvard Education Press. 8 Story Street First Floor, Cambridge, MA 02138.

Lage, M.J., Platt, G.J. & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. The Journal of Economic Education, 31, 1, 30–43.

Yorke, M. (2003). Formative assessment in higher education: Moves towards theory and the enhancement of pedagogic practice. Higher Education 45, 477–501. https://doi.org/10.1023/A:1023967026413

Pereira, D., Assunção Flores, M. & Niklasson, L. (2016). Assessment revisited: a review of research in Assessment and Evaluation in Higher Education. Assessment & Evaluation in Higher Education, 41, 7, 1008-1032. DOI: 10.1080/02602938.2015.1055233

Jones, E., Priestley, M., Brewster, L., Wilbraham, S.J., Hughes, G. & Spanner, L. (2021). Student wellbeing and assessment in higher education: the balancing act. Assessment & Evaluation in Higher Education, 46, 3, 438-450. DOI: 10.1080/02602938.2020.1782344

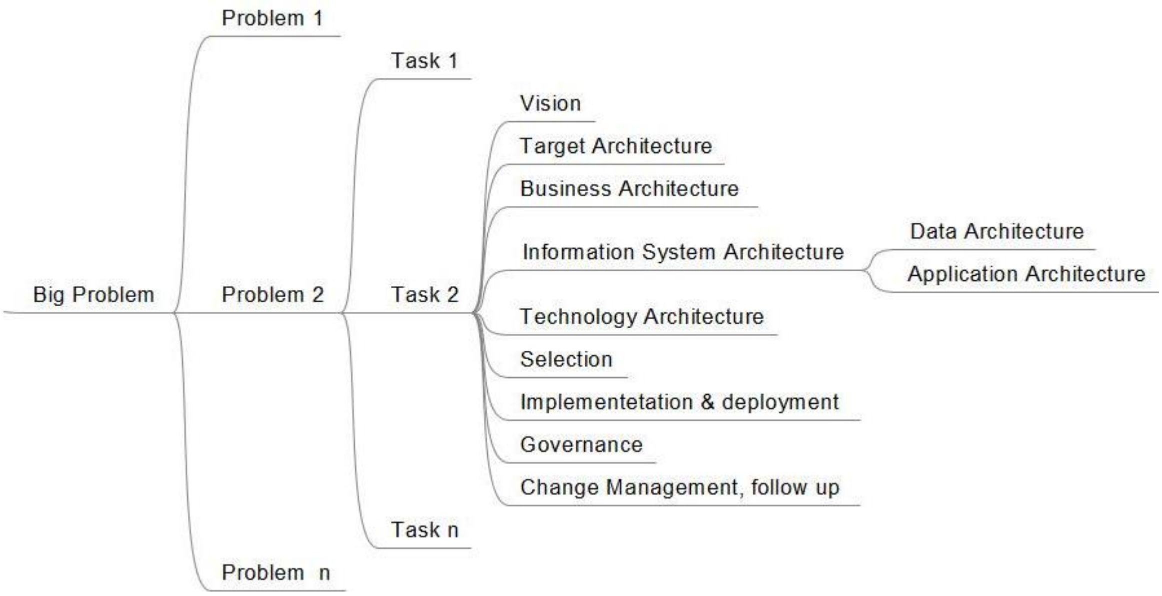
4. CASE STUDY REQUIREMENTS

4.1. Problem-based T&L Approach

The general purpose of the case study (CS) is to provide a **framework** to study every aspect of the BIS curriculum. We promised and chose in the project proposal the **Enterprise Architecture** (model, management, development – EAM in the following) as the theoretical foundation of the BIS T&L process; therefore, the case study must reflect the minimum **complexity** and detailed **levels (domains)** of EAM.

*It is crucial, whatever is the objective of the Smart City project, there should be an **enterprise** or any kind of **organisation** that will organize, coordinate, facilitate the Smart City actions.*

Following the TOGAF principles, slicing down the case into different levels and layers, first the disassembling is going on according to the architecture **layers**:



6. Figure Problem - Task – Architecture (Source: Authors)

4.2. Relevant Goals of BIPER

The main aim of the BIPER project (or, to be more precise the method it aims at developing) is to facilitate the education of Business Information Systems (BIS – or Business Informatics) students in the age of digitalization, fast-changing environments and rapid technological advances. Such a future workplace would require adaptability, fast learning and the ability to be able to attack and solve very complex problems.

Problems in future employment of BIS graduates would assume organisational and project knowledge beyond mere technical capacities – and their integrated handling. What do we mean by "complexity" in this context? Problems are complex because solving them requires **explicit articulation and enforcement** of economic, societal, and technical aspects of a problem.

In addition, BIPER intends to promote architectural thinking – thus case should address related areas, issues, and questions. Students should be directed towards formulating (refining) the problem in terms of all aspects of architecture (i.e. further embracing its complexity). BIPER Case Study Evaluation Criteria

4.3. Why Do We Need an Evaluation Criteria?

Core part of the BIPER project is to test the idea of TOGAF-based program-level curriculum design. This is done through case studies. A case study of this purpose may exists at three levels: a) a general case study framework – the meta-level -, which describes the key features (context, situation, goals, challenges, etc.) at an abstract general level; b) such a case may be implemented in a specific context (for a specific local by a specific institution or partner); and c) actual executions of the case in point b) (i.e. with students working on it).

The development of each case study (including the meta) should considered these criteria (as questions – whether they have been considered during the design of the case). These are not about the evaluation of how students actually solved the problem, rather an inventory, to make sure the case (challenge) is a good fit for BIPER goals.

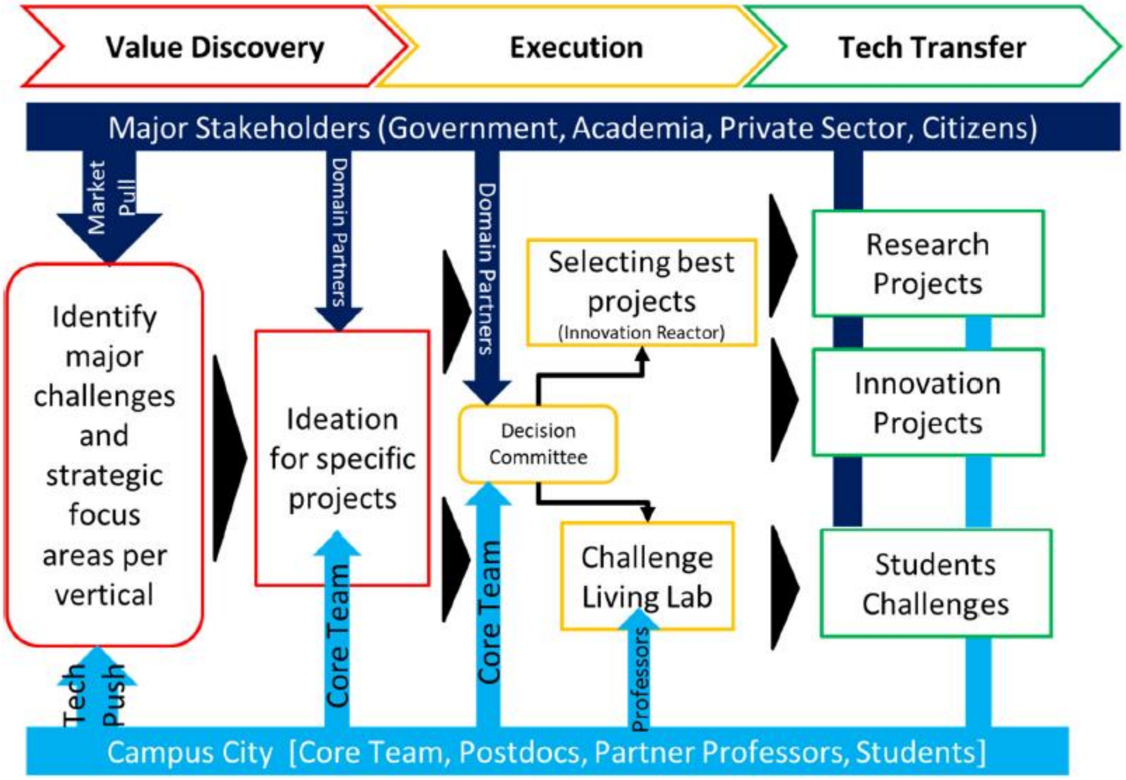
4.4. Evaluation criteria for potential cases

To understand the usability and validity of a (potential) case for BIPER purposes, it is important to evaluate its abilities to fulfil those goals. The criteria list and system aim at just that.

4.4.1 Introduction to the Criteria List

Development of holistic case study for BIPER framework is complex and resource intensive endeavour, which require coordination and collaboration of lecturers from complete set of EAM domain. Case study should engage student to learn solving complex problems from business information systems domain through smart city challenges which address real world issues. Huertas et al (2021) proposed following working model for selecting smart city challenges which would be then worked on within Campus City curriculum (see student challenges).

With holistic approach to design case study, academic institutions becomes key stakeholder for identification of smart city challenges based on innovation, research and collaboration with city/local community. Further academic institutions could become key stakeholder for development of human resources with skills to design solutions at different levels ai a smart city (Huertas et al, 2021). Proposed model for selection of case study would provide firm foundations for development of case study which would engage and motivate student to learning through case study which would address meaning and real world smart city problems.



7. Figure Campus City working model (Source: Huertas et al, 2021)

In order to design a holistic case study, we defined criteria on following levels:

- Criteria at the Level of Society
- Economic and Market-Related Criteria
- Business and Organisational Criteria
- Information (Application and Data Architecture) Criteria
- Technological Architecture Criteria
- Implementation Criteria
- Pedagogical Criteria.

4.4.1.Criteria at the Level of Society (societal)

- social well-being criteria – and wealth
  - housing
  - mobility
  - handling inequality
- general UN goals (the 17 Sustainable Development Goals of the United Nations)
  - climate impact and consideration of climate change
  - carbon footprint
  - emission neutrality
  - green design
- decision making
  - citizen involvement in decision making
  - transparency of decisions
- is there an operating organisation?

  - the TOGAF approach assumes an organisation
- are co-creation or co-design approaches considered?

4.4.2. Economic and Market-Related Criteria:

- financing and profitability
  - is discussion of financing part of the case challenge
  - is the profitability of the solution considered in the description of the case
  - would financing come from grants, or even crowdfunding?
- should existing solutions be reviewed
  - state-of-the art of the market
  - potential competitors

4.4.3. Business and Organisational Criteria

- is business-thinking present in the case solution requirements?
  - customer view
  - product-focused approach
  - business model
  - financial model
  - how about the use of a Business Canvas?
- are students required / warned to consider that the solution should involve an organisation
  - even if project-consortia
- is the stakeholder approach present?
- would requirements be part of the process?
  - is there an understanding that requirements (from different stakeholders) would likely be contradictory?
- are organisational models considered?
  - how about non-traditional, atypical organisational forms, such as project organisations, or even crowd-based forms?
- operations
  - (see financing)

4.4.4. Information (Application and Data Architecture) Criteria

- Is the question 'Where would data come from' covered?
- are data sources considered?
  - is open data appearing in the thinking?
  - how about public service and administration data by public authorities (such as firm registry, tax, etc.)?
  - are there proprietary data sources?
- are data management tasks covered?
- is there anything about privacy (i.e. GDPR in EU context)?
- information security issues?
- how about application architecture (cloud, mobile, SOA, …)?
- would there be integrated data handling (e.g. GIS-based, …)
  - managing demographic, geographical, utility, traffic, etc. data, for example
  - heterogeneity of data sources should be covered
- are all functions of the business model be covered?
  - are there KPIs?

- how about legal constraints?

4.4.5. Technological Architecture Criteria

- enabling services
  - for data handling and integration (authentication, authorization technologies)?
- implementation of function
  - in light of data integration?
- is role IoT covered?
  - how does it occur?

4.4.6. Implementation Criteria

- The whole case solution should be designed such, that it can be executed in iterations, because a whole new, complex architecture may not be implemented at once.
  - is there a clear end goal?
    - although it, of course, may change during the course of implementation
  - those are the transition ”waves” – with each wave with well-defined content and conditions
  - thus, steps need to be defined
  - however, each step ought to be complete in itself (otherwise one part or another of the architecture elements would not work)
  - transition also should depend on business / organisational capabilities
  - procurement is also part of each wave

4.4.7. Pedagogical Criteria

- how the case is structured pedagogically:
  - is timing of the work considered (does it fit the time, and does it have deadlines)?
  - how does students' evaluation work (marking and grading)?
  - is their regular feedback planned?
  - are students required to do self-assessment?
  - are students required to do peer-assessment?

4.5. BIPER and the Design Thinking and Design Science methods

One important question concerns the applicability of the Design Thinking (DT) method in the context of the BIPER approach: can DT inserted into the TOGAF frame is case execution methodology? Differences of TOGAF approach and the Design Thinking methods (with its dedicated steps, tasks, and models) need to be clarified, therefore, this section elaborates the option of using the Design Thinking or the Design Science Research Principles in the context of Challenge/Problem Based Learning.

As a general approach to solving organizational problems, which some authors call weak or even wicked problems, we use systems thinking and the systems approach based on systems theory. The result of problem solving is usually some kind of artifact that is man-made and did not exist before. One of the leading thinkers in this field, Herbert Simon (Simon, 1969), paved the way for future methods of solving complex problems in his book The Science of the Artificial.

Two of the methods that stem from Simon's book today are Design Science and Design Thinking.

Design Thinking refers to creative strategies that designers use during the design process. It is solution-oriented and creative problem solving and addresses " wicked problems" and "ill-defined problems", meaning that the problem and solution are unknown (Buchannon, 1992). "Design thinking in business uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity." (Brown, 2008). However, design thinking often lacks rigor and neglects the need for deeper understanding. Design thinking has been used in education since the 1980s, for example at Stanford University, where it is believed that students need both the skills and the tools to participate in a society where problems are increasingly complex and nuanced understanding is essential. Chekland's soft systems method (Checkland, 2000) and design thinking principles have been used in many business schools. We derive from this the thesis that universities need to include Design Thinking in the curricula, but should not forget the general and domain knowledge that is a prerequisite for understanding the complex world. And this can be achieved by applying the principles of Design Science Research.

Both methodologies aim at solving complex problems and the result is a prototype, model, instantiation etc. Design Science (Design Science Research) (Hevner et al., 2004) and Design Thinking are two of the best known. Both methodologies provide framework for developing artifacts, but have different purposes and goals. The first is more focused on scientifically rigorous development and evaluation of the solution (artifact), while Design Thinking is more focused on the value (to the user) of the developed solution and less concerned with scientific rigor. While both methodologies stem from a real complex problem and try to solve the problem, design science needs to build on existing theories and contribute to new knowledge. Therefore, Design Thinking tends to be used in a business environment and Design Science in an academic setting. In our teaching approach, we try to combine both worlds because students need to build on prior knowledge and apply rigorous methods to evaluate the developed artifact, but at the same time consider the value or user experience that the artifact would provide.

References

Brown, T. (2008). Design Thinking. Harvard Business Review.

Buchannon, R. (1992). Wicked Problems in Design Thinking. Design Issues, 8(2), 5–21.

Checkland, P. (2000). Soft Systems Methodology: A Thirty Year Retrospective. Systems Research and Behavioral Science, 17, 11–58.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. MIS Quarterly, 28(1), 75–105. https://doi.org/10.2307/25148625

Huertas, J.I.; Mahlknecht, J.; Lozoya-Santos, J.d.J.; Uribe, S.; López- Guajardo, E.A.; Ramirez- Mendoza, R.A. (2021). Campus City Project: Challenge Living Lab for Smart Cities. Applied. Science., 11, 2021, 1085. https://doi.org/10.3390/app112311085

Simon, H. A. (1969). The sciences of the artificial (3rd editio). MIT Press.

5. SMART CITY AS CASE STUDY CONTEXT

5.1. Why Smart City?

Fortunately, or unfortunately there are plenty of very complex situation that are potential basis for a case study. We may consider a potential candidate the COVID pandemic, and the complex epidemiological measurements, or global climate change policy and action plans, the list is endless. Smart City (SC) concept has similar features. In the previous section, we already mentioned the fundamental requirements: *complexity* (this is easy since almost every SC project affects more than one SC subdomains, political, economic, sociological, and IT aspects appear together); *decomposition* (starting with a very complex issue and slicing it while an operational problem left to work with); *distinguishing* between problems and tasks (what tasks will result from a solution to the problem) and finally separating tasks according to different *granularity levels.*

There is no universally accepted definition of what a Smart City is exactly. A good description might be: "Connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city"[2]

5.2. What is Smart City?

The main characteristics, or in other words, the subdomains of Smart City are the following:

1. Smart economy (innovative and entrepreneurial, digital currency)
2. Smart people (qualified, pursues life-long learning, creative)
3. Smart governance (participatory, provision of public and social services)
4. Smart mobility (access to transport, ICT infrastructure, sustainable and safe transport systems)
5. Smart environment (attractiveness of natural environment, sustainable resource management)
6. Smart living (facilities for culture, health, safety, housing, education, and social cohesion) (Giffinger et al., 2007).

A Smart City project always addresses one or more concrete social, economic and/or technical, technological objectives, it is impossible to give an exhaustive list of them. Just a few from the literature for the purpose of illustration:

1. **Shared ICT**, common infrastructure for communications using an optical fibre backbone
2. Information collection via **sensors** like smart meters monitored from a central control centre
3. **Open government** to bridge gaps between citizens and administrations
4. **Energy-efficient** technologies like smart streetlights
5. Time optimization like **multi-level parking** for revenue generation, global positioning system-enabled vehicles
6. **Zero emissions** which mean reduced utility bills
7. Green rooftops and a **green environment** (Hayat, 2016).
8. Smart Grid

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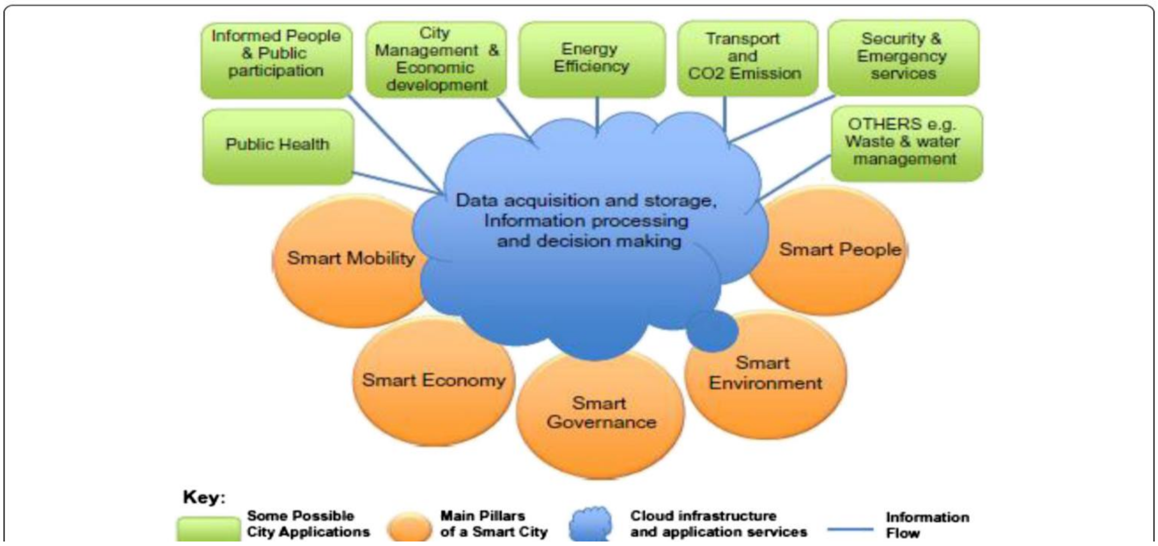
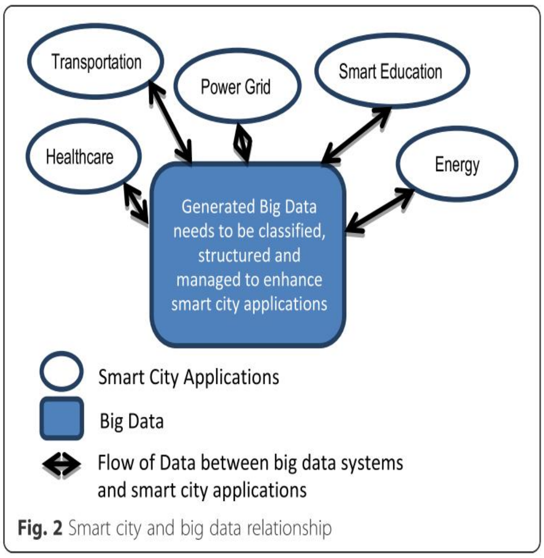
[2] H. Samih (2019) Smart cities and internet of things, Journal of Information Technology Case and Application Research, 21:1, 3-12, DOI: 10.1080/15228053.2019.1587572

The Smart City projects usually build around significant data processing, considering the extended sensor-based applications; the projects often end up in Big Data projects and applications.



8. Figure Smart city domains (Source: Al Nuaimi et al., 2015)



9. Figure Smart City and Big Data (Source: Al Nuaimi et al., 2015

The introduction of the Big Data concept easily leads us to cloud computing. Cloud computing, as for the time being the most advanced computational and software solution, gives several opportunities to combine the case study with the other business informatics areas, an interesting one amongst many others: trust and security. Based on security risk management, privacy data security can be discussed in detail. Since the terms trust and security usually go together, although trust is far not a computational category. This gives another interesting opportunity to introduce sociological, social-psychological dimensions as well.

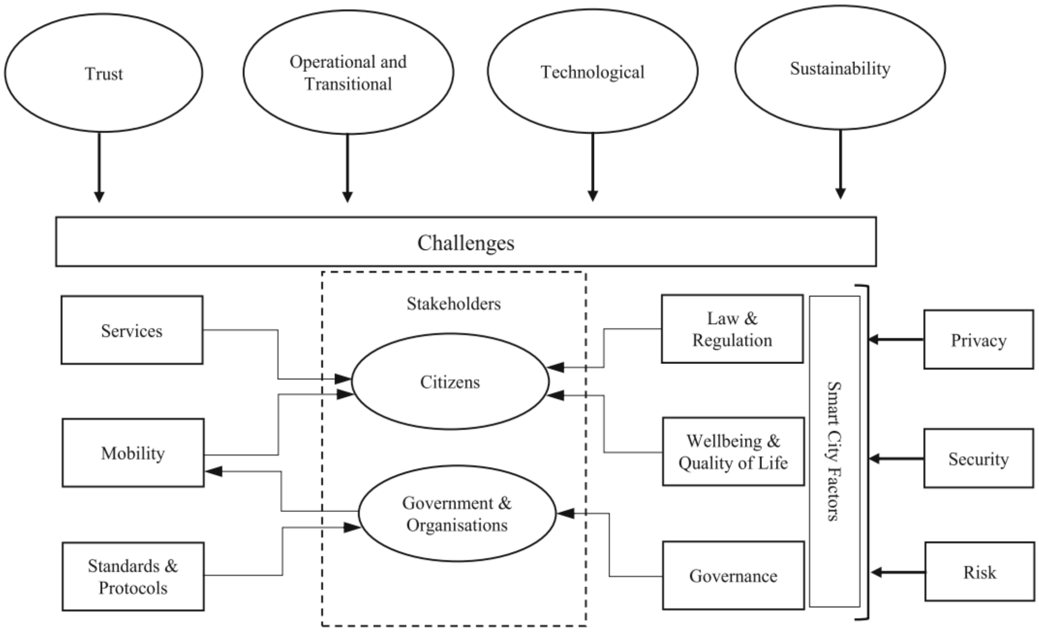


Fig. 3 Smart cities security & privacy framework

(Ismagilova *et al.*, 2020)

10. Figure Smart City security and Privacy Framework (Source: Ismagilova at al., 2020)

References

Allahar, H. (2020) 'What are the challenges of building a smart city?', Technology Innovation Management Review, 10(9). doi: 10.22215/TIMREVIEW/1388.

Ismagilova, E. et al. (2020) 'Security, Privacy and Risks Within Smart Cities: Literature Review and Development of a Smart City Interaction Framework', Information Systems Frontiers. doi: 10.1007/s10796-020-10044-1.

Al Nuaimi, E., Al Neyadi, H., Mohamed, N., Al-Jaroodi, J. (2015) 'Applications of big data to smart cities', Journal of Internet Services and Applications, 6(1). doi: 10.1186/s13174-015-0041-5.

Ooms, W. et al. (2020) 'Ecosystems for smart cities: tracing the evolution of governance structures in a dutch smart city initiative', International Entrepreneurship and Management Journal, 16(4). doi: 10.1007/s11365-020-00640-7.

H. Samih (2019) 'Smart cities and internet of things, Journal of Information, Technology Case and Application Research', 21:1, 3-12, doi: 10.1080/15228053.2019.1587572