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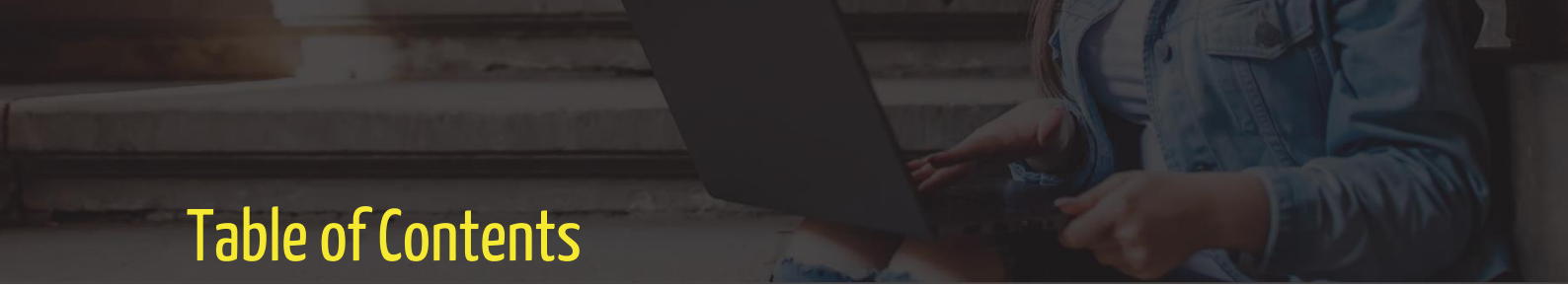
How to Set Up The IT Infrastructure for Digital Education

DANTE PROJECT GUIDELINES



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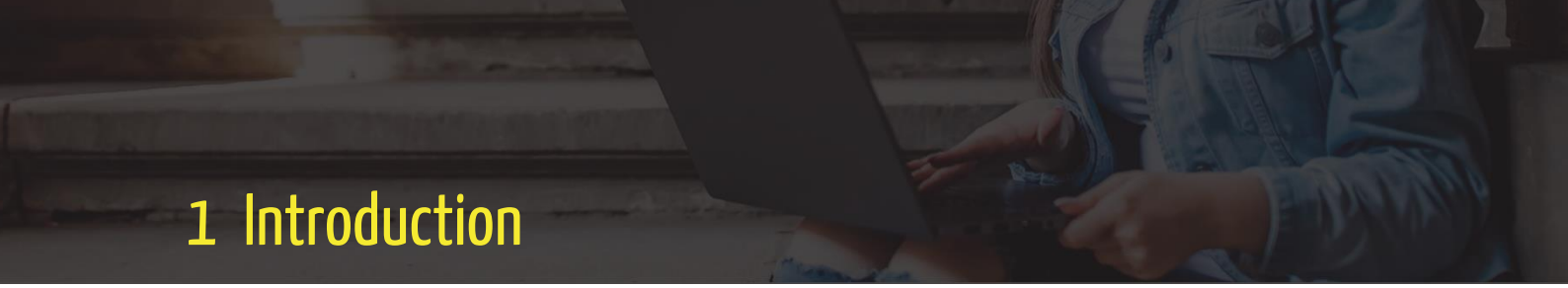


1 Introduction

These guidelines are part of the DANTE project, which consists of:

- DANTE market research and survey report
- DANTE guidelines - How to Develop a Digital Course
- DANTE guidelines - How to Develop IT Infrastructure for Digital Education
- DANTE guidelines - How to Communicate with Students and Motivate Them in Digital Education
- DANTE Digital Courses

The main objective/idea of the DANTE project is the support of education at HEIs (Higher Education Institutions) through the development of digital competencies of teachers, academic staff, university/faculty management, and university students. This wide portfolio of stakeholders also defines the focus of the Guidelines How to Develop IT Infrastructure for Digital Education.

Changes in teaching methods bring with them not only adjustments in the field of pedagogy, but also in the field of IT governance. The result is different demands on IT assets and their structure and management. The situation is all the more complicated because both the university education provider and the recipient (students) must be considered, as they are expected to use their IT resources primarily in a distance form.

The guidelines focus on IT management, defining key elements that are important to implement the educational process. It identifies the factors that affect the requirements for IT assets and, consequently, defines the principles of IT management.

2 Guidelines context in DANTE project

Most of the outputs in the DANTE project are primarily pedagogically orientated. Therefore, it is appropriate to state the position of guidelines for IT infrastructure, which are different in their character.

Figure 1 shows the structure of the project. The main content of each output is also displayed. The guidelines How to Develop IT Infrastructure for Digital Education are thus directly connected in terms of content with the guidelines How to Develop a Digital Course, where the pedagogical support of the teaching process is primarily addressed. The link between these outputs can be expressed by the fact that the IT infrastructure provides IT resources for the implementation of distance learning. On the contrary, digital courses define the requirements for IT resources and IT support. Another direct link is between guidelines for IT infrastructure and guidelines How to communicate with students and motivate them in digital education, which are focused on the issue of communication within the learning process. Communication and information sharing are an integral part of IT asset management and go beyond communication between teacher and student. Therefore, within the area of IT infrastructure, the issue of communication and information sharing is addressed at a more general level and includes communication outside of the teaching process.

Indirectly, IT infrastructure guidelines are linked to survey results. The survey provides some input information. It is worth recalling that management was one of the target groups interviewed. The guidelines How to Develop IT Infrastructure for Digital Education indirectly affects also digital courses, because the creation of courses is dependent on IT assets.

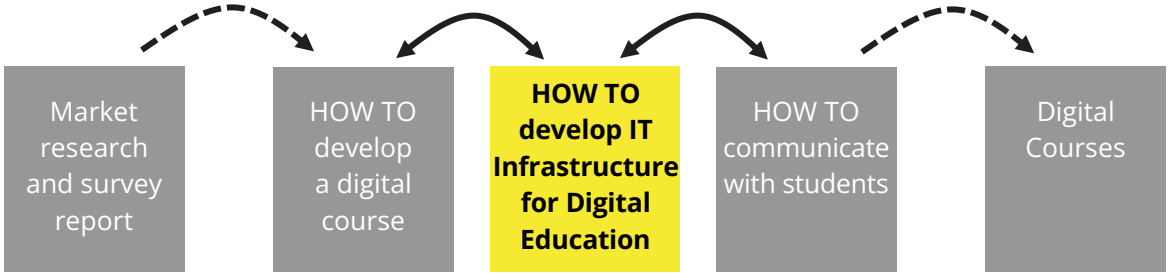
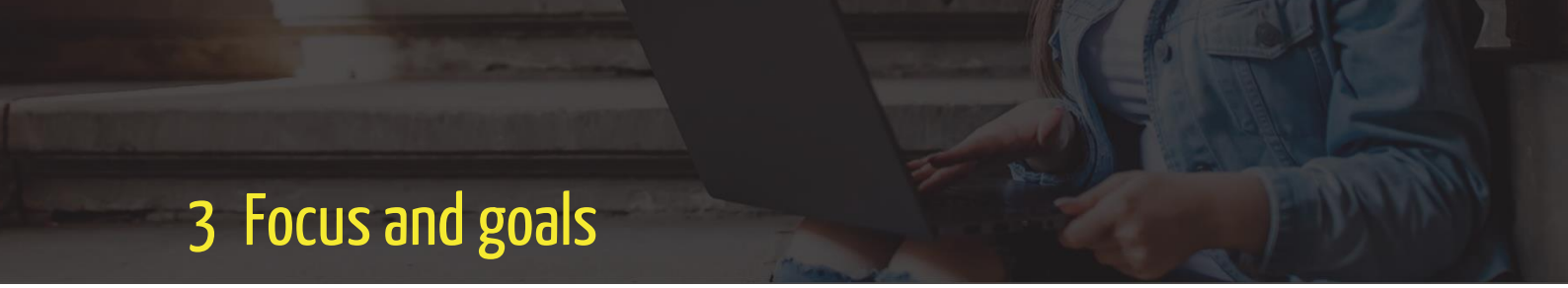


Figure 1 *Project structure*



3 Focus and goals

As the title of the guidelines implies, the goal is to organise and manage the technical background, which will be a suitable support for educational activities. Of course, each school has its own specifics, which make it impossible to define precise instructions or rules, but based on an analysis of the situation at five universities, we tried to define basic recommendations. Universities are primarily focused on the field of economics and business economics education. However, they also provide more or less related courses on, e.g., business informatics, legal sciences, and psychology. Therefore, the general focus is on the humanities.

Regarding changes in partners in the project, the questionnaire survey was carried out in four countries (CZ, PL, SK, and POR). The analysis of the IT situation and infrastructure for teaching processes was also carried out in collaboration with the Icelandic partner, who later joined the project.

Therefore, the results of guidelines will focus on recommendations, guidelines, and scenarios with the assumption of adaptation in use.

The guidelines address, among other things, the following issues:

- How to set up the infrastructure that is needed for the complex multimedia interaction of the teacher with students in the context of hardware and software, processes, and information.
- How to effectively use and manage existing resources to quickly switch from face-to-face to online teaching?
- How to provide an appropriate environment for sharing and transferring information.
- How to ensure the creation of lecture recordings and its availability for students.
- How to ensure the support for students with special needs (esp. people with vision disorder or hard of hearing).

4 Theoretical background

The area of strategic management of business informatics has been a hot topic for a long time. Secondary reasons have changed over the decades, but primary reasons remain, such as support of business goals, efficient use of resources, and risk mitigation (ISACA, 2018a). Secondary reasons currently affecting management include IT services, ongoing digital transformation (Matt, Hess & Benlian, 2015; Nielsen, 2019). The fundamental challenge for the management of enterprise informatics is IT/Business alignment, because if there is a harmonisation of the use of information technology resources for the realisation of business plans, then the meaning of their application is fulfilled.

With regard to the goal of the project, to support the preparation of IT infrastructure for education, we have chosen IT Governance and Enterprise architecture as the key areas.

4.1 Enterprise Governance of Information and Technology

IT Governance or, in the newer terminology, Enterprise Governance of Information and Technology (EGIT) focusses on information and technology (I&T) for enterprise risk management and value creation. (ISACA, 2018a). Furthermore, it should be part of the corporate governance system (OECD, 2015). The key idea of governance is simple. The requirements of business are primary and the demands on resources are derived from it, in our case, it is IT assets and their management. The goal is to achieve Business/IT alignment. The best-known methodological framework for this area is the ISACA COBIT framework.

The current version of COBIT is the COBIT 2019 framework that builds on the long development in the field of strategic IT resource management framework for business support. Methodologically, COBIT is based on balancing the interests of stakeholders and optimising the use of resources (in the sense of finding the right level of risk, portfolio of resources, etc.).

The COBIT addresses the areas as follows:

- Strategic alignment, business alignment, and IT alignment.
- Value delivery.
- Risk management.
- Resource management.
- Performance measurement.

At the implementation level, the framework is based on process management. It aims to create a governance system which can be understood as an organised and controlled set of components through which we consciously and transparently manage the organisation.

The development of a governance system is based on the components and their active management. At the same time, respect for the interrelationships (holistic approach) and the specifics of each organisation is important (ISACA, 2018b).

In COBIT, the key components used to build an IT governance system are as follows:

- Processes – described practises and activities that achieve specified objectives.
- Organisational structures – key decision-making entities in an organisation.
- Principles, policies, and frameworks - Methodological background of activities.
- Information – information that is needed in the governance system.
- Culture, ethics, and behaviour, factors that support processes and are often underestimated.
- People, skills, and competencies, human resources and their ability to carry out activities.
- Services, infrastructure, and applications – the IT world - infrastructure, technology, and applications.

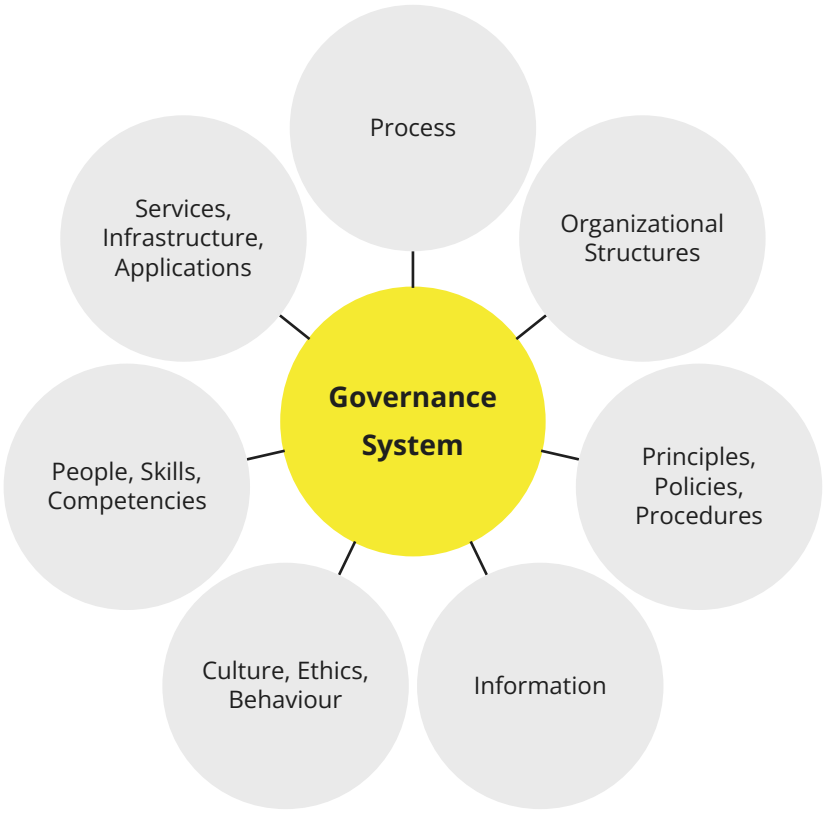


Figure 2 COBIT key components (Source: ISACA, 2018)

To simply put, we are trying to identify business goals and transform them into IT to identify the IT processes we can support. We then strengthen the implementation of IT processes by defining them and targeting people, organisational structures, working with information, and other components.

In conclusion, COBIT is the so-called best-practise framework. When implemented in a specific organisation, it is therefore necessary to adapt the application to the specific conditions of the organisation.

4.2 Enterprise architecture

Enterprise architecture (EA) is an area that supports the organisation of IT infrastructure to align with business goals (Kotusev, 2021; Lankhorst, 2009). EA can be seen as an approach, as a process, and as an expression of the structure (model). EA is widely discussed and scientifically researched; frameworks and software support are available. The TOGAF framework (OpenGroup, 2018) is one of the methodological frameworks for EA. At the theoretical level, TOGAF provides a structured view of IT

resources and infrastructure. It is important to note that EA is not only about IT assets (resources), but also about business perspectives (goals, processes, role of people, etc.).

The enterprise architecture can be defined as follows: EA is the process by which organisations standardise and organise the IT infrastructure to align with business goals. These strategies support digital transformation, IT growth, and the modernisation of IT as a department. (White, 2018). Understanding the IT infrastructure available for business use is beneficial to the dialogue between the IT world and business. Naturally, it is not only about the IT infrastructure, but also about the ability to describe the "business" infrastructure. What are the plans, strategies, processes, and projects that ultimately affect (and are affected by) IT?

To illustrate, let us mention some entities that can be used according to TOGAF (OpenGroup, 2018) to describe the infrastructure (both in the business domain and in domains orientated to the IT environment). The selected entities are as follows:

- Business capacity - a particular ability a business may possess or exchange to achieve a specific purpose.
- Process - A process represents the flow of control between or within functions and/or services (depends on the granularity of definition). Processes represent a sequence of activities that together achieve a specified outcome, can be decomposed into subprocesses, and can show the operation of a function or service (at next level of detail). Processes may also be used to link or compose organisations, functions, services, and processes.
- Goal - A high-level statement of intent or direction for an organisation. Typically used to measure the success of an organisation.
- Physical application component - an application, application module, application service, or other deployable component of functionality. For example, a configured and deployed instance of a commercial-off-the-shelf (COTS) enterprise resource planning (ERP) supply chain management application.
- Requirement - A quantitative statement of business need that must be met by a particular architecture or work package. (OpenGroup, 2022, Chapter 30)

Lankhorst states (Lankhorst, 2009) that EA can be understood and defined as follows: 'a coherent whole of principles, methods, and models that are used in the design

and implementation of an enterprise's organisational structure, business processes, information systems, and infrastructure.'

What are documents or artefacts meant by EA terminology? It is an output, a work product, that describes an aspect of the architecture (OpenGroup, 2018). A document is an expression of a description of a part of an organisation from a point of view. The role of documents as an instrument that supports communication and cooperation is important. The result is a reduction in problems resulting from mutual misunderstandings, differing interests, and perspectives. Documents are a tool between stakeholders. TOGAF (OpenGroup, 2018) lists three types of artefacts: matrices, diagrams, and catalogues. This corresponds to the basic description options in the format: text or graphics. The matrices express the relationship using crosslinks. In addition to artefacts, the TOGAF framework states the need for additional elements for building the architecture (principles, guidelines, etc.). Thus, a set of documents can be listed that are part of the architecture idea. Let us mention at least a few:

- Principles.
- Business capability models.
- Overviews of solutions.
- Guidelines.
- Landscape diagrams.

Identification of key elements of the organisation, their description, including the position and role they represent in the organisation. And then use for communication. Kotusev states the specific direct and indirect effects of EA's application. Direct are as follows:

- Improved effectiveness of IT investments.
- Improved efficiency of IT investments.
- Reduced costs of IT operations.
- Reduced technical and compliance risks.
- Reduced complexity of the IT landscape.
- Increased reuse of available IT assets, etc. (Kotusev, 2021)

The indirect (business) effects are as follows:

- Better operational excellence, customer intimacy, and product leadership.
- Increased speed to enter new markets and overall organisational agility.
- Improved managerial satisfaction. (Kotusev, 2021)

We can also talk about the possibilities of simulation of future development (prediction, especially in the case of deploying EA software), expression of causality between elements, etc.

4.3 Summary

Both areas mentioned above support management, harmonise goals and requirements with the use of I&T, are based on a holistic management approach, use best practise, independent of the specific technology, etc.

Thus, these areas are a suitable theoretical basis for the identified problem area, because the aim of the project is not to find a suitable solution for a strictly defined, specific situation, but rather general recommendations and definitions of possible solution scenarios.

In crisis situations where a quick solution is required, there is generally a greater need to know the current resources and options on the basis of which it is possible to respond and find a solution. At the same time, it is necessary to have prepared organisational capacities, roles, defined powers, and responsibilities to be able to define goals. Both areas discussed above (ITG and EA) enable organisations to improve capabilities based on flexibility, knowledge, and prepared processes.

Of course, there are other areas that have more or less influenced the solution of this guidelines within the project, but since it is not a theoretical work (article, monograph), let us leave other details aside.

5 Outputs and results

In this chapter, we present the results and outputs of the DANTE Guidelines How to Develop an IT Infrastructure for Digital Education. We proceed from the theoretical concept to practical recommendations. These are based on an analysis of the situation in selected universities.

The solution procedure is as follows:

1. Theoretical Background - Chapter 4
2. Questionnaire Survey Results - Chapter 5.1
3. Solution approach - See DANTE model - Chapter 5.2
4. Analysis of the situation in the partners' universities, identification of processes, Chapter 5.3
5. Analysis of situation in the partners universities, identification of educational scenarios, common elements for solution definition - Chapter 5.4
6. Definition of general principles - Chapter 5.6

5.1 Questionnaire survey

The questionnaire survey was the initial phase of the project. For guidelines, it is one of the components on which the output solution is built. The selected results of the questionnaire survey supplemented the conclusions of the environmental analysis at partner universities. Please, find a detailed analysis of the questionnaire in Market research and survey report of this project.

Based on the results, we present the general outputs/opinions of the respondents.

- Information is one of the issues for which teachers would appreciate improvement. **Teachers want to have information in advance and to have support and certainty in the information.**
- Adequate IT equipment is important to work in the home office mode. Teachers and students agree here.
- **The definition and follow-up of rules** is important for a group of teachers and students. Rules must be clear, comprehensible, and consistent.
- The students preferred a unified platform (**one environment**) for teaching.

Selected results of the relevant questionnaire survey for guidelines. A complete evaluation of the results is given in the market research and survey report.

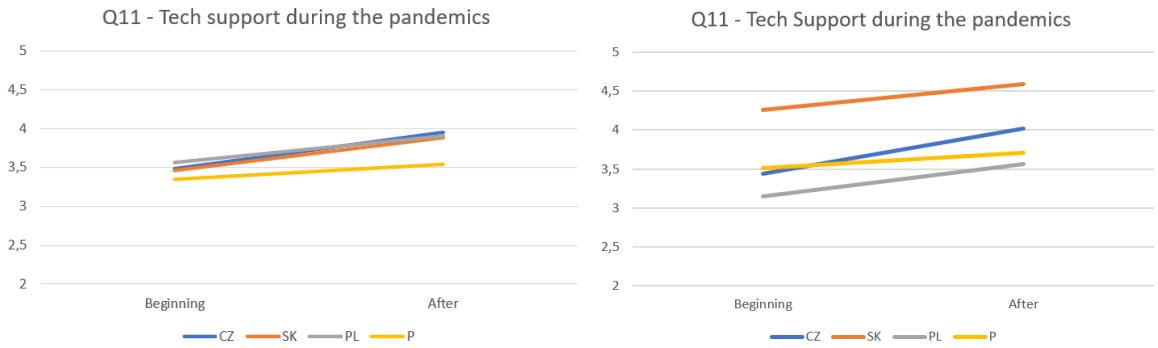
Technical support during the pandemic

The results of the questionnaire survey show that satisfaction with technical support has increased (across respondent groups – academics and students).

We can state that the respondents managed to adapt to the new conditions and the technical support has improved (and at the same time, universities have prepared the environment for distance education?!).

Especially for academics, this is the result of such a development of the IT environment at the university, which provides employees with a suitable background for work. This is partly true for students, as they have to take care of IT resources themselves (it must be emphasised that universities can also greatly influence the situation of students - they can help). For example, access to information, help system (Service Desk), simplification of access across all platforms).

Graph 1 Quality of technological support during pandemics.



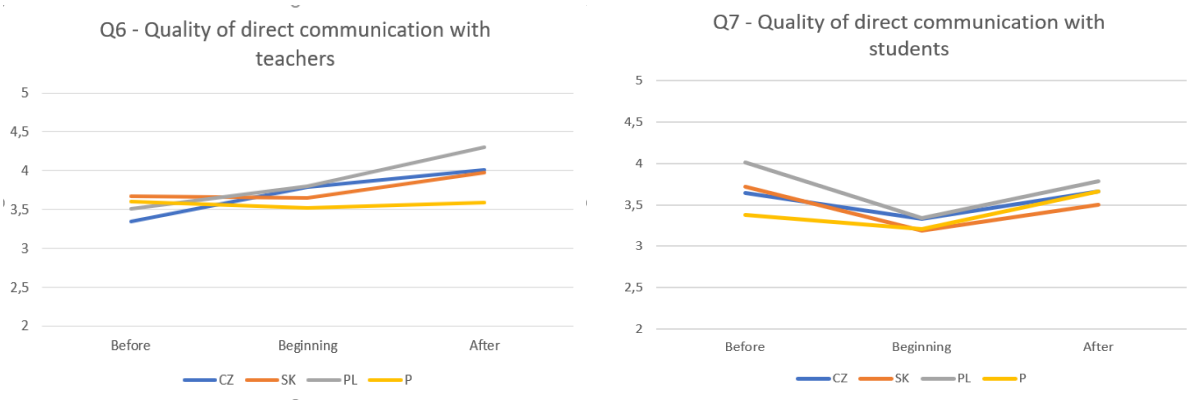
Note: Answers from students on the left and academics on the right.

Quality of direct communication between students and teachers and vice versa

The result in the area of the quality of direct communication (with the use of equipment supporting direct communication) also appears to be interesting. Throughout the period, an increasing trend in communication quality is evident. However, for academics, there is a clear drop at the beginning of the period, while for students, it is rather stagnant. Overall, the result for students at the end of the period is better than before the pandemic.

In general, we can state the ability to adapt to a new situation. From the point of view of the IT environment (study environment), the result is significant, because the equipment used to create the "environment for communication" is very significantly influenced by the university as the creator of the "environment for study".

Graph 2 Quality of direct communication between students and teachers and vice versa.



Note: Answers from students on the left and academics on the right.

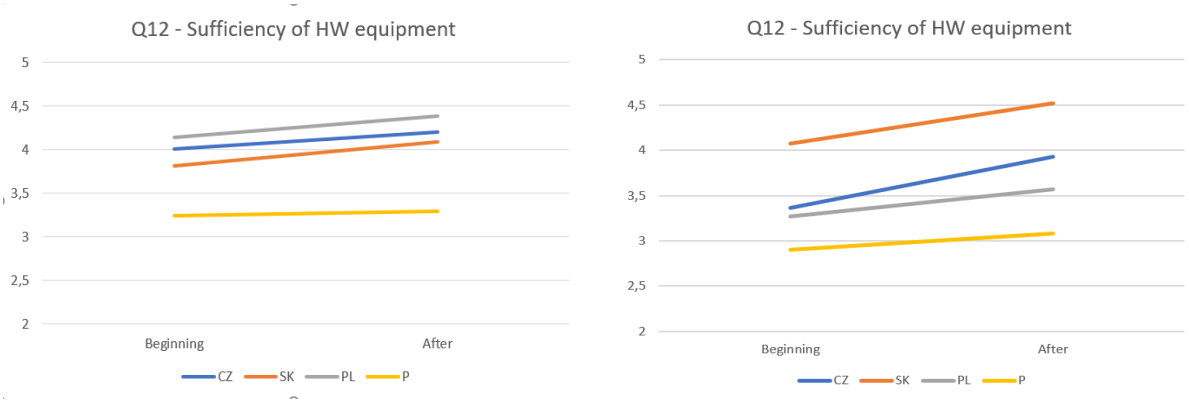
Sufficient technical equipment

The question evaluating the HW equipment shows an increase in satisfaction (with the exception of PT). The results correspond to the course of the period in which there was a conscious effort to equip oneself with technical means. This can be seen, especially in the increased satisfaction of academics (where there was support from the universities).

The question remains: why is satisfaction significantly lower in Portugal? The results do not provide an explanation in this case.

We can only guess whether this may be due to the fact that the respondents in Portugal are students orientated to study programmes in the field of IT; therefore, they are more critical in their opinion.

Graph 3 Sufficient technical equipment



Note: Answers from students on the left and academics on the right.

The results of the opinions of members of the academic community (considered collectively, students and academics) support the idea of creating a compact university environment where it is possible to collaborate and communicate in a distance form at a level that is close to the "on-campus" situation and mode.

Efforts to build such an environment must include the following.

- Equipment on the side of the university, the basic environment for education.
- Information and technical support.
- Appropriate participation of people (according to their roles, students, teachers, IT experts, management, etc.).

In this way, not only must all stakeholders be taken into account but also appropriate processes must be set up to ensure long-term operation and development (stability and sustainability).

5.2 SEE DANTE Model - Theoretical Concept

The preparation of a suitable IT infrastructure includes not only technological issues but also organisational and managerial issues. Generally speaking, there must be consistency between IT and business.

Great attention is paid to the issue of IT / Business alignment (Njanka, Sandula, & Colomo-Palacios, 2021; Chan & Reich, 2007; Coltman, et al., 2015). Management activities represent the purposeful organisation, combination, use, etc. of the organisation's

resources. These activities must be carried out with care and efficiency with appropriate risk. Therefore, knowledge of objectives, on the one hand, and knowledge of resources, on the other, are the basis for successful management.

It is also worth noting that the change in education caused by the pandemic represented a digital transformation where there has been a massive increase in the use of IT. Specifically, remote communication technologies were introduced into the educational process to allow teaching in a real-time environment (Matt, Hess, & Benlian, 2015; Nielsen, 2019; Brown & Brown, 2019).

The concept of the approach is based on the above-mentioned foundations, which respects:

- General levels of management in the organisation, specifically the 3-level model, strategic, management, and operational levels. The need to separate the different levels of management is due to their different scope of work (ISACA, 2018). However, the need for their coordination, communication, and cooperation remains.
- Identification of key elements that are important to organisation and management. The term element is not intended on a theoretical level but in a practical sense. In the field of EA, it is often synonymous with a 'document' as an expression of description or/and explanation, thus the basis of communication (Kotusev & Kurnia, 2021; Kotusev, Kurnia & Dilnutt, 2022).
- The need to share information, in our case not only in the pedagogical sense, study materials, but also in the managerial sense. This is to share information with organisational guidelines, legislation, and IT support (Q&A, HelpDesk, Guidelines, and others). Obviously, the area of information sharing goes through all levels of management. By character, it connects the elements in the organisation because the life of the elements, their measurability, management, etc. are intrinsically linked to information.
- Knowledge of context (e. g. continuity of processes, knowledge of resources, etc.), knowledge of the interrelationships between the elements in the system.

The area of information sharing is spread across all levels of management. By character, it connects the elements in the organisation because the life of the elements, their measurability, management, etc. are intrinsically linked to information.

The 'SEE DANTE model' (see Figure 3) illustrates the position of the elements at the various levels of management and the overlap of the information sharing area.

The name of the model stands for Smart Education Environment, because it is the basis for defining future outputs, recommendations, scenarios where resources are identified and combined. The word 'Smart' expresses flexibility, adaptability, the ability to work effectively, to have information to make decisions, and implement related activities.

Details of the relationships between entities can be found in the TOGAF framework, Chapter 30 (OpenGroup, 2018). However, the perception of vertical decomposition at the management levels is more important to the solution because it is essential for the assignment of stakeholders.

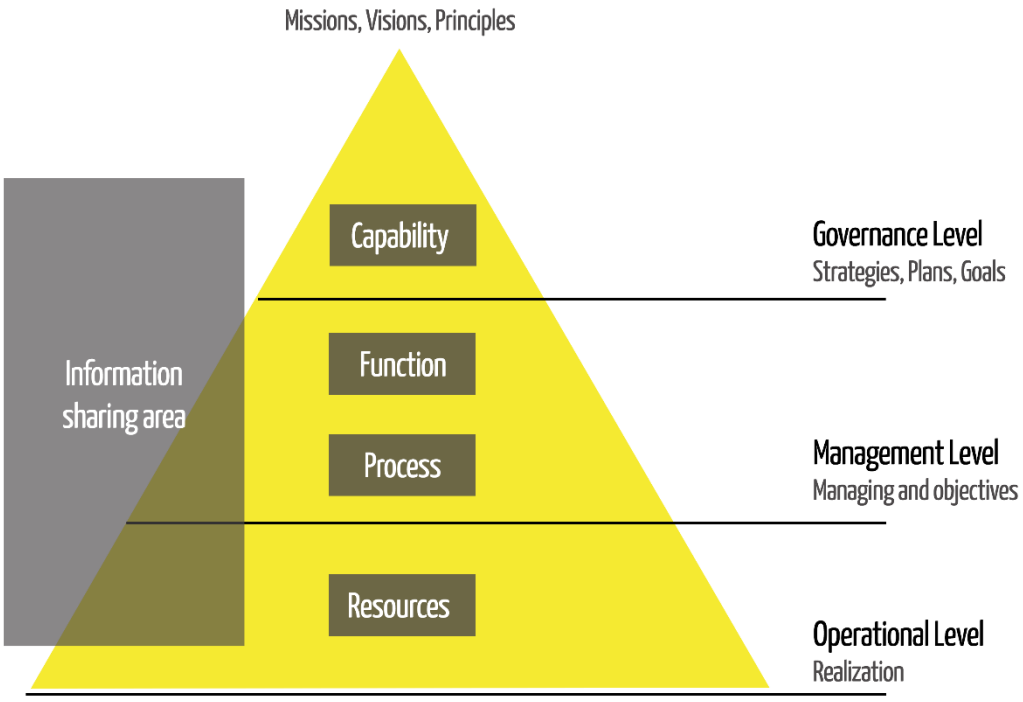


Figure 3 SEE DANTE Model structure

5.3 Analysis of the situation in universities

According to the implementation plan, an analysis of the teaching process and related processes was performed during the restriction period. The following information is based on an analysis of the situation of the four project partners (VSB-TUO, Czech Republic; TUKE, Slovakia; UEK, Poland; IPS, Portugal).

The main objective was to identify the aspects that affect the classification and variants of the teaching process. In the beginning, the identification of entities is based on the SEE DANTE model. Figure 4 provides an overview of the capabilities, functions, and processes identified.

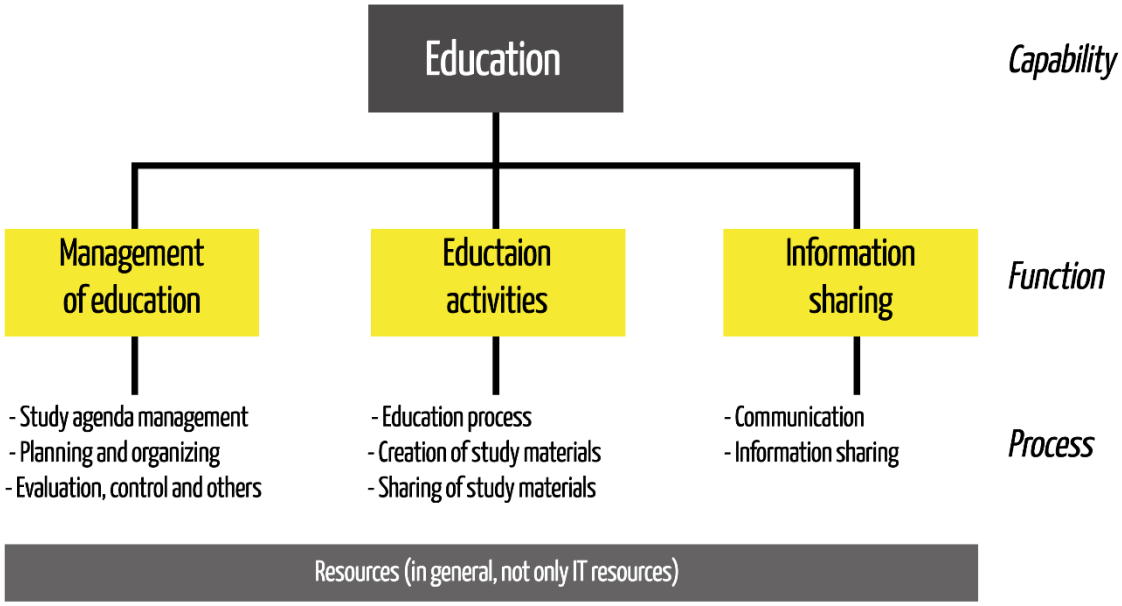


Figure 4 Hierarchical breakdown of key elements

Description of capabilities, functions, and processes

We present a brief description of the elements. It is obvious that if the situation in the organisation is different, other elements can be identified (rather their content can be different) or next elements can be defined. However, the access remains. We try to identify important elements of management with a structured approach and then work with them further.

Education capacity

Capability education was identified as the main concern for the project area. It is long-term - for example, in connection with the pandemic situation, it was not affected; on the contrary, the goal was to maintain education even in critical moments. The capability is further broken down into functions. We also take into account non-educational issues, as their implementation is also necessary within the framework of education.

Management of the education function

The function includes the organisational and management aspects of education. These activities are in the background of the learning process, but are an essential part of university functioning. At present, we can record the wave of electronization of processes, in this area. It is a response to the problems of connection with agendas, which were based 1) on direct contact between the client and the employee and 2) on the transfer of information in paper form.

Study agenda management process

Activities directly related to the study (organisation of credits and exams, assignment of subjects to students, choice of subjects by students).

Planning and organising process

Activities related to the organisation of teaching (schedule, classroom block, teaching records).

Evaluation, control, and other processes

Activities related to the preparation of studies, evaluation, and other agendas (preparation of study plans, accreditation of studies, archiving of materials related to teaching).

Function of educational activities

The function covers the processes associated with teaching. Great attention has been paid to this part in recent years.

Education Process

Activity directly related to teaching.

Creation of study material process

Support in the creation of study materials (especially multimedia materials). Activities can include video recording and editing, subtitling, audio recordings, etc. Support thus includes not only human resources, but also software and hardware resources (recording equipment, but also, for example, a television studio).

Sharing of study material process

Sharing of study materials for the needs of the teaching process (it is not about sharing information in the sense of legislation, study organisation, etc.).

Information-Sharing Function

An area that is very specific, which also shows its position in the SEE DANTE model. Ensuring an environment where horizontal and vertical information flow between stakeholders can take place is not a trivial matter. At critical moments, however, information transfer and communication are the key to keeping the organisation running.

Communication Process

Communication between participants: academic staff (guarantor, teacher), students, non-academic staff (IT staff, management, study department staff). It includes any form of communication with IT support: call, instant messaging, video call, email, help desk. In variants of communication one-with-one or group communication.

Information-Sharing Process

Information sharing is the ability to share information between organisations between different recipients. The goal is to create an environment where it is possible to share and transmit information at the level of the entire organisation (or in the context of the chosen organisational structure). This is not direct, targeted communication between two or more participants.

5.4 Educational Scenarios Classification

The analysis continued by defining the key aspects that affect the variants of the teaching process (educational scenarios). In addition to the aspects related to the way of teaching, the above-mentioned outputs have already been taken into account. As an important part of the whole educational process 1) matters of study organisation must also be taken into account and 2) depending on the situation, also relevant IT resources (especially in the case of special equipment that is not a common part).

The recommendations do not take into account quantitative characteristics such as the number of students, the number of teachers, etc. The aim is not to offer optimisation of planning and organisation. That is not even real. The aim is to offer a relevant framework in the form of aspects and recommendations, and thus define a general approach. Specific parameters and specifics of the organisation's situation must be the subject of individual application.

In the project, we tried to identify characteristics that significantly influence university life.

There are interrelationships between the characteristics. Consider the location and time. The example can be combining personal, face-to-face teaching and distance learning (using IT and Internet connection in online form). It is problematic to combine these forms during one day, when the students do not have the opportunity to move to a place from where they can easily participate in online education with IT support (or, vice versa, from the home where they are watching online education to immediately move to the university).

A good practise can be the approach to UEK, where they combined these forms of teaching, but the schedule respected the problems mentioned above - face-to-face teaching was on different days of the week than distance teaching. Therefore, students could attend classes at home or at the university.

The following characteristics were identified to identify the form of teaching:

Location

One of the key aspects in a situation where mobility has been restricted. The place where the teaching takes place. We distinguish the following.

- University/Faculty, on campus.
- Home, distance location.

All participants are affected; we distinguish between staff and students.

Time

The time aspect indicates whether the teaching is carried out at the exact time and in the presence of the teacher, and whether the student is necessary (synchronous) or whether the participants are independent of each other in time (asynchronous). Two variants:

- Synchronous, real-time.
- Bichronous (a combination of asynchronous and synchronous).
- Asynchronous.

Support

The teacher can be supported in the teaching process mainly in two ways. Firstly, there is support in the creation of study materials; secondly, there is support in the implementation of teaching.

It is necessary to define the scope of support, determining the content (what the support consists of), etc. A detailed definition would not allow for a reasonable classification, so we leave it to the application in a specific situation. We distinguish whether support is provided or not (with / without).

There are two main support options:

- Support for teaching. All participants are affected; we distinguish between staff and students.
- Support for content/study material creation (e.g., also includes the creation of audio/video recordings). Teachers are affected.

Note: In the support for teaching variant, it is appropriate to monitor the support of students, because according to experience from the period of hygienic

restrictions, students had problems with IT equipment and were not able to solve them without "IT support" - in other words they were dependent on technologies that are functional. Previously (face to face teaching and normal availability of services) this situation did not occur or was not so significant because in the unrestricted period, the availability of support was greater (or not necessary).

Among the other aspects that are important for the classification of scenarios were the following:

Management of education

The function is described above. The degree of electronic processes supporting teaching and the related digitisation of documents is important for scenarios. For classification, we, therefore, distinguish whether the current situation is without restrictions or whether only activities in electronic form are available via the Internet.

This aspect can include a wide range of factors that must be taken into account when organising the learning environment. Let us mention at least the following: time (for preparation, long-term measures/changes, etc.), database with key information (students, study programmes with subjects, timetables, etc.) for the availability of information within the administration of the teaching process, management method (centralisation of responsibility, authority versus independence of organisational structures), goals and objectives that are affected, etc.

All participants are affected; we distinguish between staff and students.

Hardware / software equipment

The appropriate IT equipment is a prerequisite for many activities in the educational process. This is true for the full-time form, for distance learning it is basically a necessity. Therefore, when classifying scenarios, we present this characteristic, especially in the context of ownership, which is related to availability.

Especially for teachers, it is assumed that the IT equipment is available to them from the university on an employment basis. However, even for students, universities

have HW and SW equipment available on campus. In both cases, this condition is affected by the place of teaching, mobility, etc.

We distinguish between IT assets provided by the university (the university is a de facto provider of IT assets) and our own IT assets.

Matrix 1 lists the main characteristics of the learning scenarios according to the aspects described above.

Description of scenarios

We present a more detailed description of individual scenarios. For simplification, the description on the part of the university distinguishes between a teacher, an actor active in educational activities, and a staff, an actor responsible for the management of education.

Scenario 1

Scenario 1 could be described as a traditional model, where both the student and the teacher are present on campus (learning environment) and can make full use of the university's assets (environment, infrastructure, HW and SW, support).

Scenario 2

Scenario 2 represents a situation that is historically based on the idea of distance learning using IT, where the teacher is on campus and the students are connected remotely.

Scenario 3

Scenario 3 extends the previous scenario with the possibility of the physical presence of the students. It is a hybrid variant, where students choose the full-time or distance form of presence. It should be noted that this scenario describes teaching in real time; it is necessary to reconcile communication between teacher and students (two groups of students). Of course, it is also about communication between staff and students.

Scenario 4

Scenario 4 is a variant of scenario 2, but in principle it is a teaching on demand, not in real time. Fundamental is the preparation of the environment and study materials that the student has available according to his time preferences.

The scenario assumes that communication between the employee and the student takes place according to the characteristics of the agenda that is addressed.

Scenario 5

Scenario 5 is based on Scenario 4, but assumes that the teacher is not present at the university. In this way, it replicates a situation of limited mobility or restrictions on access to the university campus. It is obvious that this type does not have to be bound by restrictions, but can / is applied even in a normal situation, when the advantage for the teacher/staff is the possibility of eliminating travel to work (application of home office regime).

Scenario 6

Scenario 6 could be described as a lock down model from the point of view of recent years, more optimistically as a distance form of education in the home office regime on the part of the teacher / staff.

Typical educational scenarios have been identified on the basis of aspects.

Matrix 1 Classification of typical educational scenarios

				Educational activities		Management of educational	IT assets
Scenario	**Time**	**Location**	**Form**	**Support – teaching**	**Support – content creation**		**HW/SW equipment**
		Teacher / Student		Teacher / Student	Teacher	Staff / Students	Teacher / Student
1	Synchronous	On campus / On campus	Face-to-face	Yes / Yes	Yes	Without restriction	UNI IT assets – all participants
2	Synchronous	On campus / Home	Distance learning	Yes / No*	Yes	Without restriction / only in electronic form via available IS	UNI IT assets / Own IT assets
3	Synchronous	On campus / On campus and at home	Hybrid	Yes / No*	Yes	Without restriction / only in electronic form via available IS	UNI IT assets / UNI or own IT assets
4	Asynchronous	On campus / Home	Distance learning	Yes / No*	Yes	Without restriction / only in electronic form via available IS	UNI IT assets / Own IT assets
5	Asynchronous	Home / Home	Distance learning	No* / No*	No*	only in electronic form via available IS / only in electronic form via available IS	Own IT assets - all participants
6	Synchronous	Home / Home	Distance learning	No* / No*	No*	only in electronic form via available IS / only in electronic form via available IS	Own IT assets - all participants

** No support means no direct support. Manuals, online help, guidelines etc. are of course available.*

Scenario identification is only the first step toward a structured approach to resource organisation. The next step is to identify the IT tools that are used for the study (again in the context of agendas outside of the study).

Therefore, in the analysis of the situation in the solving universities, which are part of the project, the basic IT systems and IT assets that support the mentioned activities were identified. These groups were defined on the basis of dominant characteristics. It is obvious that the partial characteristics overlap and that the tools are more or less universal or have a different range of functionalities.

The following groups of IT systems have been identified. The characteristics are limited to some functionalities, which we present as they are understood within the solution of project outputs.

Communication platform

Communication platforms are applications that enable remote communication and collaboration between participants. The key functionalities are calls (video calls), instant messaging, and team communication. Other functionalities include content sharing, time management, etc.

Examples of systems: MS Teams, Google Meet

Learning Management System (LMS).

LMS systems probably do not need to be introduced. The project mainly concerns the functionalities associated with the organisation of studies in the field of pedagogy (structured approach to subjects and their content), sharing content and information, evaluation of study outcomes, etc.

Examples of systems: Moodle, Google Classroom (together with other Google apps)

Electronic mail services (email)

Electronic mail services are also a natural part of life. In the project, they represent a form of communication between the participants.

Intranet

In the solution, the intranet is understood as a private web presentation, where the content is personalised to the participants (recognisable by their login). This is an important channel for sharing content (including internal character) and thus a form of communication.

Web

The Web as a space on the Internet where information or documents are publicly shared.

Service Desk

The Service Desk is the point of contact between the service provider and the customer. It can also be understood as a Help Desk within the solution.

Manuals and Guidelines

Systems that support content sharing with their orientation designed to support users in the form of instructions, manuals, FAQs, Wiki, etc.

IS study agenda

Systems that support the agenda associated with the management and organisation of the study. See also the description of processes in this area. Different information systems are used in universities, for example IS Edison in VSB-TUO, Wirtualna Uczelnia (WirtUcz) in UEK, or MAIS in TUKE.

Social networks

Social networks are becoming an increasingly popular way to inform students about what is happening at the university. They basically replace and supplement the "Web" see above. Examples include university Facebook or Instagram.

Matrix 2 shows the relationships between processes and the major systems that are relevant to the education area.

Matrix 2 Processes versus software/IS (+ HW equipment)

Process	Communication platform	LMS	SW + HW	Email	Intranet	Web	Social Networks	Service Desk	Manuals and Guidelines	Study agenda IS
Example	Teams, Meet, (Moodle*)	Moodle	Camera, Ntb, audio/video studio		InNet			HelpDesk	Wiki FAQ	Edison, MAIS, WirtUcz
Education	X	X	X					X	X	X
Creation of study materials			X					X	X	
Sharing of study materials	X	X								
Communication	X	X		X	X					
Information sharing	X	X		X	X	X	X	X	X	
Study agenda activities					X					X
Planning and organizing				X	X					X
Evaluation, control and other					X					X

Comments and explanations:

Communication platforms are related to education and study materials sharing because their functionalities can be used in this way.

Intranet - they are related to the processes within the Management of education function, because they typically represent a place where forms and internal information (e.g., legislative documents) are available, etc. In general, they may include support for these internal activities associated with the core business of the organisation.

Service Desk - is related to the process of information sharing, as the availability of manuals, FAQs, and user support has the character of disseminating know-how (information).

Moodle* - with the Big Blue Button plugin, Moodle also provides the functionality characteristic of this group of tools.

Matrix 3 Scenarios (and processes) versus importance of software (hardware) / IS

Processes in scenarios	Communication platform	LMS	UNI HW + SW	Portable HW + SW	Email	Intranet	Web	Social Networks	Service Desk	Manuals and Guidelines	Study agenda IS
			Teacher or staff / student	Teacher or staff / student							
Scenario 1											
Education	1	2	2/2	2/2	1				1	1	2
Creation of study materials		1	2/2	2/2							
Sharing of study materials		3									
Communication	1	1			1						
Information sharing	1	3			1	1	1	1	1	1	1
Study agenda activities											3
Planning and organising		2									3
Evaluation, control and other		2									3
Scenario 2											
Education	3	2	3/	3/3	1						2
Creation of study materials		1	3/	3/3							
Sharing of study materials	2	3									
Communication	2	1			1						
Information sharing	2	2			1	2	1	1	2	2	1
Study agenda activities											3
Planning and organising		2									3
Evaluation, control and other		2									3
Scenario 3											
Education	3	2	3/	3/3	1						2
Creation of study materials		1	3/	3/3							
Sharing of study materials	2	3									
Communication	2	1			1						
Information sharing	2	2			1	2	2	2	2	2	1
Study agenda activities											3
Planning and organising											3
Evaluation, control and other											3

Processes in scenarios	Communication platform	LMS	UNI HW + SW	Portable HW + SW	Email	Intranet	Web	Social Networks	Service Desk	Manuals and Guidelines	Study agenda IS
			Teacher or staff / student	Teacher or staff / student							
Scenario 4											
Education	1	3	2/	2/2	1						2
Creation of study materials		1	3/	3/3							
Sharing of study materials	1	3									
Communication	1	1			1						
Information sharing	1	2			1	2	2	2	2	2	1
Study agenda activities											3
Planning and organising		2									3
Evaluation, control and other		2									3
Scenario 5											
Education	1	3		2/2	1						2
Creation of study materials		1		3/3							
Sharing of study materials	1	3									
Communication	1	1			1						
Information sharing	1	2			1	2	2	2	2	2	1
Study agenda activities											3
Planning and organising											3
Evaluation, control and other											3
Scenario 6											
Education	3	1		3/3	1						2
Creation of study materials		1		3/3							
Sharing of study materials	2	3									
Communication	3	1			1						
Information sharing	3	2			1	2	2	3	3	3	1
Study agenda activities											3
Planning and organising											3
Evaluation, control and other											3

Comments and explanations:

Matrix 3 summarises the relationships between the scenarios and the selected information technologies. The relationship is expressed by the importance of IT for a given scenario. The scale used is: unused, 1 - little / occasionally used, 2 - commonly used, 3 - important.

Thus, matrix 3 illustrates the different levels of use in individual situations. Although it is a matter of simplification, there are still visible trends associated with scenario and IT.

In real-time teaching, the importance of an environment for learning process is growing, where it is possible to communicate, share content (at a given moment, for example, a screen), interact. In matrix 3, this is visible in the communication platform column and partly in the column of portable devices. There is a greater emphasis on HW and SW in synchronous teaching, where their immediate unavailability practically eliminates the possibility of participation in the teaching process.

The columns dedicated to HW and SW deserve a broader comment. Matrix 3 is more about the HW and SW equipment used in processes (as opposed to Matrix 2, where it is more about general support for processes).

The data in matrix 3 in the column show HW and SW together, the dividing criteria are their portability (HW) and remote availability (SW). We distinguish between the use of the teacher (or staff) and the student. In the process of creating study materials, the student is also listed in matrix 3, as they form the outputs for the study.

It is obvious that especially for portable devices, it would be possible to more thoroughly analyse the role of HW and SW separately. Although SW can usually be provided by a university over the Internet (using technologies such as VPN or RDP links), HW is not typically offered to students. Therefore, the availability of HW is more difficult for students (solved by their own equipment). For teachers and staff, the provision of portable facilities by the university in the above sense is commonplace.

In these columns, it is visible that portable devices and software available remotely are universally applicable in every situation, whereas common equipment (non-portable

computers, classroom equipment, audio / video studios, etc.) are only available in a university environment.

It can be seen from matrix 3 that the roles of certain systems do not fundamentally change in any scenario. This condition is visible for e-mail or IS for the study agenda. Electronic mail has a stable place in processes, and for distance forms of education, other communication channels are a supplement to real-time communication.

The study agenda is implemented in all scenarios, it is important to realise that electronization and digitisation are key in these processes (usually the systems are available via the Internet).

For scenarios where the absence of process actors at the university is assumed, the role of systems supporting the functioning of IT is growing, e.g., help desk, Intranet, sharing guidelines, etc.

An important part of the infrastructure is systems such as LMS, which support the teaching of their ability to organise and share study materials and create additional elements related to teaching (surveys, tests, and more). Some of these functionalities are also available on communication platforms. However, from our analyses, universities prefer the separation of primary functions in these two types of systems, i.e., communication platforms, communication and LMS, organisation and content sharing.

Basically, the same starting points apply to building an IT infrastructure as to other areas of human activity. We have limited resources that we can use and that have limited functionality. Therefore, we must combine resources to achieve the desired result. In the university environment, there are also typical requirements for functionalities that are satisfied by partial resources - technologies. Let us mention Study agenda IS for ensuring these processes (VSB-TUO - Edison, UEK - Wirtualna Uczelnia, TUKE - MAIS, IPS - SIGARRA); organisation and information sharing – typical LMS-type systems (VSB-TUO, TUKE, IPS – Moodle) or real-time communication functionality (VSB-TUO and TUKE – MS Teams, UEK – Google Meet, IPS – MS Teams or Zoom).

As mentioned above, the areas of HW and SW can be analysed to a greater extent. Here are some examples of equipment (mini scenarios) that can be used to support education.

- **Capture of lectures.** A portable device for capturing lectures (video + sound + presentation) is a technology that has been used for a long time (at VSB-TUO, Accordent Capture Station). A record was created, which was subsequently available online. However, hygiene restrictions eliminated the use of this technology, which required the presence of an IT staff. Ensuring the recording of the lecture, which the teacher conducts on his computer, is possible with variant procedures: 1) in offline mode, screen recording and sound capture (e.g., OBS Studio, Bandicam, and others); 2) in online mode, recording in the software of the communication platform (e.g., in MS Teams).
- **360 cameras** + projection and communication platform-for Scenario 3, in which students are present at the university and at the same time connect remotely, it is possible to use, for example, a camera with automatic recording and recording in 360 degree mode. These devices respond to the voice and, without the assistance of another person, are able to ensure the detection of the speaking person. In this way, it is possible to mediate the dialogue conducted in the classroom for remotely connected students (that is, not only the teacher's recording, but also the students' reactions). In combination with the projection (where the present students can perceive remotely connected colleagues), the necessary interaction and communication takes place.
- **The audio / video studio** is a space equipped with audio / video technology adapted to film video materials. Thus, it provides quality support for the creation of video outputs such as lectures, interviews, etc. The teacher can focus on content preparation, while studio staff provide recording and subsequent editing.
- **Different OS on users' end devices** - In situations where students do not work on devices administered by the university, we must be prepared for the diversity of platforms among students. It is a typical situation that requires flexibility and foresight. Situations that may be affected can be identified and we can prepare for them: manuals, instructions, providing access to the necessary software, etc.

5.5 Students with special needs

The great challenge is to approach students with special needs, both in the full-time teaching regime and in other scenarios of the teaching process. However, in principle, the situation is the same. It is necessary to create a communication platform between the teacher and the student to ensure a suitable form of information mediation.

Traditionally, special attention has been paid to the proper teaching of students with specific needs (e.g., UDL in CAST, 2022). In the DANTE project, we want to point out that as part of the methodology to support students with specific needs, attention must also be paid to the general background of the university. In this way, it is possible to create an environment where students with specific needs can handle everything related to their studies.

This chapter does not aim to provide a detailed analysis and design of study support for students with special needs. The aim is to mention this type of students and their inclusion in the preparation and subsequent implementation of educational activities.

Differences in the organisation of studies may occur in technologies and procedures that are influenced by the specifics of the student given his needs (longer teaching time, mobility, motor skills, etc.). We can state that universities have been paying attention to this area for a long time. Therefore, while pandemic restrictions meant new barriers to teaching students with special needs, on the other hand, it was often possible to see an increased degree of flexibility in dealing with 'new' situations. Flexibility was based on the habit of dealing with emergencies. Both on the part of students who are used to overcoming obstacles and on the part of the university, where there is usually a department dedicated to students with special needs (based on an analysis of the situation at the universities involved in the project).

For universities, the first impulse is the identification of a student with special needs, his presence at the university and belonging to the study programme. Respect for needs is key, so follow-up activities depend on identifying needs and determining the form of assistance. After this phase, the study is carried out. In both the area related to the

study agenda and with the teaching itself. Figure 5 illustrates the main phases and activities.

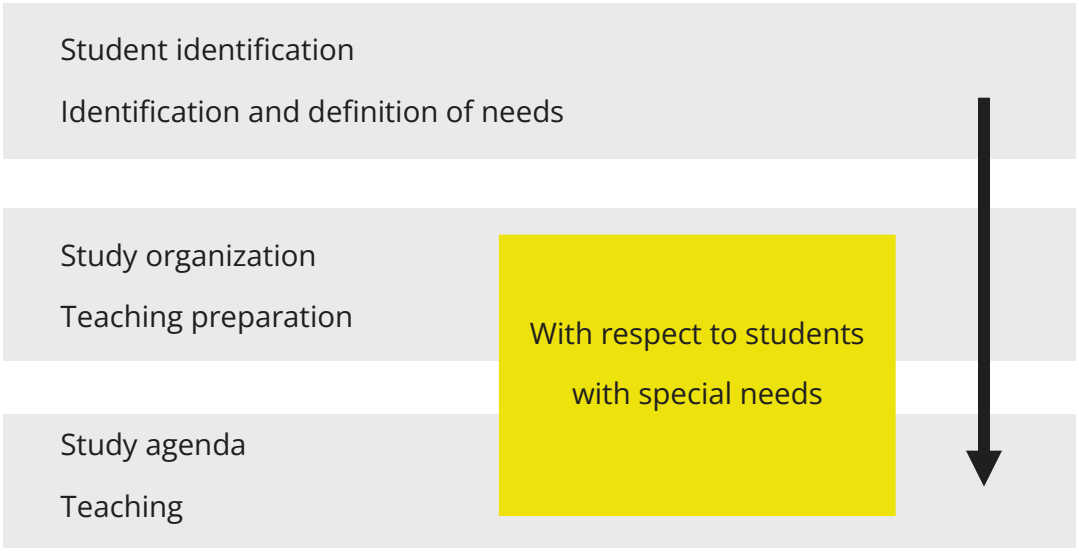


Figure 5 Main phases and activities

Aspects that need attention are given to the following:

- Environment preparation - both on campus (physical world) and in electronic form (digital, virtual world).
- Organisation of studies and activities related to the study agenda - specific requirements must be taken into account outside teaching.
- Preparation of teaching and teaching materials, a very challenging task, which represents for teachers the application of a different way of thinking (see UDL in CAST, 2022).
- Increased demands on communication and information sharing. It is clear that the above aspects bring with them a greater need for communication and information sharing between actors in the educational process, as students with special needs bring "specifics" to the processes. As a result: additional information, individualisation, etc.

As can be seen, attention is paid not only to study-related activities but also to aspects of study organisation, the university environment.

These aspects should be reflected in the universities in the recommendations as follows:

- Pay attention not only to teaching, but also to the overall background of the organisation.

        - Part of the organisational structure is the department (unit, office), which is specifically dedicated to students with special needs. In this department, communication between a student and a university employee can take place without restrictions due to specific needs, with the support of special equipment, knowledge of the situation, etc.
        - Targeted support and building of all IT systems with regard to students with specific needs (not only LMS and SW used in teaching).
    - The preparation of materials and teaching requires appropriate approaches. That is, the knowledge and skills of the teacher. An example is the Universal Design for Learning (UDL) approach (Meyer, Rose, Gordon, 2014; CAST, 2022).
    - Targeted building of an environment supporting students with special needs (outside the scope of education and IT areas that are affected in the DANTE project focus).

For all these aspects, their long-term perception is crucial, as they become an integral part of the organisation's functioning over a longer period of time, so they cannot be seen as "extraordinary" or "atypical" elements. On the contrary, they become an integral part of the organisation and processes. A good example is the use of UDL in the application of which the educator does not primarily address "students with special needs", but rather a suitable way of preparing study materials for "students".

5.6 Principles

The long-term development of the IT infrastructure as a background for educational processes, where various learning scenarios are implemented, is only possible if all stakeholders respect the principles that represent fundamental, initial tenets and rules influencing our behaviour.

Main Principles for Infrastructure and Management

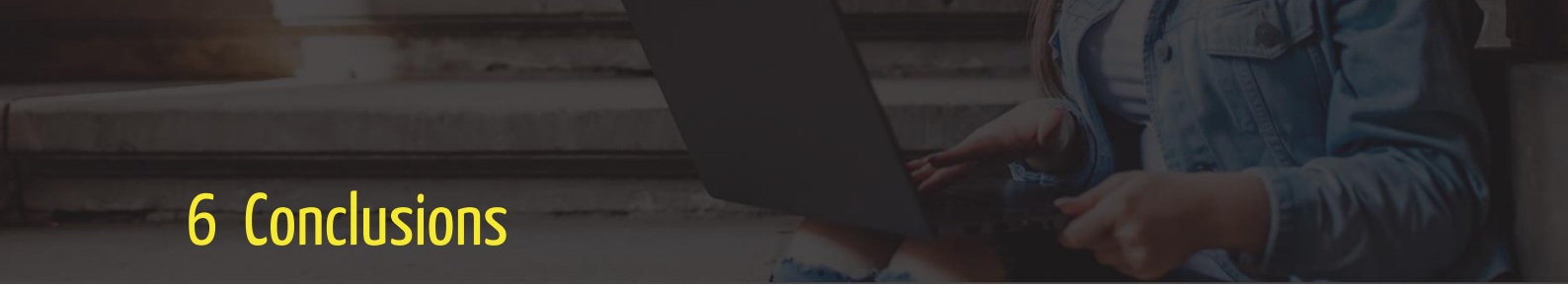
- Education continuity, the ability to provide an educational process.
- Flexibility - ability to adapt to a changing environment.
- Continuous improvement - the ability to continuously improve and support innovation.
- Compliance with laws and standards - Keep activities complying with laws and regulations.
- User-friendly environment - The environment (technology) is transparent and easy to use.
- Dissemination and sharing of information, information as an asset for successful development, the basis for knowledge-based management.
- Sustainability – in environmental meaning (can work on older equipment, big hardware requirements can lead to increased power consumption, etc.) and also financial meaning (for example, future growth of licence fees).

Principles are important, especially in the sense that they are valid for all stakeholders and thus form lines for thinking and acting. These are not specific orders or standards. The principles define the approaches applied in the organisation.

It is also necessary to emphasise the role of principles with regard to the time aspect. It is appropriate to consider the perspective of time at least as

- Long-term – especially strategic level - strategical, long-term planning of activities and resources, know-how and knowledge management, etc.
- Short-term – especially operational level – daily routines (education realisation), short-term planning of resources, information sharing, etc.

It is clear that in the short term activities may be affected by efforts to find an immediate solution that may not be optimal in the long run. Principles can help eliminate long-term and short-term decision making.



6 Conclusions

The long-term building of the digital learning environment (design of the IT infrastructure) should be conceived as a holistically solved problem with the effort to harmonise between the IT area and the goals of the educational institution. Both approaches used in guidelines as a theoretical background are supported by knowledge of the links between the elements of the organisation, both horizontally and vertically. In other words, there is respect between management levels and respect between problem-orientated areas.

In our project, we support these links within the SEE DANTE Model, where there is a hierarchical breakdown of the strategic goal into individual processes that contribute to its fulfilment. At the same time, we define the primary scenarios of the teaching process and identify the information technologies that serve to implement them. We look at educational capability not only from the point of view of education, but also from the point of view of activities necessary for the preparation of the educational process (e.g., simplification of the study agenda). This approach **brings flexible behaviour and the ability to change different forms** of education (basically because we distinguish between individual forms, and we are ready for different variants, which we then only apply. In addition, not only the teacher is prepared in this way, but basically all elements of the organisation). The biggest innovation needs to be implemented in a change of thinking and management area!

The structure formed in this way creates a link between IT resources at the operational level and strategies at the top management level.

Let us use an example.

Equipping teachers with portable technology (e.g., laptops) is a matter that is part of the organisation's long-term plan, as the HW life cycle is typically several years. It is reflected in increased employee mobility, better usability of HW and generally supports the flexibility of the organisation's resources.

In the text, we also **address students with special needs**. Also here, an approach based on knowledge of needs, possible solution variants, knowledge of resources, and therefore possibilities, is the basis for the preparation of a quality IT infrastructure.

From the results of the questionnaire survey, it is clear that the students appreciate the unified environment, which achieves better orientation and clarity of the environment. The result also is better information sharing, as the information is provided by fewer communication channels.

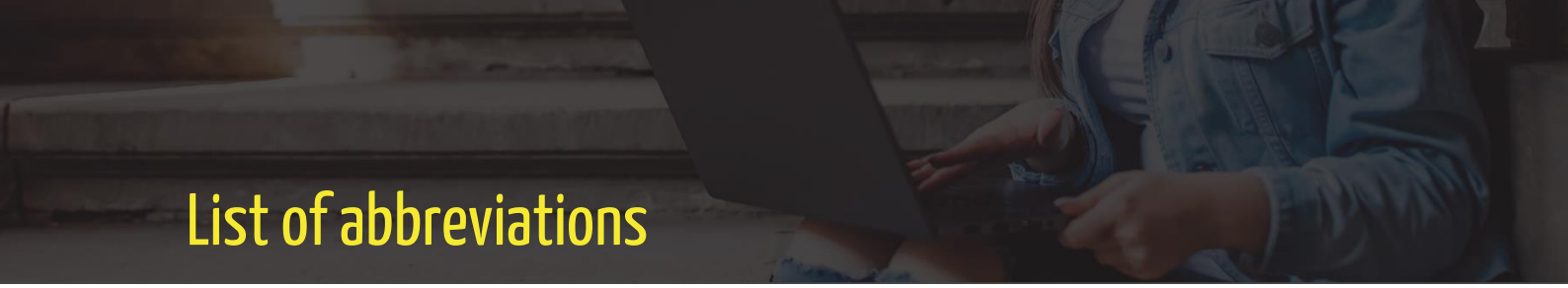
The decision to use a specific software for this type of functionality and to ensure its use is again a matter of cooperation between the management (management component) and the technology provider (usually the IT department).

An example of the interconnection of technologies, strategies, and decision-making can be the choice of environment for the implementation of teaching. Let us take the basic variants presented in the analysis of project partners: MS Teams, Moodle with the BigBlueButton plugin, or Google Meet. Teams and Meet are IT services of external SaaS providers. The customer does not address performance, availability in the context of the number of users, etc. On the other hand, he pays for the service according to the contract. The Moodle variant, where the typical installation is on premise, in the university infrastructure, is then the responsibility for the operation fully on the university side. Both methods are not only technologically different but also economical. Operational risks (outages, continuity of operation, but also dependence on the provider and others) must be calculated differently. This is a complex decision-making process for all stakeholders (it is not a technical decision).

We point out that the main ideas presented in the text are also presented in the condensed form of one-page recommendations. Thus, one-page materials dedicated to concept, SW versus processes and scenarios are available.

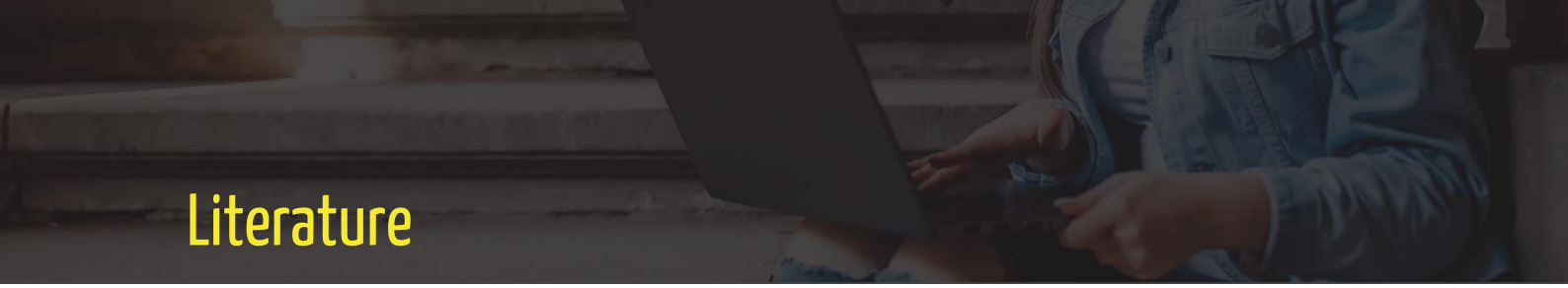
In the text, we try to outline the management of IT infrastructure for education as a technological-pedagogical-managerial problem, where it is necessary to harmonise individual aspects so that they support each other and do not contradict each other. We want to emphasise the role of nonteaching staff for the operation of an educational

organisation, as they are an indispensable part of the organisation's operation. The IT infrastructure must also be prepared for these agendas, not only for teaching. This presupposes communication between all stakeholders and awareness of the goals we want to achieve in the long term.



List of abbreviations

IT	Information Technology
IS	Information system
HW	Hardware
SW	Software
UNI	University
VŠB-TUO	Vysoká škola báňská – Technická univerzita Ostrava
TUKE	Technická univerzita v Košiciach
UEK	Uniwersytet Ekonomiczny w Katowicach
IPS	Instituto Politécnico De Santarém
SaaS	Software as a Service
WirtUcz	Wirtualna Uczelnia
Ntb	Notebook



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