

Models at Work - Enterprise Architecture at Frankfurt University of Applied Sciences

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Abstract

Similar to many other companies, the IT department at Frankfurt University of Applied Sciences is responsible for providing and supporting a set of applications that are used by different organisational units. There are still some insecurities, for example undefined responsibilities, or no clear understanding about the business fit of the whole application landscape. The current architecture is a result of uncontrolled growth, which also leads to missing documentation, as well as a missing Enterprise Architecture model. The following case study has the objective to analyse and document the Enterprise Architecture of the university. The purpose of this model is to make the university's landscape more transparent, enabling conscious and fact-based decisions for future software applications against the as-is landscape and relevant needs of the organisation. To achieve this, a Business Capability Map, a Business Object Model, an Application landscape and a Business Support Matrix were created as artefacts.

Keywords

enterprise architecture, university, BCM, BOM, Application Landscape, BSM

1. Purpose and Requirements

The models were created during a class on Enterprise Architecture Management (EAM) at the Frankfurt University of Applied Sciences (UAS). Students learned methods and tools for managing Enterprise Architecture (EA) and had to apply them in a case study assignment. The case study was conducted together with the IT department of the Frankfurt UAS, known as Campus IT, as the IT team aims at applying a structured approach for business-driven IT in the future. Consequently, the head of the IT department participated at the lectures and was providing input for the case study.


The current situation of the Frankfurt UAS looks quite similar to the one in other companies. The IT department is responsible for providing and supporting a set of applications that are used by different organisational units (e.g. central administration and faculties). However, there are still undefined responsibilities and there is no clear understanding about the business fit of the whole application landscape. In many cases, the responsibility is seen with Campus IT, as they provide the applications. But the question arises whether the responsibilities should not rather lie with the organisational unit or even with the professors who use the applications in

13th International Workshop on Enterprise Modeling and Information Systems Architectures (EMISA) 2023

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order to ensure clear responsibilities. Furthermore, there is no clear governance for introducing new software systems so that the current architecture is a result of uncontrolled growth.

Of course, there are various reasons for explaining the current situation, such as legal constraints or lack of alternatives in the past. Due to the dynamic evolution not everything was documented properly and an EA model is missing. For that reason, we had the task to analyse and document the EA of the university.

The main purpose of the model was to make the university's landscape more transparent, enabling conscious and fact-based decisions for future software applications against the as-is landscape and relevant needs of the organisation. It starts with the question of which capabilities the university actually has. The next question which was addressed is the distribution of the responsibilities among the organisation. At this point, it is important to find out which applications are supporting respective business capabilities. This opens the doors for needed analysis of the application landscape, like investigating for monolithic systems or redundancies. In addition, it was also a requirement to find the flow between the applications.

The following artefacts were expected as part of the case study:

- Business Capability Map (BCM) as a standard framework for documenting functions at a university and required applications' functionality
- Business Object Model (BOM) for classifying data processed in applications
- Application landscape to gain an overview of the applications at the university and their interactions
- Business Support Matrix (BSM) for documenting applications' support of business capabilities

During the creation of the model, the analysis was expected to result in an improvement plan. The improvement plan then could be analysed by the Campus IT, the unit responsible for the digital infrastructure, to determine the feasibility of certain points. For this work, the primary audience was the Campus IT and the university management. Beside the Campus IT, other organisational units, like the digitization department, of the university have an interest in the final results.

2. Context and Challenge

The resulting models were created in the context of an EAM class at the Frankfurt UAS. Students worked as a team of enterprise architects, aiming to create an architecture model of the university. Work started with a case study description referring to the current situation at the university. The technical context was the case study assignment given by the IT department of the Frankfurt UAS to provide transparency on the IT department's application landscape. The main contact (e.g. the customer) was the head of the Campus IT.

A couple of challenging tasks and uncertainties needed to be handled as the team acted like enterprise architects but were still in their role as students.

One main challenge was to get all information needed to receive a detailed view of the application landscape. The lack of information was basically caused by our role as external enterprise architects with no insight into internal processes and without access to relevant

sources. Necessary information had to be obtained through employees of the university, which required additional time. The insufficiency of information was also caused by missing documentation in general. In this case, it was not possible to get the required insight from the existing documentation. Therefore, the only way to obtain the knowledge was through interviews with employees who know more details about respective applications.

Furthermore, in the application landscape, the business responsibilities and owners are often unknown or not properly defined, leading to scattered gaps and ambiguities in the models.

Based on the social context of an EAM course at the university, the model was created in a given period of time (3 months). This limited available time has also made it more complex to fulfil the task.

3. Activities and Effort

To create the resulting model, it was first necessary to develop a theoretical understanding of the fundamentals of EAM. For this purpose, research and review of existing EA documents for higher education were conducted. Furthermore, interviews were performed with the professor, the client, and employees to obtain information on specific topics which could not be detected by research. Discussions and brainstorming were also used to develop a common understanding regarding the model.

Different tools were used for creating the models, such as Mindomo (an online mind mapping tool), which allows the joint creation of mind maps and is thus a helpful tool for the brainstorming process. Furthermore, draw.io was used to visualise the different models. The visualization of the models focused on their contents, which is why they were kept as simple as possible. Excel was also one of the tools used, especially for the creation of the BSM.

Work started with a Business Motivation model in order to shape a common understanding of the university and its objectives. It was created using Mindomo so that the team could collect their ideas remotely. Various sources, including the university's target definition and strategy, have been consulted.

As a next step, a BCM and a BOM were created by the team. First versions have been done with Mindomo, but the team later on switched to other tools. The BCM was influenced by existing maps and by knowledge about activities at the university. We incorporated the students' perspective (e.g. teaching, examination management) but also general-purpose capabilities (e.g. human resources, facility management). Besides the knowledge about this particular university, other capability maps in the university context have been used as a reference, like the map of UCISA UK HE model [1]. After having a stable version, the capabilities have been transferred to an Excel template. This can be handed over to the customer and used as a common repository. Furthermore, information on software applications including description and responsibilities (e.g. contact information) have been added to the Excel template.

After completing data gathering, a BSM (showing applications supporting respective business capabilities) has been created by inserting a pivot table. It was used for visualising and analysing application support at the Frankfurt UAS. Since Excel has only limited capabilities for graphical formatting, a business capability tree has been created with draw.io. This resulted in redundancies, but was necessary for an adequate presentation in PowerPoint.

Each model's validity was evaluated and validated by the professor and the client through student submissions and presentations. These submissions happened multiple times during the semester, in order to present the progress and get feedback. In addition, the final results were presented to the chief administrative officer of the university, one of the key stakeholders. For this purpose, after setting a date, a presentation was created which was adapted according to the target group, the stakeholder, in order to present the developed contents to him. Through his feedback, the results could be validated one more time and the relevance of the topic became clear once again.

4. Resulting Model

In this chapter, the resulting model will be presented. The models are the BCM, the BOM, the application landscape and at least the BSM. However, they will not be shown in their entirety, but excerpts will be. The models originated from a project at the Frankfurt UAS and their original language is German. For this work, parts were translated into English.

Throughout the images, the colours were used to indicate to which category some elements belong. Blue is for guiding, green for core and yellow is for enabling. Guiding means that the capabilities define somehow how the business has to develop. It contains the leading functions of the university. The capabilities generating added value are categorised as core, whereas non-added value creating categories are called enabling. Enabling is also known as supporting, meaning that they are needed for the business, but are not central. These concepts, how they were used in this work, were inspired by Roger Burlton [2].

4.1. Business Capability Map

The BCM documents the business functions of the university (e.g. what is done at the university). It is organisation agnostic, this means that no individual departments or organisational units are reflected. However, there might be cases where the capabilities overlap with departments. The capabilities were categorised as guiding, core or enabling.

The excerpt seen in Figure 1 from our findings shows the core capabilities (level 1) like research and the underlying capabilities (level 2) like publish. As research is a vital part of a university's portfolio, it was assigned to the core capabilities. The same holds true for teaching. Also, student administration and student counselling have an important role and are directly adding value. A maybe controversial decision we made is to put IT Management into core. The operation, maintenance, and other administrative tasks of applications are a direct-added value for all employees, students and other parties alike. This shows how essential these capabilities are for a modern university, making it a perfect candidate for core.

In the following few lines, some level 2 capabilities whose meanings are ambiguous are described in more detail. First one being research program development. Before the research can be conducted, the feasibility and the way the research will be conducted, the framework and the details are determined which happens during the development of the research program. Second, the research administration manages all research that is planned or done at the university. Third, in student administration, application management refers to the management of potential students who have applied to study. In the next steps, new or already existing students are

Capability Map			
Core			
Research		Student Administration	
Research Conduct	Publish	Application Management	Matriculation / Exmatriculation
Research Program Development	Research Administration	Course Division	Performance Management
Student Counseling		Teaching	
Counseling	Writing Counseling	Event Planning	Event Execution
Course Counseling	Career Counseling	Exam Planning	Exam Execution
Counseling for Stays Abroad and for Students Abroad		Degree Distribution	
IT Management			
Operation and Maintenance	IT Security Management		
Tool Supply			

Figure 1: Capability Map – Core Capabilities

divided into their respective courses and exercises. Finally, grades are assigned to individual students at the end of the semester, which is done with performance management. At the end of a student’s studies, the degree is distributed, depicted above by degree distribution.

Here we also want to emphasise that there is not only one possibility to categorise these items. Above it was mentioned that IT Management fits well into the core capabilities. The reason for that was the direct-added value to the university. There might be other capabilities that some would put into other categories. One could possibly see course administration as core capability. However, these capabilities are setting the direction or the strategy of the course. This was for us a clear indicator for a guiding capability. To break it down, we basically asked ourselves three questions for categorising the capabilities into the three categories. Guiding: Does it define how the business develops?, Core: Does it add direct-added value?, Enabling: Is it needed, but is not central?

4.2. Business Object Model

This type of model depicts the so-called business objects of the Frankfurt UAS. Furthermore, the relationships between the single objects are drawn to make clear how they interact among each other.

In the example shown in Figure 2, one can see a small section of the BOM. Here, some core business objects of the Frankfurt UAS are shown. To make this graph easier to understand, especially in later analysis, the objects were coloured in the colours of the three capability categories in which they occur most frequently. This may not be confused with the capabilities themselves, but should show that these business objects correlate with the business capabilities. For example, the business object teacher is connected to the capability event execution, which

is a core business capability. Like a teacher, a student is also an entity interacting with other business objects. This can be the application for a study course or the usage of the consultation offer. Each business object can be specified by attributes, for example, the business object student can be described by the attributes name, date of birth and matriculation number.

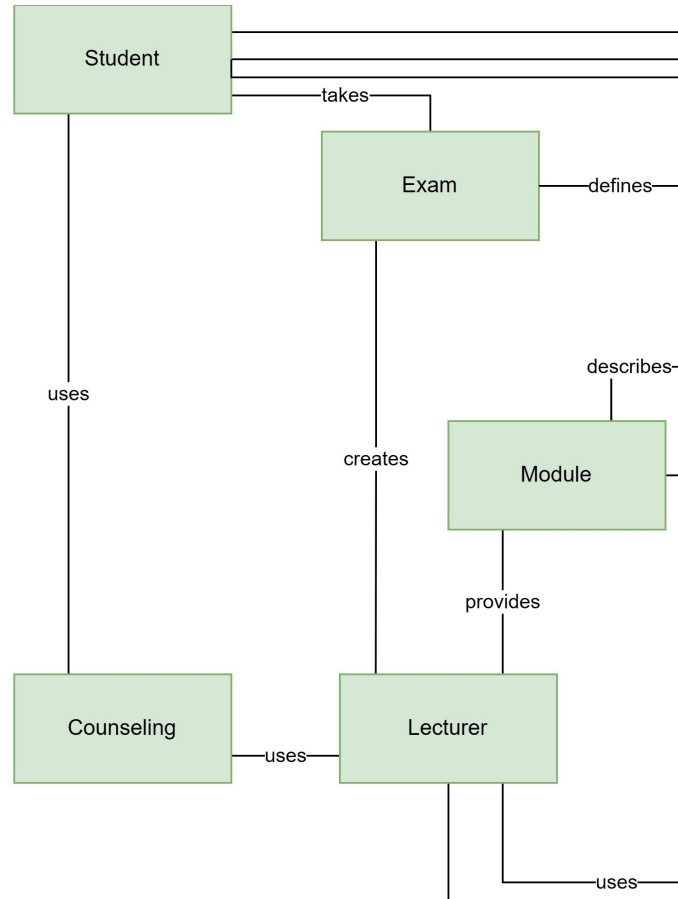


Figure 2: Business Object Model – Excerpt

4.3. Application Landscape

The next step was to list the applications at the university and depicted them in a chart. In addition to that, data flows were drawn with the business objects as data. This makes sure to gain an overview of the applications and their interactions.

For brevity reasons, this shows also only an extract of the complete model. The first diagram, as seen in Figure 3, shows the data flow from the e-learning platforms, campUAS and Moodle, to embedded applications. campUAS is a second Moodle instance, hosted by a different provider and will replace the old Moodle instance. Panopto is a video streaming system and Speexx Campus is an interactive platform for learning languages. The data is exchanged, in order for the users to watch and upload videos or save progress in their language learning activities.

The second graph, as seen in 4, is a depiction of how data is passed between various library systems. The library management system is used to manage the locally available books and media. DBIS and hebis-Portal are online databases for books, which can be accessed by students. In order to access the databases, the Library Management Tool therefore exchanges data with DBIS and hebis-Portal. Furthermore, the Library Management Tool can show a list of the other two systems' inventory.

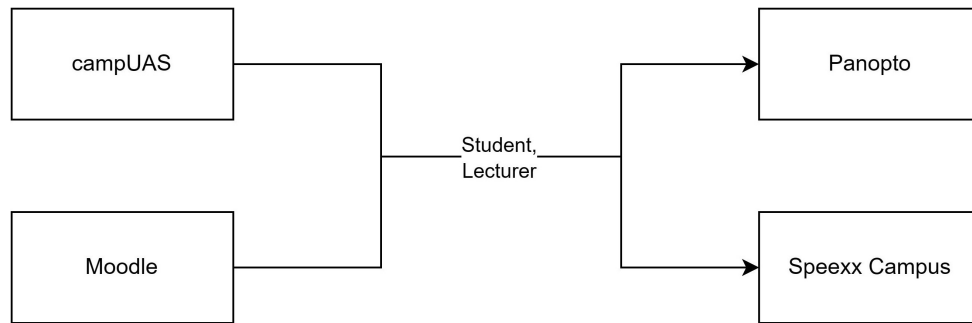


Figure 3: Data Flow E-Learning Platforms

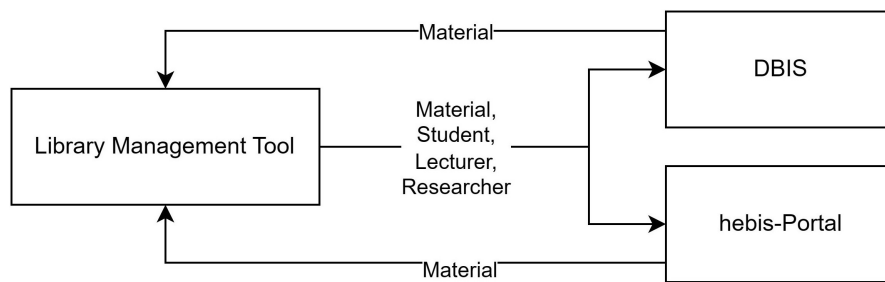


Figure 4: Data Flow Library Systems

4.4. Business Support Matrix

At this point, it is important to bring the gathered information together in order to get a better picture of the university. This is done by creating a BSM, where the capabilities and the applications are joined. With this tool, it is possible to recognise redundancies and monolithic systems in the structure.

The following excerpt from the BSM in Table 1 summarises the applications used in the core capabilities, indicated by an x. The analysis, for example, shows that there are redundancies in the course division. This capability describes the administration of the students on who will be assigned to which course or practice lessons. As Moodle and campUAS are both used as e-learning platforms, one could be removed from the stack. From previous knowledge gathering, it is known that Moodle is replaced by campUAS, meaning this redundancy can be ignored at that place. However, what could be improved is the usage of HISQIS, a university information

system used university-wide for all students and all examination offices, as it is a monolith. For example, whether HISQIS should necessarily be used for students' applications has to be evaluated in the next steps.

Table 1
Business Support Matrix - Core Capabilities Excerpt

Business Capability (Level 1)	Business Capability (Level 2)	Application					
		campUAS	Confluence	GitLab	HISQIS	Moodle	Zoom
IT Management	IT Security Management						
	Operation and Maintenance		x				
	Tool Supply		x				
Research	Publish						
	Research Administration						
	Research Conduct			x			
	Research Program Development						
Student Administration	Application Management				x		
	Course Division	x			x	x	
	Matriculation / Exmatriculation				x		
	Performance Management				x	x	
Student Counseling	Career Counseling						x
	Counseling for Stays Abroad and for Students Abroad					x	x
	Course Counseling						x
	Psychosocial Counseling						
	Writing Counseling					x	x
Teaching	Degree Distribution				x		
	Event Execution	x		x		x	x
	Event Planning						
	Exam Execution				x		x
	Exam Planning				x		

5. Return on Modelling Effort

Even though the students worked on the project as part of the examination of an EAM class, the case study addressed the EA of the university and the head of Campus IT was involved as a customer. In this role, the task was to provide information on the current situation, to clarify open questions and to explain connections and decisions from the past. It should be emphasised that due to decentralised structures, many decisions in the past were not made from an economic point of view and are, therefore, difficult for outsiders to understand. The aim was to bring these points into a comparable form of presentation and to document them. The task of the consultants (i.e. students) was to create a basis using existing material, to complete the documents through cyclically recurring coordination rounds with the head of the IT department and to bring them into comparable and easily understandable form of presentation. The level of detail can be increased almost indefinitely by the frequency of the recurring votes.

The benefits are difficult to express in measurable terms, but gaps or unexplainable duplications were already revealed in the first appointments. The neutral view from the outside has awakened the internal focus. In the course of the project, a clear presentation of requirements and solutions in the form of applications gradually emerged. Missing relationships or duplicates can be presented in a simple form so that third parties can identify gaps or discrepancies without much explanation. With a completion and final sharpening, these documents can be the basis for financial decisions at management level as well as the strategic orientation of the IT department.

As the last act, there was a joint meeting between the advisory group, the previous customer representative and the chancellor of the university, whose field of activity includes IT. During this meeting, the basic idea as well as specific areas of investigation and recommendations for action were presented. In just 30 minutes, the chancellor could be shown that this is an easy-to-use tool with great power in terms of controlling the IT application landscape. Ultimately, this meeting can be the decisive point for the establishment of IT architects at the university.

6. Reflection

The task of creating an EA model of the university gave us insights on why to make the effort to create such documentation. It made it clearer why it is so important that the business side and the IT side work together, as otherwise the two might diverge. That divergence could cause problems in the future and make it costly to align both sides again.

Listening to other fellow students in the course faced with similar issues, one could see that there is more than one possible approach to solve them. The understanding that there is not only one right solution is important. This is also what the professor and the client indicated at the beginning of the course. Although both had a vague vision of what the result might look like, they were open-minded to unexpected solutions too. However, this uncertainty of what the model should look like was a challenge that we were confronted with and had to learn that there is not only one solution.

One of the biggest challenges was the search for the responsibilities for applications, business objects and capabilities. Once the responsibility was found, questions about the used systems could be asked. This also touches another obstacle we faced, which was finding systems and

applications used at the university. We had to find out all this information by asking our professor and the customer (e.g. head of the Campus IT) or by researching on the internet. Not all details or information could be found on the website, so we were also given some documentation, which could not be accessed by students. This highlights an aspect which has to be fulfilled in order to create a more valuable model, which is the unrestricted access to resources and documentation about the used systems. Without it, important information might be missing in the final model, which could lead to wrong assumptions in the later analysis.

At last, we saw that all these challenges do not exist only at our university, but are universal to most institutions and companies. We came to this conclusion, not only from the experience our professor shared with us, but also by abstracting single concepts and recognising them in the context of businesses in general.

Finally, we hope to spark a discussion on how to analyse other institutions of higher education. Maybe, our work could even act as a template, especially for the capability map, as other universities' maps seemed to be too individual to have common ground. We also found too little literature on the creation of capability map in the context of universities, making this work a well suited starting point. Furthermore, we showed a detailed and creative approach and how to decide on some specific capabilities' categories. One could even spot parallels to companies' maps.

7. Evidence

While creating the resulting models, information of different sources was used. The main sources were existing documentation from the Frankfurt UAS, for instance the official university website and internal documentation intended for all members of the university. For example, the application landscape with the applications at the university and the data flows between them were mostly filled through the information from these two sources. As already mentioned, we did not have access to all internal documents or in some cases the documentation was missing in general. In these cases, the information source was through interviews with employees who know more details about it. Therefore, during the creation of the models, we had interviews with the head of the IT department, the lecturer of the class and the secretary of the computer science teaching unit.

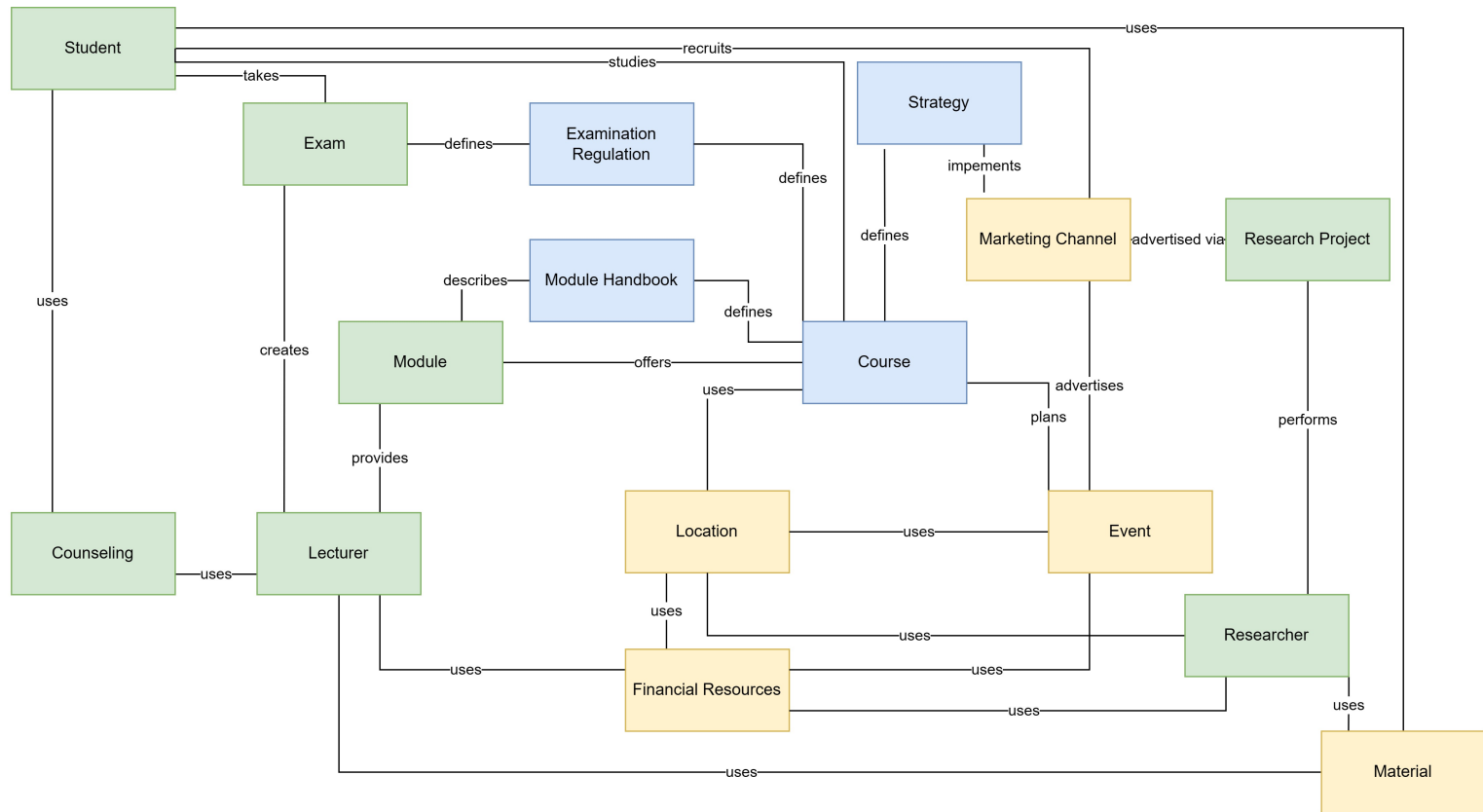
In order to validate the results, there were a number of meetings regarding the progress of the created models with the lecturer and the head of the IT department during the creation period. In these meetings, the current status of the models was presented, feedback was given, and changes and further ideas were discussed.

At the end of the course and when all models were completed, the models were presented to the chief administrative officer of Frankfurt UAS as one of the key stakeholders of the results. The chief administrative officer agreed with the results and thus also validated their accuracy. He also mentioned the relevance of the resulting models for the university, and moreover he thought of how and where to use them to improve the application landscape of the university.

References

- [1] UCISA, Uk he capability model - for the he sector, 2022. URL: <https://www.ucisa.ac.uk/Groups/Enterprise-Architecture-Group/UK-HE-Capability-Model>.
- [2] R. Burlton, Developing your capability architecture: It's all about being able to get things done, 2017. URL: <http://www.brcommunity.com/a2017/b927.html>.

A. Business Object Model with the business objects of the Frankfurt UAS as well as whose relationships.



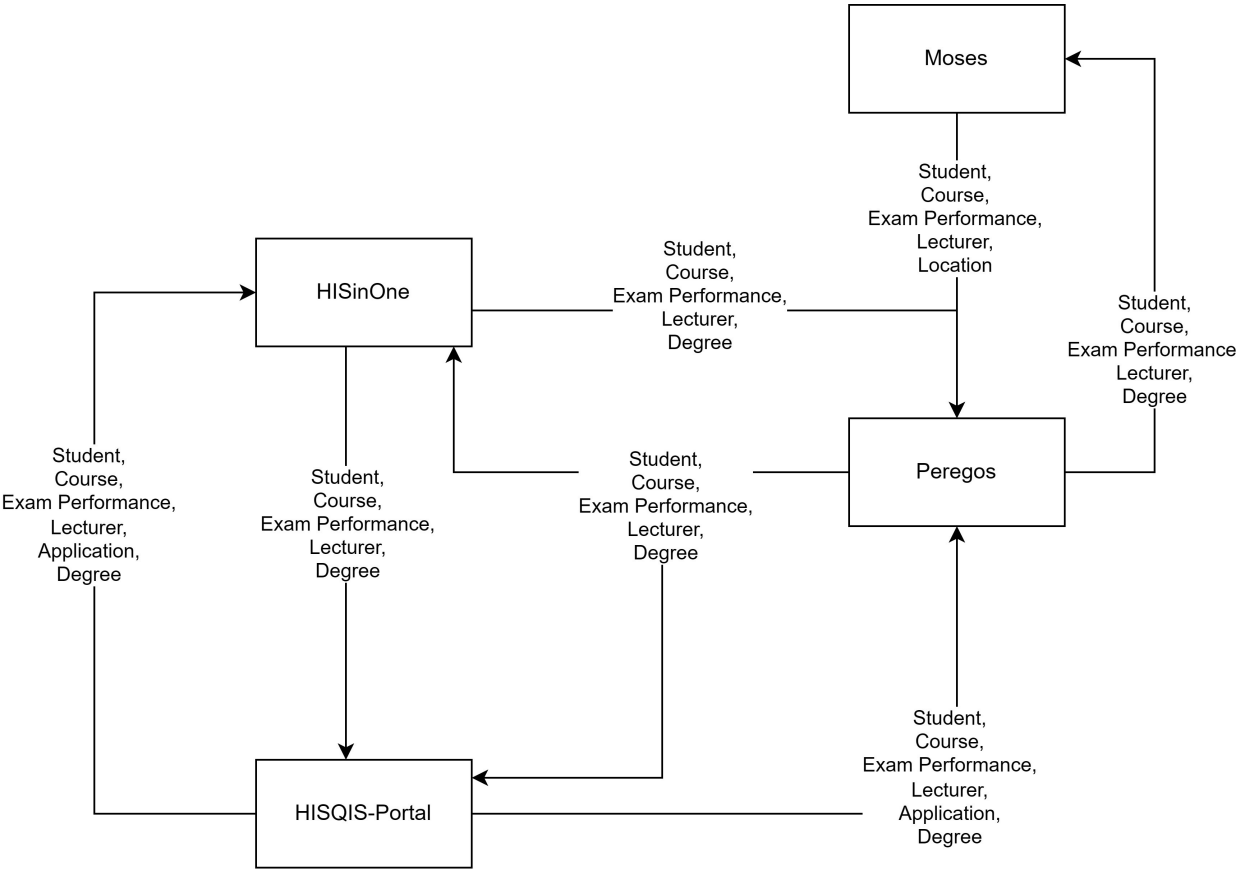
Legend		
Guiding	Core	Enabling

B. Business Capability Map with the business functions of the Frankfurt UAS.

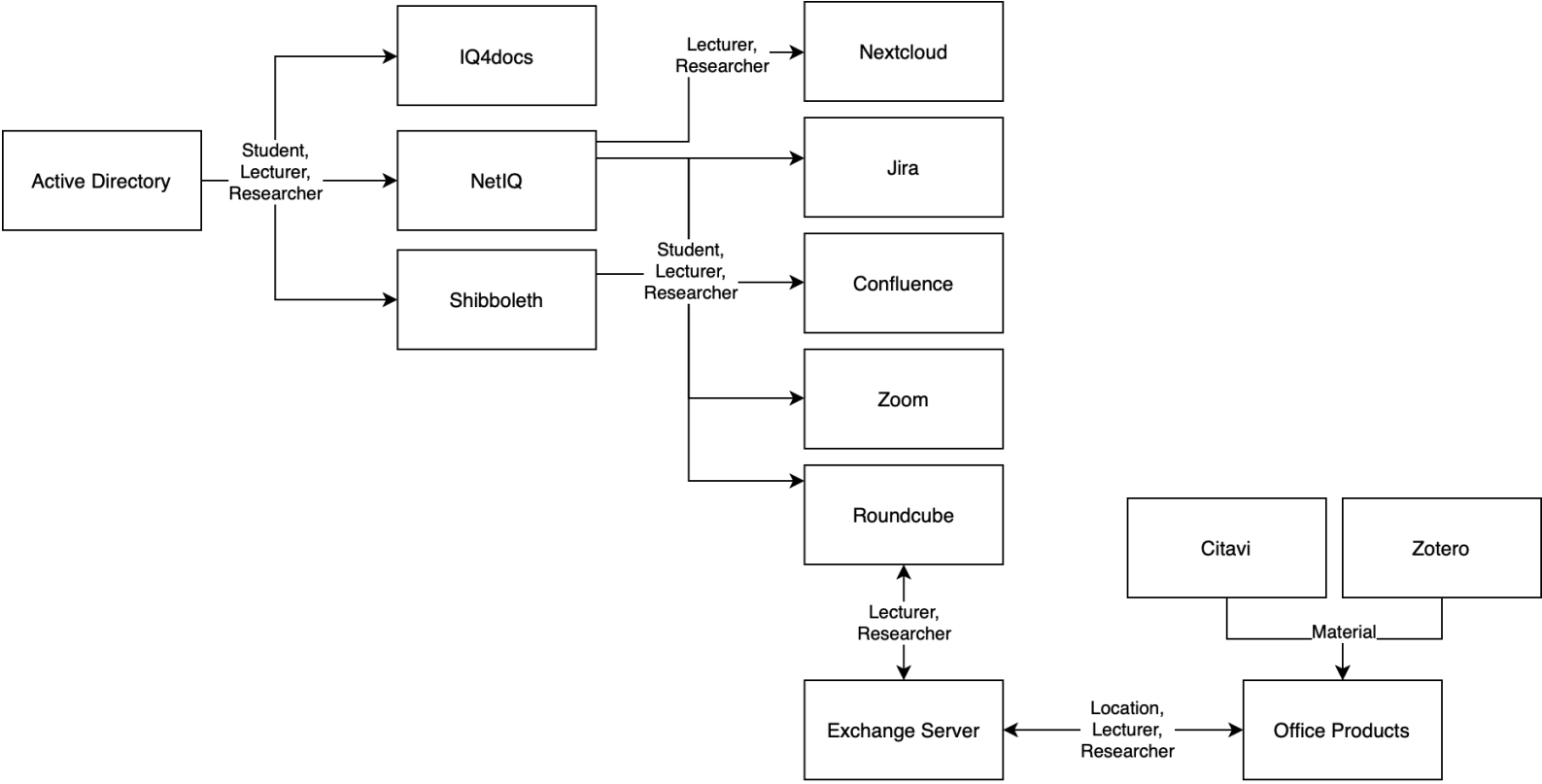
Capability Map			
Guiding			
Course Administration		Strategy Management	
Planning	Offer	Competence Development	Development
Administration	Accreditation	Planning	Corporate Design Development
Leadership and Compliance			
Feedback Management	Election Management		
Risk Management	Quality Management		
Core			
Research		Student Administration	
Research Conduct	Publish	Application Management	Matriculation / Exmatriculation
Research Program Development	Research Administration	Course Division	Performance Management
Student Counseling		Teaching	
Counseling	Writing Counseling	Event Planning	Event Execution
Course Counseling	Career Counseling	Exam Planning	Exam Execution
Counseling for Stays Abroad and for Students Abroad		Degree Distribution	
IT Management			
Operation and Maintenance	IT Security Management		
Tool Supply			
Enabling			
Logistics Management		Financial Management	
Distribution	Storage	Budget Management	Asset Management
Inventory Management	Procurement	Investment Planning	Salary Management
Request Management	Complaint Management	Fundraising	Fees Management
Marketing		Building Management	
Recruiting of Companies	Recruiting of Students	Allocation	Rental
Social Media Management	Event Management	Maintenance	Construction Contract Management
Legal Administration		Office Management	
Represent / Defend University	Counseling	Office Administration	Office Communication
Contract Management			
Human Resource Management			
Recruitment and Staffing	Education and Training		
Employee Hiring	Personnel Development		
Counseling	Absence Management		

C. Application Landscape with the used applications at Frankfurt UAS and the data flow between them.

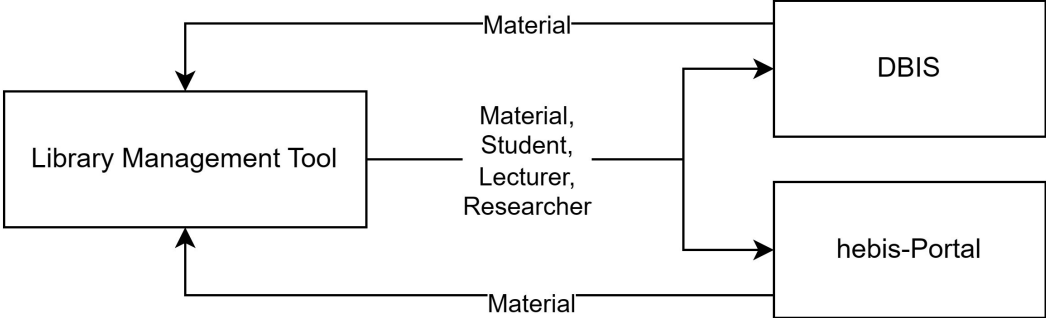
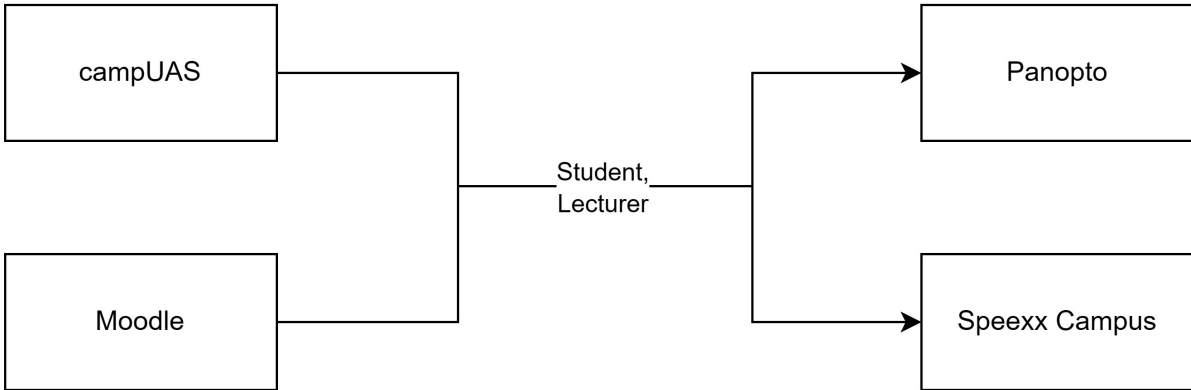
C.1. Data flow between different applications for administration.



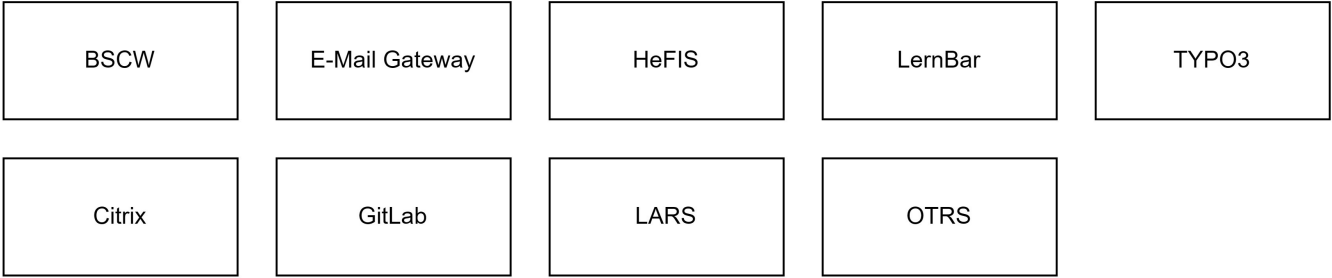
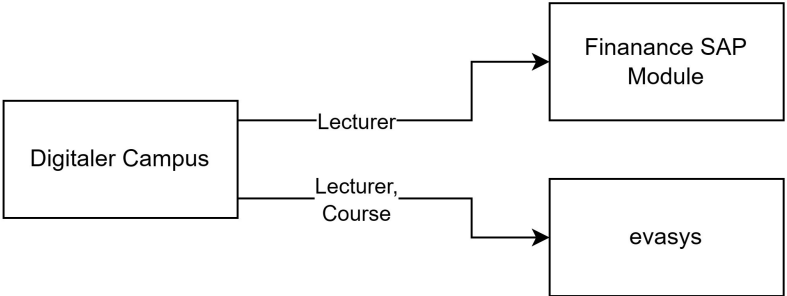
C.2. Data flow between different applications for authentication and contact exchange, as well as for source management.



C.3. Data flow between different applications for digital teaching and for the library.



C.4. Data flow between different applications for invoice and evaluation, and the applications with no data flow.



D. Business Support Matrix, where the capabilities and the applications are joined, to recognise redundancies and monolithic systems.

COUNTA of Application		Application																														
Business Capability (Level 2)	Business Capability (Level 2)	(None)	Active Directory	BSCW	campUS	Gravi	Confluence	DBS	Digitaler Campus	E-Mail Gateway	erazy	Exchanges Server	Finanza SAP Module	GitLab	hebio-Portal	HSiOne	HSQS	ira	Library Management Tool	Moodle	Mosei	NetIQ	Nextcloud	Office Products	Panopto	Panopto	Roundcube	TYPO3	Zoom	Zotero	Grand Total	
Building Management	Allocation											1								1						1						3
Building Management	Construction Contract Management	1																													1	
Building Management	Maintenance	1																													1	
Building Management	Rental	1																													1	
Course Administration	Accreditation																												1		1	
Course Administration	Administration											1					1														2	
Course Administration	Offer																				1										1	
Course Administration	Planning																1	1													2	
Financial Management	Assets Management												1																		1	
Financial Management	Budget Management												1																		1	
Financial Management	Fees Management												1																		1	
Financial Management	Fundraising												1																		1	
Financial Management	Investment Planning												1																		1	
Financial Management	Salary Management								1				1																		2	
Human Resource Management	Absence Management											1																			1	
Human Resource Management	Counseling		1																												1	
Human Resource Management	Education and Training			1																											1	
Human Resource Management	Employee Hiring								1																						2	
Human Resource Management	Personnel Development		1																												1	
Human Resource Management	Recruitment and Staffing		1																												1	
IT Management	IT Security Management			1																			1								1	
IT Management	Operation and Maintenance						1																								2	
IT Management	Tool Supply						1																								1	
Leadership and Compliance	Election Management																														1	
Leadership and Compliance	Feedback Management											1											1								1	
Leadership and Compliance	Quality Management																														1	
Leadership and Compliance	Risk Management	1																													1	
Legal Administration	Contract Management	1																													1	
Legal Administration	Counseling	1																													1	
Legal Administration	Represent / Defend University	1																													1	
Logistics Management	Complaint Management																														1	
Logistics Management	Distribution								1																						2	
Logistics Management	Inventory Management								1						1																3	
Logistics Management	Obtaining								1																						2	
Logistics Management	Request Management								1																						1	
Logistics Management	Storage																														1	
Marketing	Event Management																														1	
Marketing	Recruiting of Students																														1	
Marketing	Recruiting of Companies																														1	
Marketing	Social Media Management	1																													1	
Office Management	Office Administration																								1						1	
Office Management	Office Communication																									1					1	
Research	Publish	1																													1	
Research	Research Administration								1																						2	
Research	Research Conduct																														1	
Research	Research Program Development	1																													4	
Strategy Management	Competence Development	1																													1	
Strategy Management	Corporate Design Development	1																													1	
Strategy Management	Development	1																													1	
Strategy Management	Planning	1																													1	
Student Administration	Application Management																														1	
Student Administration	Course Division								1																						5	
Student Administration	Matriculation / Exmatriculation																														2	
Student Administration	Performance Management		1																												2	
Student Counseling	Career Counseling																														2	
Student Counseling	Counseling for Stays Abroad and for Students Abroad																														3	
Student Counseling	Course Counseling																														2	
Student Counseling	Psychosocial Counseling																														1	
Student Counseling	Writing Counseling																														5	
Teaching	Degree Distribution																														1	
Teaching	Event Execution																														7	
Teaching	Event Planning																														2	
Teaching	Exam Execution																														2	
Teaching	Exam Planning																														4	
Grand Total		17	3	1	2	2	2	3	6	1	2	4	6	2	3	3	8	2	2	2	6	4	1	2	3	1	2	1	0	8	2	108