INSTITUTO POLITÉCNICO DE BRAGANÇA
Escola Superior de Tecnologia e Gestão

Evaluation of the maturity level of the IT Services: IPB and KubSAU

Iuliia Zubar

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Escola Superior de Tecnologia e de Gestão
Instituto Politécnico de Bragança

Supervisor(s): João Paulo Pereira and Efanova Natalya Vladimirovna

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Abstract

The importance of the Information Technology (IT) services maturity is a success factor for the institutions. There is a direct correlation between IT maturity and cost, efficiency and scalability.

This work presents an evaluation of the maturity level for IT service management, of two higher education institutions (IPB/Portugal and KubSAU/Russia). We will identify the correspondences between the process capability levels and the organizational systems maturity levels.

One of the options to measured the IT maturity is by comparing the IT service team's operations, planning and processes to the international best models. In this context, we decide to use the Information Technology Infrastructure Library (ITIL) framework to analyse the selection, planning, delivery and support of IT services by IPB and KubSAU. This methodology uses units as the standard is an example of best practice that covers the control and management of all aspects of IT-related operations.

Through a questionnaire, we have measured the IT processes maturity against ITIL framework. We made questionnaires for the leadership of the IT Centers of both universities, teaching staff and students.

With the results of this work we can propose policies that can improve efficiency and achieve predictable service levels. Our goal is to help in the implementation of improvements for the management of IT services. The main conclusion is that both institutions have approximately the same high level of maturity and they are able to train and graduate specialists in different fields in accordance with all standards and requirements in the field of education.

Foreword

We would like to give my sincere thanks to IPB for my education and to the professors of IPB for permission to defend the thesis. The skills and knowledge which I have gained throughout my study will be very valuable component in my future career.

I would especially like to thank my supervisors Mr. João Paulo Pereira and Mrs. Efanova Natalya Vladimirovna for their generous support, coaching and companionship during my work on the thesis. They shared their expertise with me very generously and I have learned a lot from them. My thanks and appreciation also to the staff of IPB, mainly Mr. Jose Eduardo Fernandes for the significant support, help and above all to the good communication.

Thank you once again for your great support in the successful completion of me thesis.

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List of Abbreviations

BISL – Business Information Services Library

BMIS – Business Model for Information Security

CIT – Center Information Technology

CMM – Capability Maturity Model

CMMI – Capability Maturity Model Integration

CMMI – ACQ – Capability Maturity Model Integration for Acquisition

CMMI – DEV – Capability Maturity Model Integration for Development

CMMI – SVC – Capability Maturity Model Integration for Services

CMU – Carnegie Mellon University

COBiT – Control Objectives for Information and Related Technologies

COSO – Committee Of Sponsoring Organizations

DFD – Data Flow Diagram

DNS – Domain Name System

ERP – Enterprise Resource Planning

HTTP – HyperText Transfer Protocol

IEC – International Electrotechnical Commission

IPB – Polytechnic Institute of Braganca

IS – Information Systems

ISACA – Information Systems Audit and Control Association

ISO– International Organization for Standardization

IT – Information Technology

ITAF – Information Technology Assurance Framework

ITIL – Information Technology Infrastructure Library

ITSM – Information Technology Service Management

ITSCMM – Information Technology Services Capability Maturity Model

KPA – Key Process Area

KubSAU – Kuban State Agrarian University

PC – Personal Computer

PCMM – People capacity maturity model

PCM-MD – Process Capability Model – Mechanical Design

PHP – Personal Home Page

PL – Procedural Language

PMBOK – Project Management Body of Knowledge

SE-CMM – Systems Engineering Capability Model

SPICE – Software Process Improvement and Capability Determination

SQL – Structured Query Language

TOGAF – The Open Group Architecture Framework

VPN – Virtual Private Network

XML – Extensible Markup Language

1. Introduction

1.1 Context and motivation

A Maturity Model is a widely used technique that is proved to be valuable to assess business processes or certain aspects of organizations, as it represents a path towards an increasingly organized and systematic way of doing business. A maturity assessment can be used to measure the current maturity level of a certain aspect of an organization in a meaningful way, enabling stakeholders to clearly identify strengths and improvement points, and accordingly prioritize what to do in order to reach higher maturity levels [1].

A maturity model is needed to assess the current level of maturity of business processes in the company. Evaluation should help with further development of measures to introduce and improve process management in the organization. It is impossible jump over the level, for example, from the 1st to the 4th, without going through the intermediate stages. It is also impossible to manage processes unless they are defined and described, also, can not improve the processes if they are not measured and not controlled. Each level of maturity corresponds to its management tools. Evaluation of the maturity of the enterprise can take some time and will require certain efforts both from the manager and from the staff, but this is a necessary condition for the development of the organization in terms of a modern approach to enterprise management [2].

This topic was chosen because it is interesting to evaluate the maturity of the universities. Some literature was related with this item, for instance «The novel use of a capability maturity model to evaluate the mechanical design process» (I. Egan, J. Ritchie, P. D. Gardiner) [3]. This paper describes a process improvement study undertaken at three sites of UK electromechanical engineering companies, using a derivation of the Carnegie-Mellon/SEI Systems Engineering Capability Model (SE-CMM) called the Process Capability Model – Mechanical Design (PCM-MD). The next paper with similar theme is «Maturity Models for Information Systems – A State of the Art» (Diogo Proenca, Jose Borbinha) [4]. This paper collects and analyzes the current practice on maturity models, by analyzing a collection of maturity models from literature. The paper «Evaluation of organizational maturity based on people capacity maturity model in medical record wards of Iranian hospitals» (Mohammad H. Yarmohammadian, Nahid Tavakoli, Assadollah Shams, Farzaneh Hatampour) [5]. People capacity maturity model (PCMM) is one of the models which focus on improving organizational human capabilities. In this article, they used the PCMM for investigation of organizational maturity level in medical record departments of governmental hospitals and determination strengths and weaknesses of their staff capabilities.

This thesis is devoted to assessing the IT services maturity of higher education institutions, namely Polytechnic Institute of Bragança (IPB) and Kuban State Agrarian University (KubSAU).

1.2 Main objectives

The aim of the thesis is to analyze the standards for determining the level of maturity and to evaluate the IT maturity of IPB and KubSAU. In accordance with the set aim the following tasks of the thesis:

1) To study theoretical bases of organizational maturity models.
2) Analyze the standards for determining the level of maturity of both organizations.
3) Description of the IT services processes at IPB and KubSAU.
4) Building portfolio of applications that covered the business architecture of IPB and KubSAU.
5) Based on the selected methodology, we will evaluate the maturity of the objects of study.
6) According to the results of the analysis, we make suggestions to improve the level of maturity, or optimization of organizational structure.

1.3 Methodology

Assess the maturity of the enterprise we can use known methods, there are models such as ITIL (framework for IT services), CMMI, COBiT, ISO/IEC 33001 (SPICE) (earlier ISO/IEC 15504). All of them ITIL, CMMI, COBIT and ISO / IEC 33001 (SPICE) (earlier ISO / IEC 15504) are systems with mature processes that follow a similar and structured approach. They emphasize the need to develop processes to improve product development and customer satisfaction and support the coordination of interdisciplinary activities related to the project.

To analyze the IT services maturity of higher education institutions IPB and KubSAU, it is best to select the ITIL methodology using units as the standard is an example of best practice that covers the control and management of all aspects of IT-related operations. ITIL helps coordinate the entire IT process and the organization's resources with business processes. Also important is the fact that ITIL has such a unique advantage as performance orientation. This means that the IT department can acquire in the organization a different status that will allow it to independently solve a certain range of issues in accordance with its competence and act as a provider of IT services, which is relevant for the selected topic, since this standard allows us to certify only one process or organizational unit.

The research was based on questionnaires for the leadership of IT Centers, for the teachers and for the students. The questionnaires were built on the concept that underlies the library ITIL. It considers such aspects as Service Operation: Incident Management, Request Fulfilment, Problem Management; Service Transition: Change Management, Service Asset & Configuration Management. My intended research question requires us to collect standardized and therefore comparable information from a number of people, so questionnaires may be the best method to use. Questionnaires can be used to collect both quantitative and qualitative data. Questionnaires require a great deal of care in their design and delivery, but a well-developed questionnaire can be distributed to a much larger number of people than it would be possible to interview. Questionnaires are particularly well suited for research seeking to measure some parameters for a group of people (e.g., social status, percentage agreeing with a proposition, level of awareness of an issue), or to make comparisons between groups of people. According to the results obtained, we can do conclusions of the work.

1.4 Structure of the work

In chapter 2 we will study the definition of maturity and maturity models, main characteristics of maturity models and the state of the art of main models for the management of IS and identification techniques of architecture maturity assessment, such as ITIL (framework for IT services), CMMI, COBiT, ISO/IEC 33001 (SPICE) (earlier ISO/IEC 15504). After this we will compare presented maturity models.

In chapter 3 we will consider the business architecture of the IPB and KubSAU, make a description of business processes, compile a portfolio of application systems covering the business architecture of research objects. In accordance with the chosen maturity model, we will evaluate the maturity of the IPB and KubSAU.

In the chapter conclusions and future works we will describe the conclusions, results of the research, which was made in the previous chapter. And there are some thoughts according to the future works.

2. Maturity Models

2.1 Definition of Maturity and Maturity Models

In the process of development, organizations and enterprises consistently pass from weakly organized structures whose main goal is to survive, to more sustainable, able to manage their future and optimize all processes. This growth is impossible without targeted management and effective use of available resources and knowledge, which is reflected in the concept of development of organizational maturity.

There are several options for determining maturity, for example, [6] defines that: Maturity is a very advanced or developed form or state. The [7] defines Maturity as a measurement of the ability of an organization for continuous improvement in a particular discipline. The higher the maturity, the higher will be the chances that incidents or errors will lead to improvements either in the quality or in the use of the resources of the discipline as implemented by the organization. Based on the second definition, we can conclude that it more fully reflects the essence of maturity, therefore, it is relevant for the selected topic of the dissertation.

The first mention of the notion of maturity and of the model of maturity is reflected in the Capability Maturity Model (CMM) - it is a development model created after study of data collected from organizations that contracted with the U.S. Department of Defense, who funded the research. The term "maturity" relates to the degree of formality and optimization of processes, from ad hoc practices, to formally defined steps, to managed result metrics, to active optimization of the processes. The model's aim is to improve existing software development processes, but it can also be applied to other processes. The Capability Maturity Model was originally developed as a tool for objectively assessing the ability of government contractors' processes to implement a contracted software project. The model is based on the process maturity framework first described in the 1989 book Managing the Software Process by Watts Humphrey. It was later published in a report in 1993 and as a book by the same authors in 1995 [8].

Though the model comes from the field of software development, it is also used as a model to aid in business processes generally, and has been used extensively worldwide in government offices, commerce, industry and software-development organizations. The concept of maturity does not exist by itself, it must be measured. Different maturity models are used for this. A maturity model is a framework that is used as a benchmark for comparison when looking at an organization's processes. It is specifically used when evaluating the capability to implement data management strategies and the level at which that company could be at risk from said strategies [9].

A maturity model can be viewed as a set of structured levels that describe how well the behaviors, practices and processes of an organization can reliably and sustainably produce required outcomes. Most maturity models is assess qualitatively people/culture, processes/structures, and objects/technology [8].

Two approaches for implementing maturity models exist. With a top-down approach, such as proposed by Becker et al., a fixed number of maturity stages or levels is specified first and further corroborated with characteristics (typically in form of specific assessment items) that support the initial assumptions about how maturity evolves. When using a bottom-up approach, such as suggested by Lahrmann et al., distinct characteristics or assessment items are determined first and clustered in a second step into maturity levels to induce a more general view of the different steps of maturity evolution.

A maturity model can be used as a benchmark for comparison and as an aid to understanding - for example, for comparative assessment of different organizations where there is something in common that can be used as a basis for comparison. In the case of the CMM, for example, the basis for comparison would be the organizations' software development processes [9]. Today, there are several models for determining maturity, each of which is a characteristic for its field.

The model provides a theoretical continuum along which process maturity can be developed incrementally from one level to the next. Skipping levels is not allowed/feasible. Maturity models are tools that help assessing “the quality of a company, or virtual enterprise, of being in a condition for which it is able to create an extended product, in case through the deployment of interactions it has developed in a collaborative network (i.e. ecosystem) with other companies”. In this way, maturity models allow to consequently build roadmaps and linked change management procedures which should be enacted by companies willing to stay in the present condition with a better quality or to move towards a new one [10].

In this section, the concepts of maturity and maturity models were identified. Next, the main characteristics of maturity models, the structure and levels of organizational maturity will be considered.

2.2 Main characteristics of Maturity Models

Each organization undergoes certain stages in its development, characterized by a different mission, strategy, technology of work, organizational structure, the level of competence of personnel and other qualitative and quantitative characteristics. Transition to each following, higher level of development, makes the organization more competitive, dynamically reacting to market demands and optimally using its internal resources.

Models of organizational maturity provide organizations with an opportunity to assess the current state of the system and determine the strategy and tactics of enterprise development. Maturity models are characterized by certain indicators, criteria, structure. Consider the structure of maturity models.

The model involves five aspects [11]:

- Maturity Levels: a 5-level process maturity continuum - where the uppermost (5th) level is a notional ideal state where processes would be systematically managed by a combination of process optimization and continuous process improvement.
- Key Process Areas: a Key Process Area identifies a cluster of related activities that, when performed together, achieve a set of goals considered important.
- Goals: the goals of a key process area summarize the states that must exist for that key process area to have been implemented in an effective and lasting way. The extent to which the goals have been accomplished is an indicator of how much capability the organization has established at that maturity level. The goals signify the scope, boundaries, and intent of each key process area.

- Common Features: common features include practices that implement and institutionalize a key process area. There are five types of common features: commitment to perform, ability to perform, activities performed, measurement and analysis, and verifying implementation.
- Key Practices: The key practices describe the elements of infrastructure and practice that contribute most effectively to the implementation and institutionalization of the area.

In each organization, in addition to aspects, there are levels of organizational maturity. Models describing the stages (levels) of the development of an organization are called models of maturity levels. Let's consider them below in the form of a table [11].

	Level 1 Performed	**Level 2 Managed**	**Level 3 Established**	**Level 4 Predictable**	**Level 5 Optimizing**
People	Success depends on individual heroics. "Fire fighting is a way of life." Relationships between disciplines are uncoordinated, perhaps even adversarial.	Success depends on individuals and management system supports. Commitments are understood and managed. People are trained.	Project groups work together, perhaps as an integrated product team. Training is planned and provided according to roles.	A strong sense of teamwork exists within each project.	A strong sense of teamwork exists across the organization. Everyone is involved in process improvement.
Process	Few stable processes exist or are used.	Documented and stable estimating, planning, and commitment processes are at the project level.	Integrated management and engineering processes are used across the organization.	Processes are quantitatively understood and stabilized.	Processes are continuously and systematically improved.
Technology	The introduction of new technology is risky.	Technology supports established, stable activities.	New technologies are evaluated on a qualitative basis.	New technologies are evaluated on a quantitative basis.	New technologies are proactively pursued and deployed.
Measurement	Data collection and analysis are ad hoc.	Planning and management data is used by individual projects.	Data is collected and used in all defined processes. Data is systematically shared across projects.	Data definition and collection are standardized across the organization Data is used to understand the process qualitatively and stabilize it.	Data is used to evaluate and select process improvements.

Table 1: Organizational maturity levels [6]

The table 1 presents 5 levels: completed, managed, established, predictable, optimizing and criteria (characteristics): people, process, technology and measurement, by which levels are described. Criteria (characteristics) - a sign on the basis of which an assessment of the quality of the object, the process, the gauge of such an evaluation is formed. For example, the efficiency characterizes the level of system efficiency, and to optimality - how much the system is close to the optimal state.

Today, a lot of models have been developed, but almost all models use a five-level scale of measurement (metrics). There are models with six levels in which there is a zero level, it characterizes the situation when maturity is zero.

The maturity models that represent the theories of evolution "step by step", are meant to describe the basic steps and pathways of maturation. Consequently, it should be explained the characteristics of each phase and the logical relationship between the phases (evolutionary path).

As for their practical application, maturity models are required to state the level of maturity, current and desirable, including their measures for improvement. The objective is to diagnose and eliminate the deficiency of capacity. In general, three specific objectives can be distinguished [12]:

- Descriptive: a maturity model has a descriptive purpose when it is applied to the assessments as-is, where entities' ability under current observation are evaluated against certain criteria (Becker et al. 2009). The maturity model is used as a diagnostic tool. The maturity levels assigned are reported to internal and external stakeholders.
- Prescriptive: a maturity model has a prescriptive purpose when it allows identifying desirable levels of maturity and provides guidance on improvement measures.
- Comparative: a maturity model presents a comparative view when adopted to allow a comparative analysis (benchmarking) internal or external. Through analysis of historical data, the maturity levels of the business units and / or similar organizations can be compared with each other.

Let us consider in more detail the evaluation of the maturity. Evaluation of maturity can be carried out according to the criteria described in the table above. In particular, one of the most popular approaches or popular approaches is the approach through assessing the maturity of processes. The following gradation of state or maturity levels for processes is generally accepted [13]:

- Initial (chaotic, ad hoc, individual heroics) - the starting point for use of a new or undocumented repeat process.
- Repeatable - the process is at least documented sufficiently such that repeating the same steps may be attempted.
- Defined - the process is defined/confirmed as a standard business process.
- Managed - the process is quantitatively managed in accordance with agreed-upon metrics.
- Optimizing - process management includes deliberate process optimization/improvement.

The model identifies five levels of process maturity for the organization. Within each of these levels of maturity are the KPAs (key process areas) that characterize this level, and for each such area, five factors are defined: goals, commitment, ability, measurement and verification. KPAs are not necessarily unique to CMM, presenting - as they do - the steps that organizations need to go through on their way to maturity. It is assumed that the assessment will be carried out by an authorized leading expert. One way that companies should use the model is to first assess their maturity level, and then draw up a concrete plan for moving to the next level. Skipping levels is not allowed.

Let us consider historically the first description of levels. Depending on the model, there are options for describing the levels, but in general they correspond to the canon of CMM [8]:

Level 1 – Initial (Chaotic)	**Level 2 – Repeatable**	**Level 3 – Defined**	**Level 4 – Managed**	**Level 5 – Optimizing**
It is characteristic of processes at this level that they are (typically) undocumented and in a state of dynamic change,	It is characteristic of processes at this level that some processes are repeatable, possibly with consistent results. Process discipline is unlikely to be rigorous, but	It is characteristic of processes at this level that there are sets of defined and documented standard processes established and subject to some degree of improvement over time. These standard	It is characteristic of processes at this level that, using process metrics, management can effectively control the AS-IS process (e.g., for software development). In particular, management can	It is a characteristic of processes at this level that the focus is on continually improving process performance through both incremental and innovative technological changes/improvements. At maturity level 5, processes are concerned with addressing statistical common causes of

tending to be driven in an ad hoc, uncontrolled and reactive manner by users or events. This provides a chaotic or unstable environment for the processes.	where it exists it may help to ensure that existing processes are maintained during times of stress.	processes are in place (i.e., they are the AS-IS processes) and used to establish consistency of process performance across the organization.	identify ways to adjust and adapt the process to particular projects without measurable losses of quality or deviations from specifications. Process Capability is established from this level.	process variation and changing the process (for example, to shift the mean of the process performance) to improve process performance. This would be done at the same time as maintaining the likelihood of achieving the established quantitative process-improvement objectives. There are only a few companies in the world that have attained this level 5.

Table 2: Maturity levels corresponding to the CMM canon [8]

2.3 State of the art of main models for the Management of IS

2.3.1 ITIL (framework for IT services)

ITIL, formally an acronym for Information Technology Infrastructure Library, is a set of practices for IT service management (ITSM) that focuses on aligning IT services with the needs of business. In its current form (known as ITIL V3), ITIL is published as a series of five core volumes, each of which covers a different ITSM lifecycle stage. The basis of ITIL is the discipline of IT Service Management (IT Service Management, ITSM), which describes ten processes and a Service Desk providing support and provision of IT services. Having defined the service orientation as the key in the work of the IT service, ITSM assumes a change in the nature of the interactions between the IT department and other business units. Although ITIL underpins ISO/IEC 20000 (previously BS 15000), the International Service Management Standard for IT service management, there are some differences between the ISO 20000 standard and the ITIL framework. ITIL describes processes, procedures, tasks, and checklists which are not organization-specific, but can be applied by an organization for establishing integration with the organization's strategy, delivering value, and maintaining a minimum level of competency. It allows the organization to establish a baseline from which it can plan, implement, and measure. It is used to demonstrate compliance and to measure improvement [14]. Graphically, ITIL model can be represented as follows [15]:

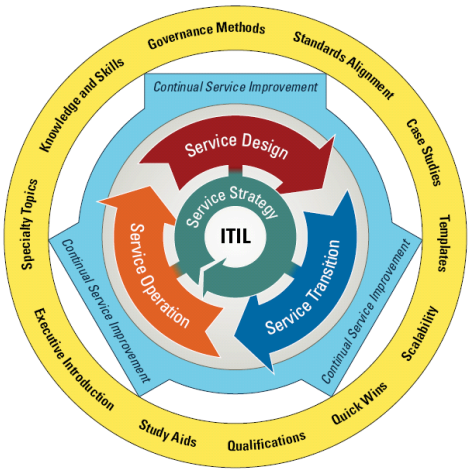

Figure 1: ITIL [15]

ITIL provides the foundation for IT management, and focuses on the continuous measurement and improvement of the quality of the IT services provided, both from the point of view of business and from the point of view of the consumer. This focus is a major factor in ITIL's worldwide success

and has contributed to its prolific usage and to the key benefits obtained by those organizations deploying the techniques and processes throughout their organizations.

Some of these benefits include [16]:

- increased user and customer satisfaction with IT services;
- improved service availability, directly leading to increased business profits and revenue;
- financial savings from reduced rework, lost time, improved resource management and usage;
- improved time to market for new products and services;
- improved decision making and optimized risk.

Rather than a rigid set of rules, ITIL provides a framework that companies can adapt to meet their own needs. Organizations need not implement every process, just those that make sense and fit into the way the organization wants to do business in the future. Some processes may be abandoned later when post-implementation reviews show limited value, while others may be implemented as gaps are uncovered or needs change.

The ITIL service lifecycle is documented in five core publications, each one covering a stage of the lifecycle [17]:

- ITIL Service Strategy
- ITIL Service Design
- ITIL Service Transition
- ITIL Service Operation
- ITIL Continual Service Improvement.

There are 26 processes and 4 functions described within the ITIL core guidance. Processes and functions operate across the entire service lifecycle but belong predominantly to one lifecycle stage (see Table 3).

<table>
<tr><th>Service Strategy</th><th>Service Design</th><th>Service Transition</th><th>Service Operation</th><th>Continual Service Improvement</th></tr>
<tr><td>Strategy management for IT services</td><td>Design coordination</td><td>Transition planning and support</td><td>Event management</td><td rowspan="10">Seven-step improvement process</td></tr>
<tr><td>Service portfolio management</td><td>Service catalogue management</td><td>Change management</td><td>Incident management</td></tr>
<tr><td>Financial management for IT services</td><td>Service level management</td><td>Service asset and configuration management</td><td>Request fulfilment</td></tr>
<tr><td>Demand management</td><td>Availability management</td><td>Release and deployment management</td><td>Problem management</td></tr>
<tr><td rowspan="5">Business relationship management</td><td>Capacity management</td><td>Service validation and testing</td><td>Access management</td></tr>
<tr><td>IT service continuity management</td><td>Change evaluation</td><td>Service desk function</td></tr>
<tr><td>Information security management</td><td rowspan="3">Knowledge management</td><td>Technical management function</td></tr>
<tr><td rowspan="2">Supplier management</td><td>IT operations management function</td></tr>
<tr><td>Application management function</td></tr>
</table>

Table 3: Processes and functions across the ITIL service lifecycle [17]

2.3.1.1 Maturity levels

The ITIL Maturity Model and Self-assessment Service is based on five levels of maturity: Initial; Repeatable; Defined; Managed, and Optimized. The five maturity levels are defined below (see next table), followed by the characteristics of each maturity level. These maturity level definitions are aligned with COBIT® and CMMI® definitions.

Level 1	Level 2	Level 3	Level 4	Level 5
Processes or functions are ad hoc, disorganized or chaotic. There is evidence that the organization has recognized that the issues exist and need to be addressed. There are, however, no standardized procedures or process/function management activity, and the process/function is regarded as of minor importance, with few resources allocated to it within the organization. There are instead ad hoc approaches that tend to be applied on an individual or case -by-case basis. The overall approach to management is disorganized.	Processes or functions follow a regular pattern. They have developed to the stage where similar procedures are followed by different people undertaking the same task. Training is informal, there is no communication of standard procedures, and responsibility is left to the individual. There is a high degree of reliance on the knowledge of individuals and therefore errors are likely. In general, activities related to the process or function are uncoordinated, irregular and directed towards process or function efficiency.	The process or function has been recognized and procedures have been standardized, documented and communicated through training. The procedures themselves are not sophisticated but are the formalization of existing practices. It is, however, left to the individual to follow these procedures and deviations may occur. The process has a process owner, formal objectives and targets with allocated resources, and is focused on both efficiency and effectiveness. Activities are becoming more proactive and less reactive.	The process or function has now been fully recognized and accepted throughout IT. It is service-focused and has objectives and targets that are aligned with business objectives and goals. It is fully defined, managed and is becoming pre-emptive, with documented and established interfaces and dependencies with other IT processes. Processes and functions are monitored and measured. Procedures are monitored and measured for compliance and action taken where processes or functions appear not to be working effectively. Processes or functions are under constant improvement and demonstrate good practice. Automation and tools are increasingly used to deliver efficient operations.	Leading practices are followed and automated. A self-contained continuous process of improvement is established, which has now resulted in a pre-emptive approach. IT is used in an integrated way to automate the workflow, providing tools to improve quality and effectiveness, making the organization quick to adapt. The process or function has strategic objectives and goals aligned with overall strategic business and IT goals. These have now become 'institutionalized' as part of the everyday activity for everyone involved with the process or function.

Table 4: Determination of maturity levels according to the ITIL model (Maturity levels [14])

2.3.1.2 Maturity levels Characteristics

Below is a list of the generic characteristics of each maturity level. These characteristics are derived from a variety of sources, including the generic attributes of the ITIL Maturity Model and Self -assessment Service [18], [19], [20]:

Level 0: absence (chaos)

- The process or function is either completely absent or only partially present.
- If the process or function is partially present, there is no structure around it, no defined responsibilities and no consistency in its operation.

Level 1: initial (reactive)

- There is little management commitment.
- No process or function governance exists.
- There is no defined vision.
- Activities respond only reactively to appropriate triggers; there is no pro-activity.
- There is no strategic direction; activities are uncoordinated with little or no consistency.

- There are few, if any, documented procedures.
- There is no definition of process or functional roles.
- Performance of the activities varies according to who undertakes them.
- There is little, or no, automation of any activities.
- Few, if any, records are kept of performance.
- There is no formal procedure for making improvements.
- People performing the role receive little training beyond 'on -the -job' learning.
- Performance of the activities is subject to no, or only basic, measures such as volume and failure rate.
- Activities have a technical rather than customer or service focus.
- No stakeholder feedback is gathered or sought.

Level 2: repeatable (active)

- Some management commitment exists.
- The activities are formally resourced.
- Goals and objectives are defined.
- The scope of the process or function and its interfaces with other dependent processes or functions are defined and agreed.
- Procedures exist but may not be fully documented.
- Procedures are usually followed but vary from person to person and team to team.
- People carrying out the activities have the skills, experience, competence and knowledge to perform their role.
- Roles are recognized, even if they are not formally defined.
- Performance is measured and reported to at least internal stakeholders.
- Performance is becoming more consistent but is still variable.
- Some automation is starting to be used to improve efficiency.
- Significant failings are recognized and remedial action taken, although in a somewhat ad hoc way.
- People performing the role receive basic, job -related training when they join, but little, if any, thereafter.
- Some stakeholder feedback is provided and major issues are responded to on an ad hoc basis.
- Improvements are focused on the activities rather than the stakeholder outcomes.

Level 3: defined (proactive)

- Management commitment is visible and evident.
- The activities are appropriately resourced, although occasionally, and in unusual circumstances, may be inadequate.

- There is starting to be a focus on operating proactively, although the majority of work is still reactive.
- Important documents are version -numbered and subject to change control.
- The scope of the process or function and its interfaces with other dependent processes or functions are documented.
- Procedures and work instructions are documented and kept up to date.
- Activities are carried out with a reasonable degree of consistency.
- Outcomes are increasingly predictable and usually meet stakeholder needs.
- Variations between people and teams performing the activities are minimal.
- Roles are formally recognized, defined and assigned.
- Performance is measured using a range of metrics.
- Performance is reported to both internal and external stakeholders.
- At least some of the activities are automated.
- Mistakes and failures to follow procedure are the exception. When errors are made, these are often recognized and are starting to be investigated to improve performance and reduce subsequent errors.
- People performing the role receive both initial and some ongoing training.
- Feedback from stakeholders is actively sought and acted on.
- Inter-process relationships and dependencies are recognized.
- Activities are subject to planning and rarely taken on an ad hoc or unplanned basis.
- The process or function is consistently employed throughout the organization.
- People skills are assessed and validated against changing requirements.
- There is a formal method for managing changes to the process or function.
- Routine activities are automated.
- Procedures and activities are tested for compliance, and clear exceptions logged and used as the basis for improvement.
- The internal (technical) and external (customer) focus is balanced.

Level 4: managed (pre-emptive)

- The process or function and the associated activities are robust and rarely fail to perform as planned.
- The organization has considered what might disrupt services and put in place measures to eliminate these or reduce their impact.
- There is a single process owner responsible for all sites within the organization. There is funding to invest and resources available to prevent failures or reduced performance.
- Process documentation is consistent (based on a standard process template) and includes the policy, purpose, objectives, procedures, roles and metrics.
- Documentation is protected from unauthorized change, centrally stored and backed up.
- Activities are performed in a highly consistent way with only rare exceptions.

- Most activities that can be automated are automated.
- Refresher training and updates are given in advance of a procedure or activity changing.
- Inter-process relationships and dependencies are fully recognized and actively embedded.
- There is a clear and documented definition of authority levels for each role.
- Skills matrices or their equivalent are used to validate people's capabilities.
- Changes to procedures rarely fail or have unexpected consequences.
- The focus is more on customer and service outcomes than technical considerations.
- Funds and resources are planned and allocated in plenty of time.
- Performance and activity are continuously measured and monitored.
- Activities are subject to a defined strategy and direction with clear objectives.
- Processes are integrated.
- Toolsets are integrated.
- There is regular measurement and review of process and function effectiveness from the customer perspective.
- Metrics and measurements are used to assess process performance against agreed process targets and objectives.
- Thresholds are established that generate warning alerts if a threshold is reached so that action can be taken before services are affected.
- Process and procedural interfaces and dependencies are recognized, documented and tested for compliance.
- Process activities and responsibilities that span more than one team are subject to operational level agreements.
- Activities are performed seamlessly across functional interfaces both internally and externally.
- Regular process reviews are completed by the process owner and reviewed with stakeholders to validate continued effectiveness.
- Compliance to the process and procedures is regularly checked against documented procedures by independent assessment or audit.
- Warnings, non-compliances and variations are actively used as a source of continual service improvement (CSI).
- Activities are highly consistent and generate predictable outcomes, regardless of who perform them.
- Improvements are identified based on audits and reviews of the process and are recorded in a CSI register.

Level 5: optimized

- All activities are subject to management control, governance and leadership.
- Activities are performed consistently and reliably across all areas of the organization in which they are used.

- Process improvements are actively sought, registered, prioritized and implemented, based on the business value and a business case.
- Plans are based, wherever appropriate, on business and service considerations.
- Metrics and measurements are used to assess the effectiveness and quality of the process outcomes and stakeholders' requirements and expectations.
- Measures, monitoring, reviews, alerts and reporting are part of a coordinated commitment to continual improvement.
- IT planning and activities are integrated with business plans and activities. Processes, procedures and functions are regularly audited for efficiency and effectiveness.
- Service governance including measures, roles and procedures span the entire supply chain to include inter-related and inter-dependent internal and third-party relationships.
- Redundant or sub-optimized procedures are identified and removed.
- Improvements are introduced across the entire organization to maintain operational consistency.
- Performance data and stakeholder feedback are retained and analyzed fort rends and improvement potential.
- There is regular communication between the service provider and its stakeholders to ensure that services and activities remain relevant and effective.

In the modern days, it is quite clearly visible that there is a growing dependency of organizations on IT in order to satisfy their corporate aims and meet their business needs. This leads to an increased requirement for high quality IT services. ITIL was developed to cope up with the lack of any former guidelines for managing different aspects of IT Service Management and hence ensure high quality IT services. Moreover, ITIL also gives a common language and clear models to IT management. It also provides a systematic and professional approach to the management of IT service provision [21].

2.3.2 CMMI

CMMI (Capability Maturity Model Integration) is a process improvement maturity model for the development of products and services [22]. Carnegie Mellon University (CMU) claims CMMI can be used to guide process improvement across a project, division, or an entire organization. CMMI defines the following maturity levels for processes: Initial, Managed and Defined. Currently supported is CMMI Version 1.3. CMMI is registered in the U.S. Patent and Trademark Office by CMU [23].

CMMI currently addresses three areas of interest:

- Product and service development — CMMI for Development (CMMI-DEV),
- Service establishment, management, — CMMI for Services (CMMI-SVC), and
- Product and service acquisition — CMMI for Acquisition (CMMI-ACQ).
- Within the thesis, it is interesting to consider CMMI for services.
- CMMI-SVC draws on concepts and practices from CMMI and other service focused standards and models, including the following:
- Information Technology Infrastructure Library (ITIL);
- ISO/IEC 20000: Information Technology — Service Management;

- Control Objectives for Information and related Technology (CobiT);
- Information Technology Services Capability Maturity Model (ITSCMM).

Familiarity with these and other service-oriented standards and models is not required to comprehend CMMI-SVC, and this model is not structured in a way that is intended to conform to any of them. However, knowledge of other standards and models can provide a richer understanding of CMMI-SVC. The CMMI-SVC model covers the activities required to establish, deliver, and manage services. As defined in the CMMI context, a service is an intangible, non-storable product. The CMMI-SVC model has been developed to be compatible with this broad definition. CMMI-SVC goals and practices are therefore potentially relevant to any organization concerned with the delivery of services, including enterprises in sectors such as defense, information technology (IT), health care, finance, and transportation. Early users of CMMI-SVC include organizations that deliver services as varied as training, logistics, maintenance, refugee services, lawn care, book shelving, research, consulting, auditing, independent verification and validation, human resources, financial management, health care, and IT services. The CMMI-SVC model contains practices that cover work management, process management, service establishment, service delivery and support, and supporting processes. The CMMI-SVC model shares a great deal of material with CMMI models in other constellations. Therefore, those who are familiar with another CMMI constellation will find much of the CMMI-SVC content familiar [24].

When using this model, use professional judgment and common sense to interpret it for your organization. That is, although the process areas described in this model depict behaviors considered best practices for most service providers, all process areas and practices should be interpreted using an in-depth knowledge of CMMI-SVC, organizational constraints, and the business environment. Organizations interested in evaluating and improving their processes to develop systems for delivering services can use the CMMI-DEV model [22].

This approach is especially recommended for organizations that are already using CMMI-DEV or that must develop and maintain complex systems for delivering services. However, the CMMI-SVC model provides an alternative, streamlined approach to evaluating and improving the development of service systems that can be more appropriate in certain contexts [24].

CMMI was developed by a group of experts from industry, government, and the Software Engineering Institute (SEI) at CMU. CMMI models provide guidance for developing or improving processes that meet the business goals of an organization. A CMMI model may also be used as a framework for appraising the process maturity of the organization. By January 2013, the entire CMMI product suite was transferred from the SEI to the CMMI Institute, a newly created organization at Carnegie Mellon. CMMI originated in software engineering but has been highly generalized over the years to embrace other areas of interest, such as the development of hardware products, the delivery of all kinds of services, and the acquisition of products and services. The word "software" does not appear in definitions of CMMI. This generalization of improvement concepts makes CMMI extremely abstract. It is not as specific to software engineering as its predecessor, the Software CMM [25].

The introduction of CMMI allows to improve the structure and quality of processes, master the processes that can serve as a basis for increasing the competitiveness and further development and expansion of the company. CMMI is based on the concept of a process. The value of the process is that it helps to capture and use the highest achievements in future projects. It is on this premise that CMMI is based.

Real processes in any organization depend on many factors, including the specifics of the business, the structure and size of the organization. Fundamental concepts of the model [26]:

- Process - technology, process;

- Process Capability - Productivity, Excellence. The range of results that can be expected from the organization;
- Process Performance – actual results achieved by the organization;
- Process Maturity – technology maturity. The degree of certainty, controllability, observability and efficiency of the process.

The CMMI model is released in two versions - a continuous view and a stage view. The difference between the two views is that the concept of process capabilities considers a set of actions ("practices") associated with one area of processes, while the concept of process maturity considers a set of processes across the organization [23].

At the heart of the stage presentation is the concept of maturity of the organization's processes as a whole (5 levels of maturity). The continuous representation is based on the concept of the possibilities of processes in a certain area (6 levels - in this concept the same levels are considered as in the five-level concept, only the zero level is added) [26].

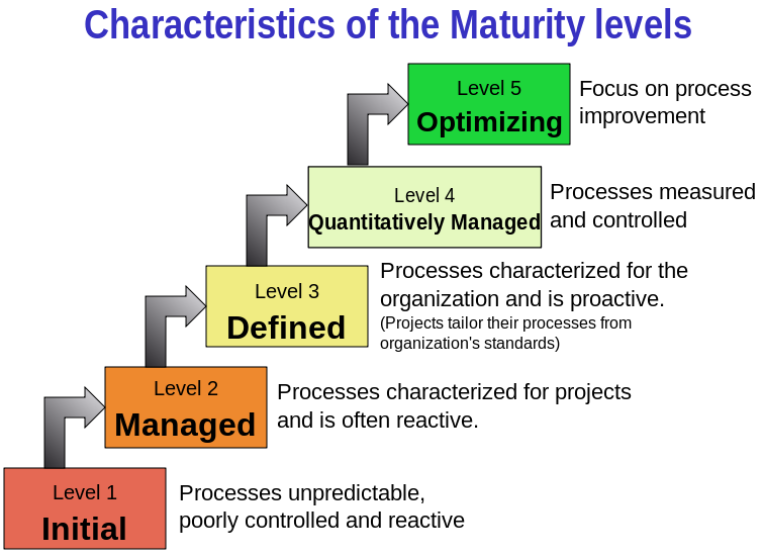

Figure 2: Characteristics of the Maturity levels [13]

Below is a list of levels with a detailed description of each of them [25].

1 level - Initial:

- Software development technology is characterized as arbitrary (improvised), in some cases - even chaotic.
- Only some processes are defined, success depends entirely on the efforts of individual employees.

2 level - Repeatable:

- Basic software project management processes are installed to track the cost, schedule and functionality of the output product.
- The necessary discipline for adherence to established processes takes place and provides the opportunity to repeat the success of previous projects in the same application area.

3 level - Defined:

- Management and engineering processes are documented, standardized and integrated into a unified technology for the entire organization of software development.

- Each project uses an approved version of this technology, adapted to the specifics of this project.

4 level - Managed:

- Detailed metrics (objective data) about the quality of execution of processes and output products are collected and accumulated.
- Process and output management is carried out according to quantitative estimates.

5 level - Optimized:

- Improvement of software development technology is carried out continuously on the basis of quantitative feedback from processes and pilot implementation of innovative ideas.

The CMMI stage view is based on the fact that, in order to achieve a certain level of maturity, the organization must implement all processes, without exception, relating to this and all previous levels of maturity. So, an organization that sets a goal to reach the 4th level of maturity must master all the processes of the 2nd, 3rd and 4th levels. If it turns out that this organization has mastered all the processes of the 3rd and 4th levels, but has not mastered at least one process of the second level of maturity, it will not be recognized as corresponding even to the 2^{nd} level of maturity.

Criteria for assessing the level of maturity [26]:

1. Key Process Group target settings are considered:
    - satisfied, if the applied practice is consistent with all key CMMI practices, or their equivalent
2. A group of key processes is considered satisfactory:
    - if all the targets are satisfied
    - not satisfying, if at least one of its target installations is not completely satisfied
3. The organization is considered appropriate level:
    - if all the key areas of this and all lower level processes are satisfied
    - not relevant if at least one key process area of this or any subordinate level does not satisfy the CMMI

A continuous view of CMMI addresses four process categories [25]:

- process management,
- project management,
- engineering,
- support.

The organization can focus on that area of processes, which is the most critical for it. In this case, you can talk about the level of potential opportunities for the selected process area. This means, for example, that an organization can reach level 5 of the potential for project management and remain below level 2 of the potential for process management. CMMI (stage view) provide for five levels of maturity of the organization: initial, managed, defined, quantitatively managed, optimized. CMMI provides [27]:

- guidance for efficient, effective improvement across multiple process disciplines in an organization;
- improvements to best practices incorporated from the earlier models;

- a common, integrated vision of improvement for all elements of an organization.
- CMMI-based process improvement benefits include:
- improved schedule and budget predictability;
- improved cycle time;
- increased productivity;
- improved quality (as measured by defects);
- increased customer satisfaction;
- improved employee morale;
- increased return on investment;
- decreased cost of quality.

2.3.3 COBiT

One of the popular maturity models derived from CMMI is the Control OBjectives for Information and related Technology (COBIT) maturity model. COBIT is an international recognized framework for IT Governance. COBIT (Control Objectives for Information and Related Technologies) is a good-practice framework created by international professional association ISACA (Information Systems Audit and Control Association) for information technology (IT) management and IT governance. COBIT provides an implementable "set of controls over information technology and organizes them around a logical framework of IT-related processes and enablers" [28].

The business orientation of COBIT consists of linking business goals to IT goals, providing metrics and maturity models to measure their achievement, and identifying the associated responsibilities of business and IT process owners. The process focus of COBIT is illustrated by a process model that subdivides IT into four domains (Plan and Organize; Acquire and Implement; Deliver and Support; and Monitor and Evaluate) and 34 processes inline with the responsibility areas of plan, build, run, and monitor. It is positioned at a high level and has been aligned and harmonized with other, more detailed IT standards and good practices such as COSO, ITIL, BiSL, ISO 27000, CMMI, TOGAF and PMBOK. COBIT acts as an integrator of these different guidance materials, summarizing key objectives under one umbrella framework that link the good practice models with governance and business requirements. COBIT 5 further consolidated and integrated the COBIT 4.1, Val IT 2.0 and Risk IT frameworks and drew from ISACA's IT Assurance Framework (ITAF) and the Business Model for Information Security (BMIS) [29].

The framework and its components can, when utilized well, also contribute to ensuring regulatory compliance. It can encourage less wasteful information management, improve retention schedules, increase business agility, and lower costs while better complying with data retention and management regulations.

COBIT components include [28]:

- Framework: Organizes IT governance objectives and good practices by IT domains and processes and link them to business requirements.
- Process descriptions: A reference process model and common language for everyone in an organization. The processes map to responsibility areas of plan, build, run, and monitor.
- Control objectives: Provides a complete set of high-level requirements to be considered by management for effective control of each IT process.

- Management guidelines: Helps assign responsibility, agree on objectives, measure performance, and illustrate interrelationship with other processes.
- Maturity models: Assesses maturity and capability per process and helps to address gaps.

COBIT was originally developed in 1993 by the Information Systems Audit and Control Association (ISACA) and is now developed further by the IT Governance Institute. The rules defined in this maturity model are slightly different compared to CMMI.

The application as defined by COBIT is to measure the state where the enterprise currently is, decide where it needs to go, and to measure the progress against that goal. Additionally, it can be used as a benchmark in order to compare the own attributes to other companies within a specific industry. The specific domain COBIT uses its maturity model for is IT Governance. More concrete the COBIT maturity model is measuring how well IT processes are managed. Therefore, COBIT defines a generic maturity model scale. Subsequently, out of this generic scale there is a specific maturity model derived for each of the 34 IT management processes defined in COBIT. The specific models consist of a textual description of the target state for each level.

COBIT consists of six maturity levels (level zero to five) [28]:

- Level 0 - Non-existent: The process is not existent at all.
- Level 1 - Initial/Ad Hoc: No standardized processes are in place.
- Level 2 - Repeatable but Intuitive: Procedures are followed but there is still a high degree of reliance on the knowledge of individuals.
- Level 3 - Defined Process: Procedures are standardized but not sophisticated enough.
- Level 4 - Managed and Measurable: The compliance with required procedures is measured and significant errors are detected.
- Level 5 – Optimized.

A refinement of processes to a good level of practice took place and variances are constantly reduced. There is the scale of maturity models [28]:

0) Does not exist. Complete absence of any IT management processes. The organization does not recognize the existence of IT problems that need to be addressed, and thus there is no information about the problems.
1) The beginning (Anarchy). The organization recognizes the existence of IT management problems and the need to address them. There are no standardized solutions. There are random, one-time solutions that are taken by someone personally or occasionally. The approach of management to solving IT problems is chaotic, the recognition of the existence of problems is accidental and inconsistent.
2) Repetition (Folklore). There is a general awareness of the problems of IT management. Performance indicators and IT processes are in development, covering the planning, operation and monitoring of IT. Information management activities are described and integrated into the management of the organization. The IT processes that affect the core business processes of the enterprise are selected for improvement and / or control. Effective planning and management of investments is carried out. The management of the organization regulated IT management measures, as well as management and evaluation methods, but the process was not adopted in the organization. There is no formal training, a set of interrelated standard management procedures, responsibility is vested in employees. Employees control the management processes through projects and IT processes. Limited management tools are selected

and implemented to collect management metrics, but are not used in full because of the shortcomings in assessing their functionality.

3) Description (Standards). The need to act in accordance with the principles of IT management is understood and accepted. A basic set of IT management indicators is developed: the relationship between the result and performance indicators is determined, it is fixed and introduced into the strategic planning and monitoring processes. Procedures are standardized and documented, staff are trained to perform these procedures. Performance indicators of all activities are recorded and monitored, which leads to increased efficiency of the entire organization. The procedures are not complex, they are a formalization of the existing practice. Ideas of balanced business evaluation cards are accepted by the organization. Responsibility for the training, implementation and application of standards is vested in the employees of the organization. The root cause analysis is applied time-from-time. Most processes are managed in accordance with some basic metrics, and usually by individual employees, so managers do not know about any deviations. However, universal reporting on the implementation of key processes is clear, and management awards employees based on measuring key results.

4) Management (Measurable). There is a complete understanding of the problems of IT management at all levels of the organization, staff training is constantly taking place. Service Level Agreements are determined and maintained in the current state. Responsibility is clearly defined, level of ownership of processes is established. IT processes are in line with business and IT strategies. First of all, improvements in IT processes are based on measured quantitative indicators. It is possible to control the procedures and metrics of processes, measure their compliance. All co-owners of the process are aware of the risks, the importance of IT and the opportunities they provide. The management of the organization has determined the permissible deviations in which the processes should work. If processes do not work effectively and productively, actions are taken in many (but not all cases). Processes are constantly being improved, their results correspond to "best practices". The order of root cause analysis is formalized. There is an understanding of the need for continuous improvement. Advanced technologies based on modern infrastructure and modified standard tools are used in a limited way. All necessary IT professionals are involved in business processes. IT governance is becoming a process throughout the organization. The activities of IT management are integrated into the management of the organization.

5) Optimization (Optimized). The organization has an in-depth understanding of IT management, IT problems and solutions, and prospects. Training and communication are maintained at the proper level, with the most modern means. As a result of continuous improvement, the processes correspond to maturity models built on the basis of "best practices". The introduction of these procedures led to the emergence of organizations, people and processes that are maximally adaptable to changing conditions, as well as fully compliant with IT management requirements. The root causes of all problems and deviations are carefully analyzed, the results of the analysis are followed by effective actions. Information technologies are integrated into business processes, fully automate them, providing an opportunity to improve the quality and efficiency of the organization.

Taking as a basis the scale of maturity models developed for each of the 34 IT processes, the manager can find out the following information [29]:

- The current status of the organization is to assess at what stage the organization is today.

- The current status of best practices in this industry is to compare your organization with the best organization in this industry.
- The current status of international standards is to compare the current status of the organization with "best practices" or international standards.
- The status of the organization after improvement (implementation of the organization's strategy) - to evaluate the organization's strategy, what results the organization wants to achieve.

There are two simple tools with which you can determine which of these estimates you want to put to the process under consideration [28]. Six attributes of maturity:

1) Awareness and communication
2) Policies, plans and procedures
3) Tools and automation
4) Skills and qualifications
5) Responsibility and accountability
6) Goals and measurement

The maturity model of each process. In the description of each process, a maturity model was given, that is, a description of the process functioning at a given level of maturity.

Criteria for evaluating information in CobiT [28]:

- Efficiency - the relevance of information relevant to the business process, guaranteeing timely and regular receipt of correct information.
- Productivity - ensuring the availability of information using the optimal (most productive and economical) use of resources.
- Confidentiality - ensuring the protection of information from unauthorized familiarization.
- Integrity - accuracy, completeness and reliability of information in accordance with business requirements.
- Suitability - providing information on the demand of business processes.
- Consistency - compliance with laws, regulations and contractual obligations.
- Reliability - access of the organization's management to relevant information for current activities, for the creation of financial reports and assessment of the degree of compliance.

In contrast to other application domains COBIT stresses that the model should not be used to assess a level of adherence to its control objectives but should be used to identify issues and set priorities for improvements. Unlike the CMMI approach the COBIT maturity model is not designed as a threshold model. Hence, it is quite common to move to a level of maturity without having fulfilled all criteria for the maturity levels below [29].

Diagram 1 shows a feasible fulfillment of the maturity levels. As aforementioned, the criteria for level one and level two are barely fulfilled although the overall process is at maturity level three which does fulfill the criteria in large part. Levels four and five comply with about 35% and 15% to the defined criteria, respectively. Depending on the domain of application, this modification of the way how to use a maturity model is feasible. Nevertheless, if a maturity level heavily depends on the fulfillment of the maturity levels above, the abovementioned approach is not adoptable.

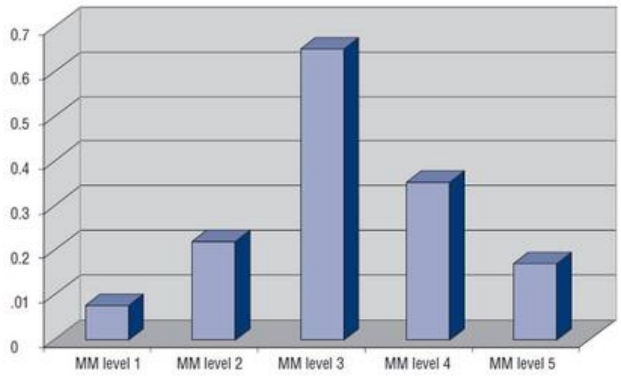

Figure 3: Exemplified maturity level fulfillment of an IT process [29]

The dimensions of maturity across these five levels are the capability, the coverage and the control of a process. COBIT also defines a graphical representation of its maturity model. As shown in Diagram 2 the graphical representation allows mapping the current status of the enterprise (circle) as well as the target state (star) on the six levels of maturity. If information about the industry average position (arrow) is available, it can also be illustrated in the same graphical representation to allow comparisons.

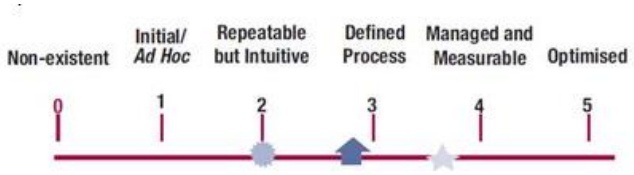

Figure 4: Graphical representation of the generic COBIT maturity model [29]

The IT Governance Institute also recommends users of the COBIT maturity model not to necessarily strive for the highest maturity level in each of the 34 processes. The right level of maturity is in many cases not the highest level of maturity since the right level of maturity is influenced by cost-benefit decisions as well as the overall strategy, the environment, and the type of enterprise. The highest maturity level for security management could for example be necessary for the most critical systems but maybe oversized for other systems [30].

To conclude COBIT is a good tool for improving IT service delivery in alignment with the business's needs.

2.3.4 ISO/IEC 33001 (SPICE) (earlier ISO/IEC 15504)

The Center for Public Research Henri Tudor, who developed the methodology for evaluating ITSM-processes TIPA, reported that in 2015 the ISO / IEC 15504 standard was updated and renamed ISO / IEC 33001. Previously, the standard consisted of 10 parts [31]:

- ISO/IEC 15504-1:2004 Information technology — Process assessment — Part 1: Concepts and vocabulary
- ISO/IEC 15504-2:2003 Information technology — Process assessment — Part 2: Performing an assessment
- ISO/IEC 15504-3:2004 Information technology — Process assessment — Part 3: Guidance on performing an assessment
- ISO/IEC 15504-4:2004 Information technology — Process assessment — Part 4: Guidance on use for process improvement and process capability determination

- ISO/IEC 15504-5:2012 Information technology — Process Assessment — Part 5: An exemplar Process Assessment Model
- ISO/IEC PD TR 15504-6:2008 Information technology — Process assessment — Part 6: An exemplar system life cycle process assessment model
- ISO/IEC PD TR 15504-7:2008 Information technology — Process assessment — Part 7: Assessment of organizational maturity
- ISO/IEC TS 15504-8:2012 Information technology — Process assessment — Part 8: An exemplar process assessment model for IT service management
- DD ISO/IEC/TS 15504-9:2011 Information technology — Process assessment — Part 9: Target process profiles
- ISO/IEC TS 15504-10:2011 Information technology — Process assessment — Part 10: Safety extension

The ISO / IEC 33001 standard is based on the ISO / IEC 15504 standard. ISO/IEC 15504 Information technology – Process assessment, also termed Software Process Improvement and Capability Determination (SPICE), is a set of technical standards documents for the computer software development process and related business management functions. It is one of the joint International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) standards, which was developed by the ISO and IEC joint subcommittee, ISO/IEC JTC 1/SC 7 [32].

ISO/IEC 15504 was initially derived from process lifecycle standard ISO/IEC 12207 and from maturity models like Bootstrap, Trillium and the Capability Maturity Model (CMM).

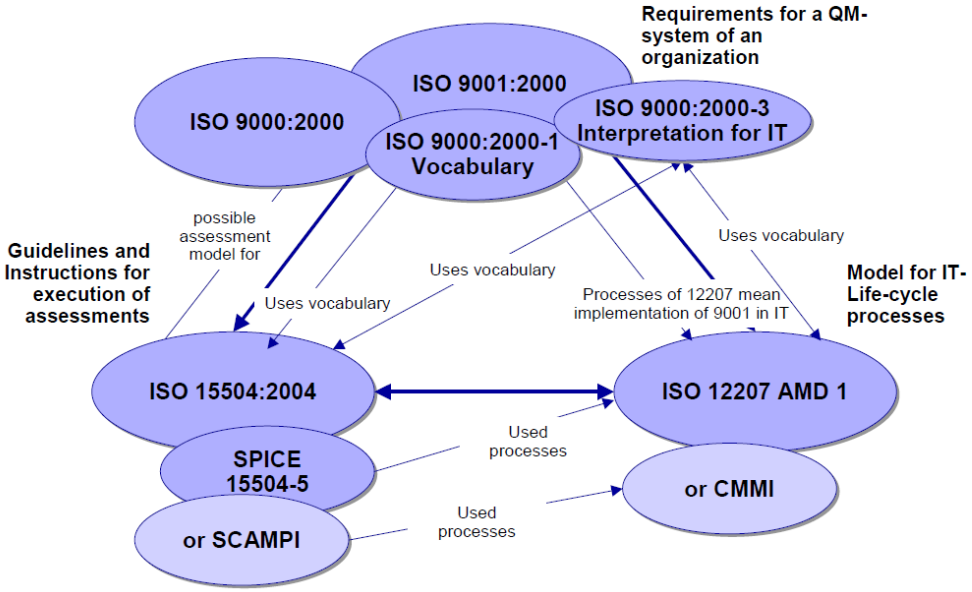

Figure 5: Dependency of Standards [33]

Next table shows the SPICE Criteria Levels[1]. The table presents the six levels of the model and their description.

[1] Levels 1 to 5 can be applied to an organization to determine its level of maturity in relation to people, process, technology, and measurement.

Level	Level Name	Capability Level Description
0	Incomplete	There is a general failure to attain the purpose of the process. There are no easily identifiable work products or outputs of the process.
1	Performed	The purpose of the process is generally achieved. The achievement may not be rigorously planned and tracked. Individuals within the organization recognize that an action should be performed, and there is general agreement that this action is performed as and when required. There are identifiable work products for the process, and these testify to the achievement of the purpose.
2	Managed	The process delivers work products of acceptable quality within defined time scales. Performance according to specified procedures is planned and tracked. Work products conform to specified standards and requirements.
3	Established	The process is performed and managed using a defined process based upon good principles. Individual implementations of the process use approved, tailored versions of standard and documented processes. The resources necessary to establish the process definition are also in place.
4	Predictable	The defined process is performed consistently in practice, within defined control limits, to achieve its goals. Detailed measures of performance are collected and analyzed. This practice leads to a quantitative understanding of process capability and an improved ability to predict performance. The quality of work products is quantitatively known.
5	Optimizing	Performance of the process is optimized to meet current and future business needs, and the process achieves repeatability in meeting its defined business goals. Quantitative process effectiveness and efficiency goals (targets) for performance are established, based on the business goals of the organization. Obtaining quantitative feedback enables continuous process monitoring against these goals, and improvement is achieved by analysis of the results. Optimizing a process involves piloting innovative ideas and technologies and changing non-effective processes to meet defined goals and objectives.

Table 5: SPICE Criteria Levels [11]

ISO/IEC 15504 is a reference model that defines «Process Measurement» and «Measurement of Maturity (Capabilities)» of process quality. «Process measurement» divides the processes into five categories: the customer-supplier; Engineering; Support; control; organization. «Measurement of maturity (capabilities)» is defined using the nine process attributes grouped at 5 maturity levels [33]:

1. Process Performance;
2. Process Management;
   2.1. Work product management;
3. Process Definition;
   3.1. Process Deployment;
4. Process Measurement;
   4.1. Process Control;
5. Process Innovation;
   5.1. Process Optimization.

Each process attribute is estimated on a scale: not reached (0-15%); Partially achieved (15-50%); Basically achieved (50-85%); Fully achieved (85-100%). ISO / IEC 15504 can be used in two contexts: to improve the quality of development processes and to determine the quality [33]. Next figure shows an example of the capability levels in ISO / IEC 15504.

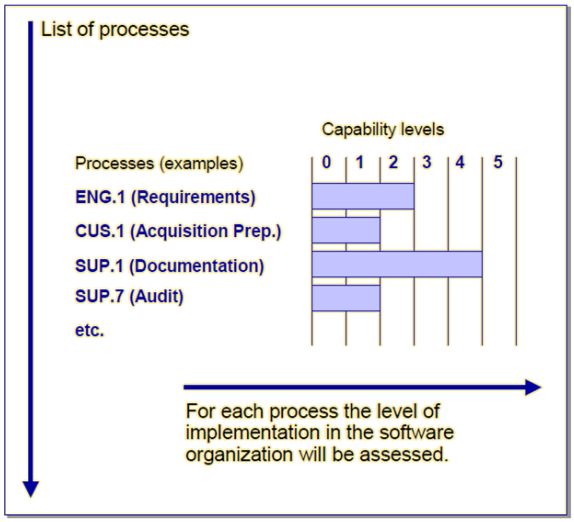

Figure 6: Capability levels of ISO 15504 [32]

The evaluation of the capability level of a process based on the compliancy to 9 attributes:

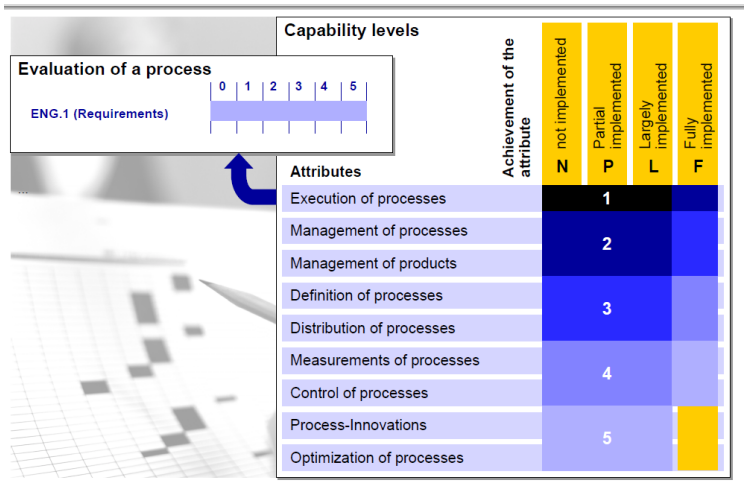

Figure 7: Interaction of Evaluation of a process, Capability levels and Attributes [33]

In the ISO / IEC 15504 standard, each factor is associated with criteria and, furthermore, metrics for measuring criteria (Figure 8).

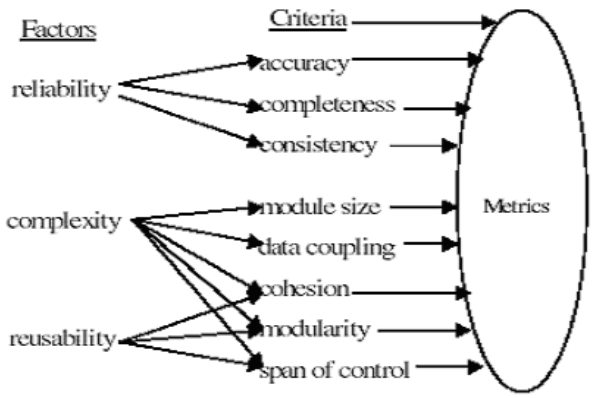

Figure 8: Model: Factor> Criterion> Metric [32]

Further, specific metrics are output in accordance with the design features of the quality criteria: accuracy, completeness, consistency, module size, data coupling, cohesion, modularity (Modularity), span of control (norm of controllability).

The processes of SPICE (ISO 15504 Part 5):

Figure 9: The processes of SPICE (ISO 15504 Part 5) [33]

The use of standards has many potential benefits for any organization. Some of the benefits of using standards ISO / IEC 15504 (SPICE):

- Improved management of software:
- Schedules and budgets are more likely to be met
- Quality goals are likely to be reached
- Employee training and turnover can be managed
- Visible certification can attract new customers or be required by existing ones;
- Partnerships and co-development, particularly in a global environment, are enhanced.

To ensure the quality of software development processes, it is recommended to use SPICE, as it provides a more complete set of tools for quality assurance and process improvement. This will help the organization to significantly improve existing processes.

SPICE can also be used in small companies, as evidenced by the results of the SPIRE project, which included the implementation of quality improvement processes in small (less than 50 people) companies from various European countries. As shown by this experience, and with small cash investments in small companies, it is possible to achieve a significant increase in labor productivity and improve the quality of products produced.

2.3.5 Comparison of the Maturity Models

ITIL, CMMI, COBIT and ISO / IEC 33001 (SPICE) (earlier ISO / IEC 15504) are four maturity models that can be complemented each other when used together. The fundamental difference between them is that CMMI and ISO / IEC 33001 (SPICE) (earlier ISO / IEC 15504) are based on the method of process for the development of software development, while ITIL and COBIT focuses mainly on IT issues.

Table 6 presents a comparative analysis of maturity models, through which it is possible to compare ITIL, CMMI, COBIT and ISO / IEC 33001 (SPICE) (earlier ISO / IEC 15504):

Maturity model	ITIL	CMMI	COBiT	ISO/IEC 33001 (SPICE) (earlier ISO/IEC 15504)
Developer	The United Kingdom Government Trade Office (OGC) has developed the IT Infrastructure Library (ITIL)	The Carnegie Mellon University Software Engineering Institute (CMU) developed the first capacity maturity model (CMM), and then developed the integration of the Capability Maturity Model Integration (CMMI)	COBIT was first released by ISACA	International Organization for Standardization, ISO (International Organization for Standardization, ISO) - an international organization that produces standards.
Year of creation	1986	1990	1996	1993 (ISO / IEC 15504); In 2015, this standard was revised to ISO / IEC 33001
Features	ITIL is a set of comprehensive and harmonized codes of best practices covering the control and management of all aspects of IT-related operations. ITIL offers three popular certification levels for practitioners: foundation, practitioner and manager, based on the degree of human competence in ITIL. The ITIL Library (Infrastructure Library Library) is an uncharacteristic tool that encourages the private sector to develop services and products, such as training, advice and tools to support ITIL.	CMMI is a process improvement model that consists of the best practices applied in software development, obtained from the industry. CMMI shares knowledge of best practices at different levels, and each level moves to higher standards. All levels are aimed at the development and maintenance of products and services throughout the life cycle of the product - from concept to delivery and maintenance.	COBIT is the basis for the development, implementation, monitoring and improvement of management and management methods in the field of information technology (IT). The CoBiT features a large coverage area (all tasks, from strategic planning and basic documents to the analysis of individual elements of the information system), the presence of cross-audit (overlapping areas of verification of critical elements), adaptability, scalability of the standard.	ISO 15504 (SPICE) is a reference model for maturity models (consisting of capability levels, which in turn consist of process attributes and additionally consist of common practices) against which appraisers can place evidence that they collect during their evaluation, That Evaluators can provide a general definition of the organization's capabilities to deliver products (software, systems and IT services).
Structure	ITIL is not descriptive and organizes the processes in the sets. Provides detailed information on how to conduct requirements analysis.	The CMMI model is not a process, but a description of the effective characteristics of the process. Sets. CMMI recommends a requirement analysis, but does not specify how to perform it.	COBiT components include: • Frames. Organizes goals and best practices for managing IT areas and processes and links them to business requirements. • Process description: a reference process model and a common language for everyone in the organization. These processes are compared with the areas of responsibility of the plan, assembly, start-up and monitoring. •Management objectives. Provides a full set of high-level requirements, which must be taken into account	ISO 15504 (SPICE) is a descriptive approach that streamlines process areas along the maturity model with maturity levels.

			by management to effectively manage each IT process. •Management guidelines: help to allocate responsibility, harmonize goals, evaluate effectiveness, and illustrate the relationship with other processes. • Maturity models: assess the maturity and capabilities of each process and help to eliminate gaps.	
Application	ITIL solves operational issues such as security, change and configuration management, capacity planning, troubleshooting, and support functions. ITIL applications help to align the entire IT process and the organization's resources with business processes.	CMMI is focused on software development, maintenance and product integration, and focuses on continuous improvement. The application of CMMI helps an organization to improve its skills and experience in developing software or a product, application.	COBITs are broad in scope and provide the basis for managing and operating IT services, including the life cycle of equipment.	ISO 15504 (SPICE) is a set of technical standards documents for the software development process and related business management functions.

Table 6: Comparative analysis of maturity models [34]

Maturity model	ITIL	CMMI	COBiT	ISO/IEC 33001 (SPICE) (earlier ISO/IEC 15504)
Advantages	- Cost reduction for the organization; - Improving the productivity of the organization; - Improving IT services through the use of proven best practices; - Improved quality control; - Better use of the skills and experience of employees; - Increase customer satisfaction through a more professional approach to the provision of services; - Use of industry standards and guidance on the provision of high-quality IT services; - Suitable for small and large organizations; - Improved delivery of third-party services using the ITIL or ISO 20000 specification as a standard for providing services when purchasing services; - ITIL also has such a unique advantage, as the orientation to performance. This means that the IT department can acquire in the organization a different status that will allow itself to solve a certain range of issues in accordance with its competence and act as a provider of IT services - ITIL does not depend on specific technologies and software and hardware, summarizing the world experience in the organization and provision of IT services.	- Culture to maintain quality in projects begins in the minds of junior programmers to senior programmers and project managers; - Centralized QMS for implementation in projects to ensure uniformity in documentation, which means less training cycle for new resources, better management of project status and health; - Incorporating best practices in software development in the organization, as described in the CMMI model; - Saving costs in terms of less effort due to fewer defects and fewer modifications; - This also leads to increased productivity; - Delivered on time; - Increase customer satisfaction; - Overall growth in return on investment; - Cost reduction; - Productivity increase.	- Better coherence based on business orientation; - A clear understanding of what IT does; -Clear ownership and responsibility based on process orientation; - General acceptability with third parties and regulators; - Common understanding among all stakeholders based on common language; - Compliance with COSO requirements for the IT management environment.	- ISO / IEC 15504 (SPICE) is a publicly available national standard; - This standard is supported by the international community; - Provides a more complete set of tools for quality assurance and process improvement; - Ability to use in small companies.

Table 7: Comparative analysis of maturity models – Advantages [34]

Name of the maturity model	ITIL	CMMI	COBiT	ISO/IEC 33001 (SPICE) (earlier ISO/IEC 15504)
Disadvantages	- The standard presupposes the informatization of the already well-organized and effective activity of the organization; - ITIL concepts are complex, and their widespread use can lead to significant costs - ITIL version 3 covers the entire life cycle and is therefore not easily understood, since version 2 focuses on the production and support of simple processes, and therefore it is easier to understand; - ITIL books are too expensive and therefore not available to non-commercial users; - The implementation and certification of ITIL requires special training. - Some experts in the field of ICT criticize ITIL as very subjective and note the emotional degradation associated with the adoption of new, modified methods of work.	- Additional resources and knowledge required in small organizations may be required to begin improving the process based on CMMI; - It may take considerable time and effort to implement; - Require major changes in organizational culture and attitudes.	There are no unique shortcomings that are not inherent in other models of maturity assessment.	- ISO / IEC 15504 (SPICE) is not as successful as CMM, since CMM is more actively sponsored, was created earlier and was later replaced by CMMI, which includes many ideas of ISO / IEC 15504, and also retains the advantages of CMM; - According to this standard, certificates of conformity are not issued. It is not normative, although it meets modern international quality requirements.

Table 8: Comparative analysis of maturity models – Disadvantages [34]

All of this models are process maturity frameworks that follow a similar and structured approach. They emphasize development of processes to improve product development and customer satisfaction and support the coordination of multi-disciplinary activities related to a project.

Both CMM and SPICE began as a means of solving one particular problem - choosing the best software vendor. However, these models outgrew their initial assumptions and successfully passed the path from research development to world standards. To date, they represent the most developed quality models that have been applied in practice. [34]

Although all of them ITIL, CMMI, COBIT and ISO / IEC 33001 (SPICE) (earlier ISO / IEC 15504) are similar in structure, the amount of duplication is, however, small and there is no contradiction between the four models, making it possible to apply ITIL / CMMI / COBIT / ISO / IEC 33001 (SPICE) (earlier ISO / IEC 15504) models simultaneously in an organization. CMMI is the de facto quality standard for software development, integration, deployment, and maintenance processes in organizations and ITIL is the first choice of organizations for standards related to operations and the infrastructure side of IT.

Implementation of ITIL / CMMI / COBIT / ISO / IEC 33001 (SPICE) (earlier ISO / IEC 15504) also aids organizations in reducing the cost of quality, improving turnaround times, and arriving at a precise estimate of efforts required that helps in costing products. Thus, compliance with the standard ceases to be a mere evidence of achieving a certain level of quality and becomes a way of real improvement of existing processes in the enterprise. Through the assessment of maturity, you can assess the quality, which, to date, is an up-to-date practice in many organizations. [34]

For the analysis of the maturity of higher education institutions of the IPB and KubSAU, it is best to select the ITIL methodology by the example of the units, since this standard is an example of best practices that extend to the control and management of all aspects related to IT operations. ITIL helps coordinate the entire IT process and the organization's resources with business processes. Also important is the fact that ITIL also has such a unique advantage as the orientation to performance. This means that the IT department can acquire in the organization a different status that will allow it to independently solve a certain range of issues in accordance with its competence and act as a provider of IT services, which is relevant for the chosen topic, since this standard allows the certification of only one process or organizational unit.

3. Case study: IPB and KubSAU

3.1 Polytechnic Institute of Bragança (IPB)

The Polytechnic Institute of Bragança (IPB) is a Portuguese Higher Education Public Institution with 7000 undergraduate and master students, embracing a wide area of knowledge and technology, including agriculture sciences, arts and sports, education and teachers' training, informatics and engineering, administration and management, health, communication and tourism.

3.1.1 IT centers

The objects of the research are the subdivisions of the IPB - Four IT Centers, whose main activities are: the provision of communications services to the Central Services and to all the schools of the IPB, is the application development, the development and maintenance of web portals/sites and management of the e-learning platform, management of software/hardware contracts and support to the users of the central services. Next figure shows the structure of the IPB Services.

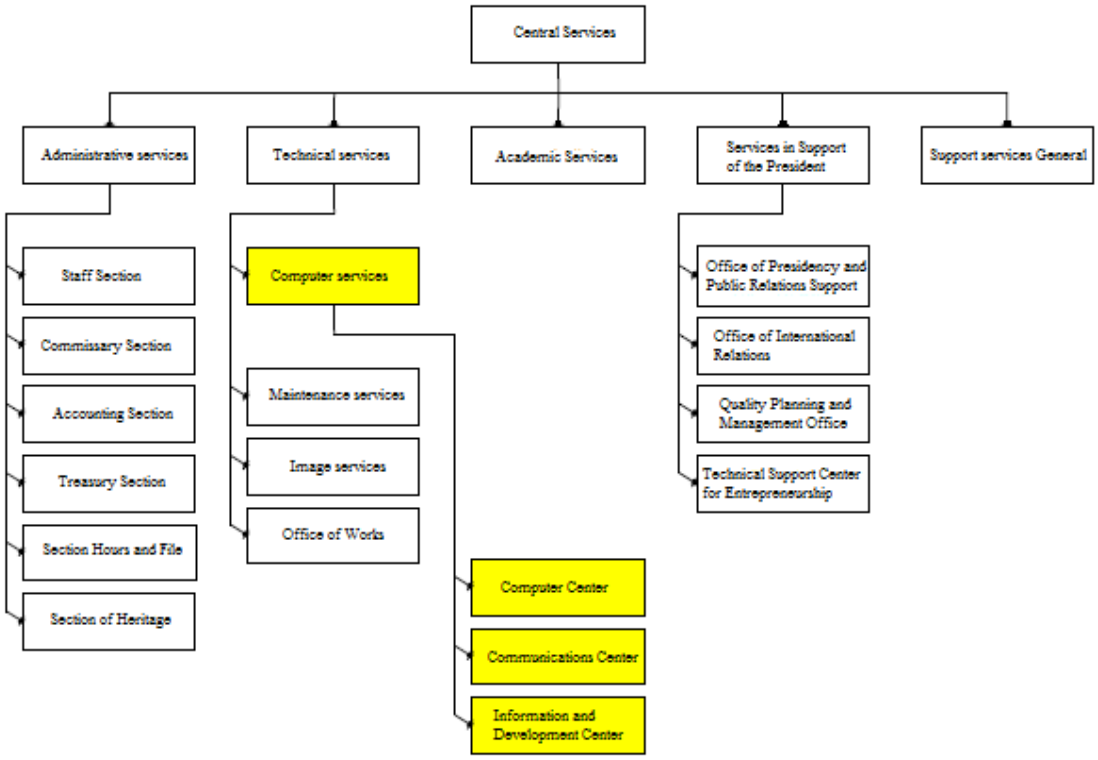

Figure 10: Structure of the IPB Services

The instituition contains four main IT Centers: Center for Communications and System Management; Center for Data Development and Management; Center for Innovation and Web Projects; and System Integration and Support Center. Next table shows the ,main assigments of each IT center.

Center for Communications and System Management	Center for Data Development and Management	Center for Innovation and Web Projects	System Integration and Support Center
- satisfy the requirements of IPB computer communications; -establish, administer, operate and develop the common infrastructure communications; -organize and maintain equipment and datacenter spaces; -fighting for the infrastructure of servers and services installed on the datacenter; - to administer the logical and physical network; -have maintenance and server configuration and active network equipment; - manage networks and IPB systems affected to the data center; -provide procedures aimed at physical security of equipment and data; -propose the purchase of equipment for the modernization and expansion of infrastructure; -propose and implement expansion and modernization of Physical and logical infrastructure of the network; -register and perform activities concerning the operation of equipment and lines of data communication; -commit and evaluate the implementation of equipment maintenance, carried out by external companies.	-develop, adapt and maintain the Information systems by the Institution; - identify, define and validate the processes and information flows in the IPB; -to perform systems analysis and software requirements survey; -plan, coordinate and execute the activities relevant to the analysis, programming, documentation and implementation of systems; -implement and maintain of SA applications; -valuate information systems provided by third parties and verify the convenience of installation at IPB; -configure and maintain availability of databases; -control access of programmers and users to databases; -setting and performing the copy policy database security; -define security policies of the information, carrying out the actions Implementation and implementation solutions; -project development projects software; -promote the adaptation of systems of information implemented at the needs of IPB; -define and adopt standards, methodologies and processes software development.	-coordinating innovation actions organizational level at the level of the IPB information; -develop work plans at the short-term and medium-term Implementation of innovative systems; -design and implement mechanisms to support teaching in the distance; -promote the development of E-services; -administer the IPB Web Portal; - ensuring the timeliness and of the IPB Portal; -develop the IPB Intranet; -create illustrations, graphics and animations, to compose and value the content of Web pages; -provide Web page patterns and develop and maintain interfaces aiming for an efficient and intuitive; -provide services to the community, within its area of action, through agreements or contracts; -study and propose digital models of official documents.	-coordinating support services to the user; -promote systems integration used in SC with the remaining SI of IPB; -produce, disseminate and keep up to date a knowledge base for user troubleshooting two SC; -provide software licenses acquired by IPB; -define the purchasing and use policy hardware and software in CS; -structure and maintain in an organized way and updated the collection of software; -diagnostic and troubleshooting hardware SC users; -register support requests in system that enables your distribution and monitoring; -identify to which of the other centers an application for support; -promote, within the framework of the IPB, global use of free software; -install software, applications and systems developed by SI, in the CS of IPB; -commit to certify the performance of services performed by companies in the scope of CS applications; -promote user training of CS, through the organization of courses; -identify training needs of CS employees.

Table 9: IPB IT centers

3.1.2 Portfolio of applications that covered the business architecture of IPB

Next table shows portfolio of applications that covered the IT architecture of IPB. We only have information about 2 IT centers.

IT center	Application / Technology	Functionality	Supported business processes
CCOM	Freeradius	Remote Authentication Dial-In User Server	Authentication
CCOM	Bind	DNS	Name Resolution
CCOM	OpenLdap	Central Authentication Server	Authentication
CCOM	PostFix	Email Server	Email
CCOM	Mailman	Email Lists	Email
CCOM	Dovecot	IMAP/POP3	Email
CCOM	Apache HTTP Server	HTTP Server	Software development
CCOM	PHP	Server Side language	Software development
CCOM	MySQL	Data base	Software development
CCOM	Open Atrium	Content Management System	CMS

CCOM	Zabbix	Monitoring	Backbone of the IPB Network
CCOM	Grafana	Monitoring	Backbone of the IPB Network
CCOM	Nginx	HTTP Server	Backbone of the IPB Network
CCOM	Cisco Prime Infrastructure	CISCO Centralized Equipment Management	Backbone of the IPB Network
CCOM	Shibboleth	Federated Services Authentication	Authentication and Authorization
CTI/CIPWeb	Linux / Apache 2 / MySQL / PHP	Web server	Websites
CTI/CIPWeb	Joomla	Web Portal	Institutional Portal
CTI/CIPWeb	Yii2	Web applications	Cross institution processes support except Academic Services
CTI/CIPWeb	Sakai	E-learning and E-collab platform	Classes and projects support
CTI/CIPWeb	Limesurvey	Survey and forms builder	Event registrations, thesis surveys, etc…
CTI/CIPWeb	Koha	Library system	Book and lending management

Table 10: Portfolio of applications that covered the business architecture of IPB

3.2 Kuban State Agrarian University

The Kuban State Agrarian University is one of the recognized leaders in a higher agricultural education system in Russia. The largest University in the south of Russia occupies 174 hectares in Krasnodar city.

3.2.1 Business Architecture of KubSAU

The object of the research is the subdivision of the Kuban State Agrarian University (KubSAU) - the Center for Information Technologies (IT Center, CIT), whose main activities are: provision of technical and software departments of the university, development of the educational portal and university site, courses, as well as helping teachers in automating student testing. Figure 23 shows the IT Center in the organizational structure of the Kuban State Agrarian University.

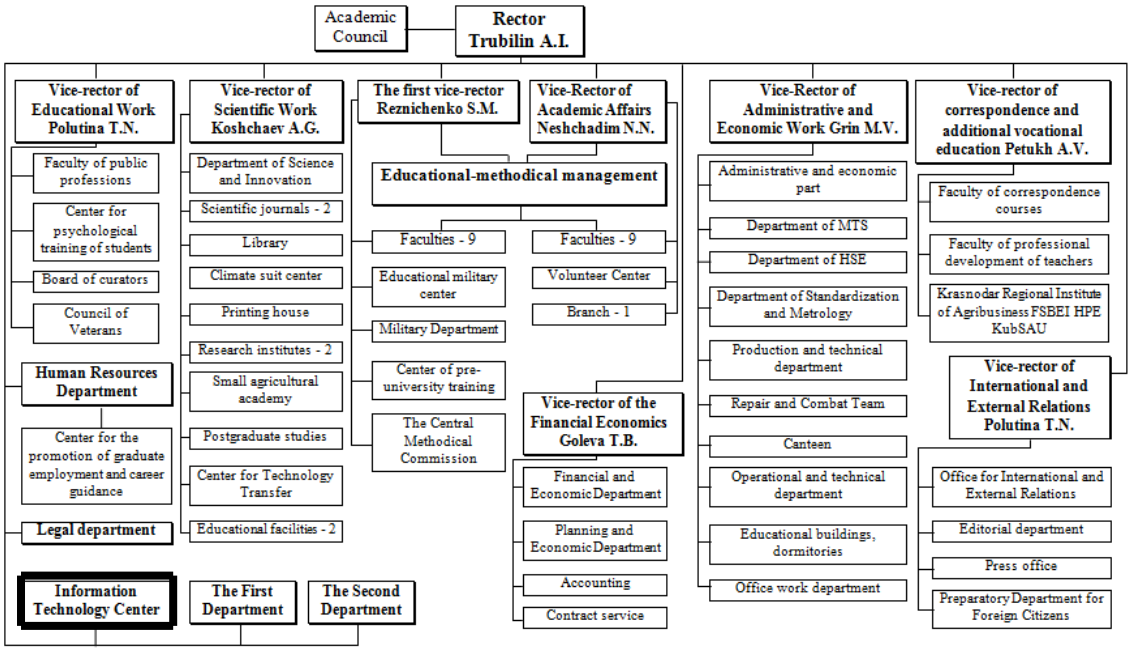

Figure 11: IT Center in the organizational structure of the Kuban State University

The organizational structure of CIT consists of the chief, deputy chief and six departments: the technical support and operation department, the department of educational projects and information resources, the web projects department, the software development and operation department, the system administration department and the testing and certification department.

In turn, each of the departments includes the head of the department and a number of employees. And the technical support and maintenance department is also divided into three sectors, each headed by a manager. Sectors of the technical support and operation department: the technical support sector consists of the head, the leading engineer and technician, the technical support sector and the service sector consist of the head, engineer and technician. The main activity of the department is to ensure the uninterrupted operation of computer equipment in the departments of the University.

The department of educational projects and information resources consists of the head of the department, the technician-testologist and the methodologist. The main activities of the department are the organization and conduct of refresher courses for students, university staff, courses for entrants, the development of an educational portal.

The department of web projects consists of the chief of department, web administrator, designer and engineer. The main activities of the department are to ensure the functioning and development of the university's website, the creation and maintenance of web sites and web applications for various structures of the University.

The department of software development and operation consists of the chief of department and the senior engineer-programmer. The main activities of the department are maintenance and further improvement of the software developed earlier, development of new software necessary for the work of the University units.

The department of system administration consists of the chief of department, the system administrator and the engineer. The activities of the department are organization, management, coordination, control and implementation of works to ensure the uninterrupted operation and development of the computer network infrastructure of the University.
The testing and certification department consists of the head of the department and the programmer. Directions of the department's activity - assistance in providing the faculties, departments and other structural divisions of the University with quality control of current and residual knowledge of students using computer testing methods.

The structure described above is shown in Figure 12.

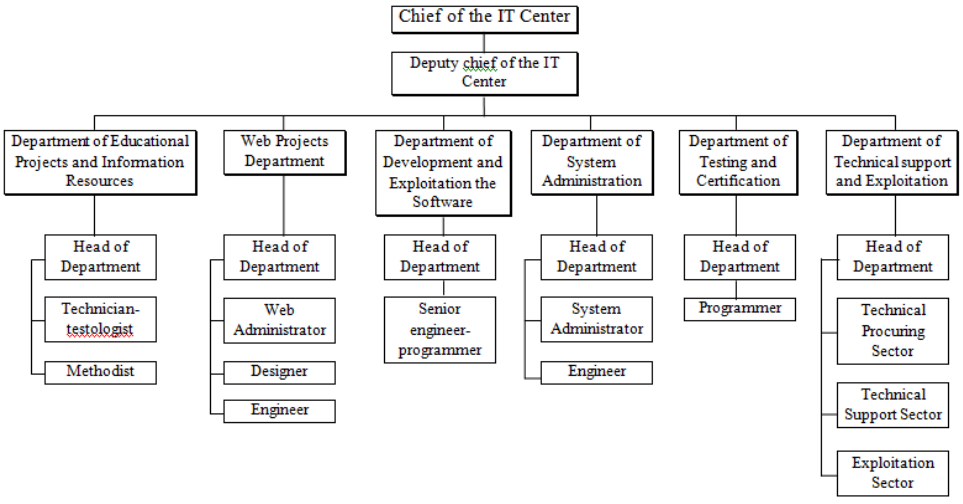

Figure 12: Organizational structure of CIT

The main objectives of the IT Center in accordance with the regulations on the "Information Technology Center" are:

- providing access to the intranet information services and resources, as well as to the resources of the global Internet network;
- development, implementation and maintenance of an automated university management system;
- implementation and maintenance of automated systems for collecting, processing, storing and transmitting information;
- maintaining the computer facilities of the university, including system software.
- The diagram of CIT's goals, performed in ARISToolset, is presented in Figure 25.

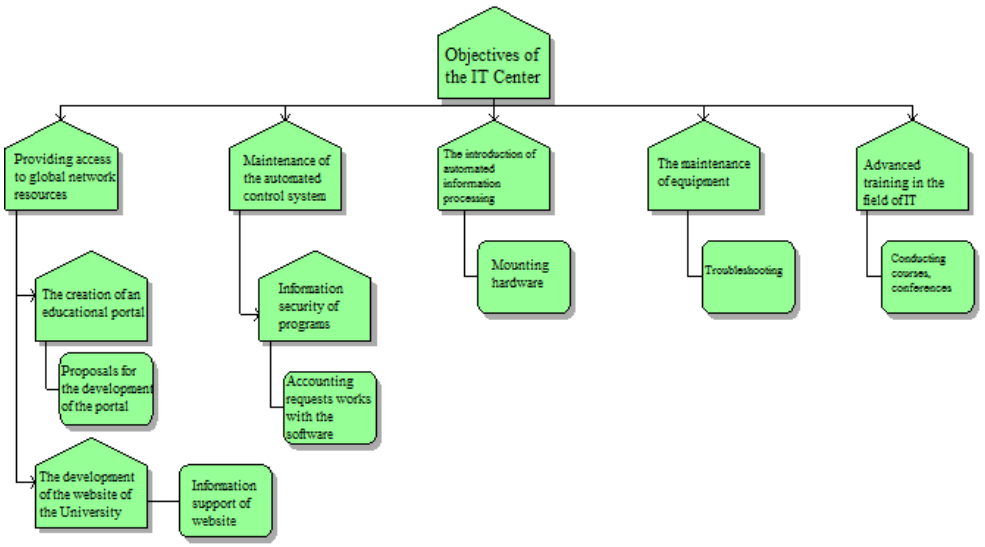

Figure 13: The CIT target diagram

The main services provided by the IT Center to the Kuban State Agrarian University:

- repair of equipment (repair of office equipment according to applications of departments or departments);
- Servicing of servers and local network of KubSAU (scheduled maintenance, tuning, debugging, administration of networks, maintenance of the KubSAU mail server);
- maintenance of KubSAU site (maintenance of the site, fulfillment of applications for filling the site, administration of department accounts);
- Maintenance of KubSAU educational portal (acceptance of applications and placement of teachers' grants on the educational portal);
- technical support for distance courses (assistance in conducting webinars, laying out materials, preparing tests);
- implementation of tests of teachers in the AST-testing system (teachers bring tests in docx format, they are transferred to the system in AST format);
- creation of AIS for the University (one of the latest applications was the Attendance Monitoring Log, which in addition to the module "Attendance" includes the modules "Attestation" and "Session").

- introduction of ready-made AIS (one of the last was the maintenance of the electronic document management system DIRECTUM);
- advising users.
- The IT Center has the following functions in accordance with the Regulations on the "Information Technology Center":
- maintenance of functioning, modernization, maintenance and repair of university lvs and computer equipment;
- increasing the effectiveness of the use of IT in the educational process, research and management of the university;
- organization of centralized software support, maintenance and repair of computer facilities of the University;
- issue to university departments recommendations on the choice of hardware and software;
- Creation, maintenance of the account and safety of library of the license system and applied on;
- development, implementation and maintenance of the university automated management system;
- advanced training of university staff in the field of information technology and telecommunications systems.

The diagram of CIT functions performed in ARISToolset is shown in Figure 12.

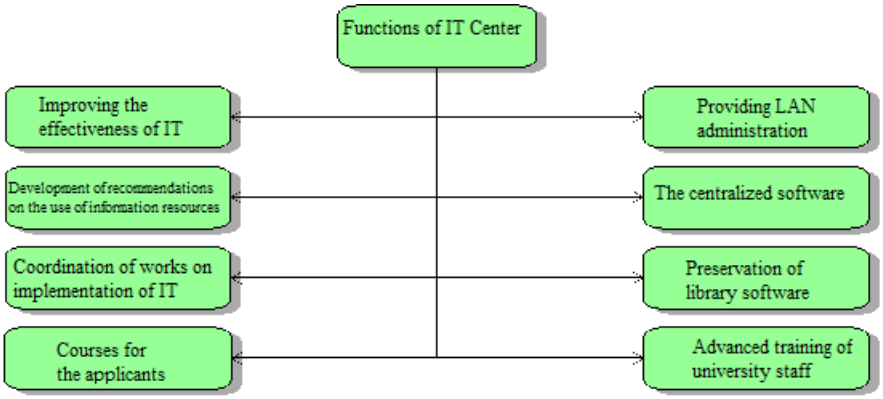

Figure 14: Function diagram of the CIT

The mission of the IT Center is projected almost completely for its functions, six departments conduct work on the development of information technologies within the walls of KubSAU.

The structure of the CIT structure has a large degree of centralization - the integrity of the enterprise, in which vertical links prevail, while the upper levels have decisive powers in decision-making, and these decisions are strictly mandatory for the lower levels (for more detailed information consult annexes).

3.2.2 Portfolio of applications that covered the business architecture of KubSAU

The existing portfolio of IT systems in the IT Center is shown in Table 13, as well as an assessment of the state of technical facilities.

System name	Functionality	Assessment of the use of the application system	Supported business processes	Assessment of technical condition
DIRECTUM	Create Service Notes Creating tasks and monitoring their execution Configuring typical routes Chancery Reception and coordination of applications from units Preparation of draft agreements	Provide support and development	Reconciliation of service requests Distribution of tasks between departments Approval of employee work plans	Excellent condition
Microsoft Visual Studio 2012	Development of console applications and applications with a graphical interface, including those that support Windows Forms technology	Provide support and development	Software Development	Excellent condition
1C: Bitrix	Corporate site support	Provide support and development	Maintenance of the official site of the university	Excellent condition
Web application “Educational portal of KubSAU"	Placement of study guides on the portal, their viewing, the formation of statistics	Develop the infrastructure of the application system	Maintenance of KubSAU educational portal	Requires modernization
Mirapolis Virtual Room	Invitation of participants to webinars View information about participants Feedback from participants Audio and video conferencing Joint viewing of materials	Provide support and development	Technical support of distance courses	Excellent condition
Microsoft SQL Server 2008	Database location	Provide support and development	Administration of the local computer network of the university	Excellent condition
AST- Tests	Passage of tests Data processing Displaying statistics	Provide support and development	Translation of texts into the format of an adaptive testing environment	Excellent condition

Table 11: Existing Portfolio of Applied Systems of the IT Center

3.3 Results and analysis

3.3.1 Description

One of the options to measured the IT maturity is by comparing the IT service team’s operations, planning and processes to the international best models. In this context, we decide to use the Information Technology Infrastructure Library (ITIL) framework to analyse the selection, planning, delivery and support of IT services by IPB and KubSAU. This methodology uses units as the standard is an example of best practice that covers the control and management of all aspects of IT-related operations.

Maturity assessments are used to understand the state of an organization. It aims to measure the degree to which an organization uses its people, processes, tools, products, and management. Assessments show opportunities to improve, identify required standards, processes and procedures, and facilitate continuous improvements.

However, assessing all processes described in ITIL would be a gigantesque task, requiring substantially more time than what was at the disposal for this thesis. It is also not a common approach to take on a full ITIL assessment – normally a few processes are chosen at a time [35].

ITIL Service Lifecycle elements	Processes/functions covered
Service strategy	Strategy management for IT services Service portfolio management Financial management for IT services Demand management Business relationship management
Service design	Design coordination Service catalogue management Service level management Availability management Capacity management IT service continuity management Information security management Supplier management
Service transition	Transition planning and support **Change management** **Service asset and configuration management** Release and deployment management Service validation and testing Change evaluation Knowledge management
Service operation	Event management **Incident management** **Request fulfilment** **Problem management** Access management Service desk function Technical management function IT operations management function Application management function
Continual service improvement	Seven-step improvement process

Table 12: ITIL Processes/functions covered in the work (gray)

The scope of the research was hence limited to 5 processes within the service transition and operation volume of ITIL:

- Incident Management,
- Request Fulfilment Management,
- Problem Management,
- Change Management, and
- Service Asset and Configuration Management.

We started by implementing the Incident management process as it is the process that ITIL books advise to start the implementation with. This area contains such elements as “Activities in Place needed for the Success of Incident Management”, “Incident Management Metrics”, “Incident Management Process Interactions”.

The next areas are Request Fulfilment Management, Problem Management, Change Management, Service Asset and Configuration Management. The next step will be to compare the both organizations: IPB and KubSAU.

Assessment of the IT maturity of institutions by questionnaire is one of the evaluation methods in the ITIL model. Through a questionnaire, we can measure the IT processes maturity against ITIL framework. We made 3 different questionnaires: leadership of the IT Centers; teaching staff; and students. The field of action includes hardware related software, network of computers and important active parts in the IT infrastructure. There is Anonymous questionnaire.

3.3.2 Results

3.3.2.1 Leadership of the IT Centers

Next tables show the results of the questionnaire of the leadership. The responsible of the IT center need to evaluate theis IT services. Each question was formulated in the form of a statement which the participants were to rate on a scale from 1 to 5: 1) Strongly Disagree (Initial maturity level); 2) Disagree (Managed level); 3) Neutral (Defined level); 4) Agree (Quantitatively managed level); and 5) Strongly Agree (Optimizing level).

A. Incident Management processes - Service Operation

Next table shows the results from the incident managent process. The results show that in the section “The Incident Management Process” in both universities the personnel responsible for Incident Management are suitably trained, the definition of an incident is clearly understood and is applied across the organization, an incident is understood as being different from a problem. Answers of the leadership of IPB in the section “Activities in Place needed for the Success of Incident Management” mostly were “Neutral”, leadership of KubSAU mostly has answers “Agree”. In the section “Incident Management Metrics” leadership of IPB and KubSAU mostly has answers “Neutral”, that means that Incident Management's KPIs and metrics are defined and in place, Incident Management Reports have been identified and put in place, Metrics have been defined and are in place for Major Incidents. In the section “Incident Management Process Interactions” leadership of IPB has most answers “Disagree” or “Neutral”, leadership of KubSAU has most answers “Neutral” or “Agree”, it means that the relationship between Incident Management and Problem Management is understood.

		IPB					KubSAU					Avg	
	The Incident Management Process	1	2	3	4	5	1	2	3	4	5	IPB	Kub Sau
1	We have clear roles and responsibilities for the Incident Management Process which have been identified, defined, documented, and appointed.	25%	25%	25%	25%	0%	0%	0%	0%	0%	100 %	2,5	5
2	Employees have the understanding that an incident has to be resolved fast, without the need for root cause investigation.	0%	25%	25%	25%	25%	0%	0%	0%	0%	100 %	3,5	5
3	The personnel responsible for Incident Management are suitably trained.	25%	0%	25%	50%	0%	0%	0%	0%	100 %	0%	3	4

4	We have a clearly defined, repeatable incident management process across the organization to manage the life cycle of incidents from their inception to closure.	25%	50%	25%	0%	0%	0%	0%	100 %	0%	0%	2	3
5	The definition of an incident is clearly understood and is applied across the organization. An incident is understood as being different from a problem.	0%	25%	50%	25%	0%	0%	0%	0%	100 %	0%	3	4
6	Incident records are maintained for all reported incidents.	33,33%	33,33%	33,33%	0%	0%	0%	0%	100 %	0%	0%	1,5	3
7	All incidents are analyzed and classified by the Global Service Desk prior to handing them over to backbone support.	33,z3%	33,33%	33,33%	0%	0%	0%	0%	100 %	0%	0%	1,5	3
8	All Incidents are assigned a priority based on impact and urgency.	25%	50%	0%	25%	0%	0%	0%	0%	100 %	0%	2,25	4
9	We have defined Incident Management's Information Management reporting	25%	25%	25%	25%	0%	0%	0%	100 %	0%	0%	2,5	3
10	Incident Management Process review procedure is in place	25%	25%	0%	50%	0%	0%	0%	0%	100 %	0%	2,75	4
11	An incident database is maintained to document details for all re-ported incidents, including resolutions and workarounds. We have a shared repository of Incident.	25%	25%	0%	50%	0%	0%	0%	100 %	0%	0%	2,75	3
12	There is a searchable Knowledge Database that contains workarounds, resolutions and known-errors…	25%	50%	0%	25%	0%	0%	0%	100 %	0%	0%	2,25	3
13	Resolved and closed incidents are updated and clearly communicated to the Global Service Desk, customers, and other parties.	25%	50%	25%	0%	0%	0%	0%	100 %	0%	0%	2	3
											Avg	2,42	3,61

Table 13: ITIL process – The Incident Management Process results

		IPB					KubSAU					Avg	
Activities in Place needed for the Success of Incident Management		1	2	3	4	5	1	2	3	4	5	IPB	KubSAU
1	The Service Desk function is defined	25%	0%	75%	0%	0%	0%	0%	0%	100%	0%	2,5	4
2	The Service Desk is aware of their role Incident Management	25%	25%	50%	0%	0%	0%	0%	0%	100%	0%	2,25	4
3	External Suppliers are aware of their role in Incident Management	25%	25%	50%	0%	0%	0%	0%	0%	100%	0%	2,25	4
4	Knowledge Bases are in place to support Incident Resolution at the Service Desk	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
5	Workarounds are document and in the Knowledge Base	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
											Avg	2,3	3,6

Table 14: ITIL process – Activities in Place needed for the Success of Incident Management results

		IPB					KubSAU					Avg	
Incident Management Metrics		1	2	3	4	5	1	2	3	4	5	IPB	KubSAU
1	Incident Management's KPIs and metrics are defined and in place	50%	0%	50%	0%	0%	0%	0%	100%	0%	0%	2	3
2	Incident Management Reports have been identified and put in place	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
3	Metrics have been defined and are in place for Major Incidents	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
											Avg	2,1	3

Table 15: ITIL process – Incident Management Metrics results

		IPB					KubSAU					Avg	
Incident Management Process Interactions		1	2	3	4	5	1	2	3	4	5	IPB	KubSAU
1	Service Asset and Configuration Management is in place and available to support Incident Resolution	25%	0%	75%	0%	0%	0%	0%	0%	100%	0%	2,5	4
2	The relationship between Incident Management and Problem Management is understood	25%	0%	50%	25%	0%	0%	0%	0%	100%	0%	2,75	4
3	A Root Case Procedure is in place as Problem Management as a process does not exist yet	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
4	The Incident Manager/The Incident Process is consulted as part of Change Management	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
5	Incidents related to releases are reported to the Change/Release Manager	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
											avg	2,4	4,4

Table 16: ITIL process – Incident Management Process Interactions results

In the area of The Incident Management Process in IPB most of votes were “Disagree” or “Neutral”, it means that The Incident Management Process has Managed and Defined maturity level. In KubSAU majority of votes were “Neutral” or “Agree”, it means that The Incident Management Process has Defined and Quantitatively managed maturity level.

In the area of Activities in Place needed for the Success of Incident Management IPB has majority of votes “Neutral” and it has Defined maturity level. KubSAU has majority of votes “Agree” and it has Quantitatively managed maturity level.

In the area Incident Management Metrics IPB and KubSAU have majority of votes “Neutral” and we can talk about Defined maturity level.

In the area Incident Management Process Interactions both universities have majority of answers “Neutral”, it means that it is Defined maturity level.

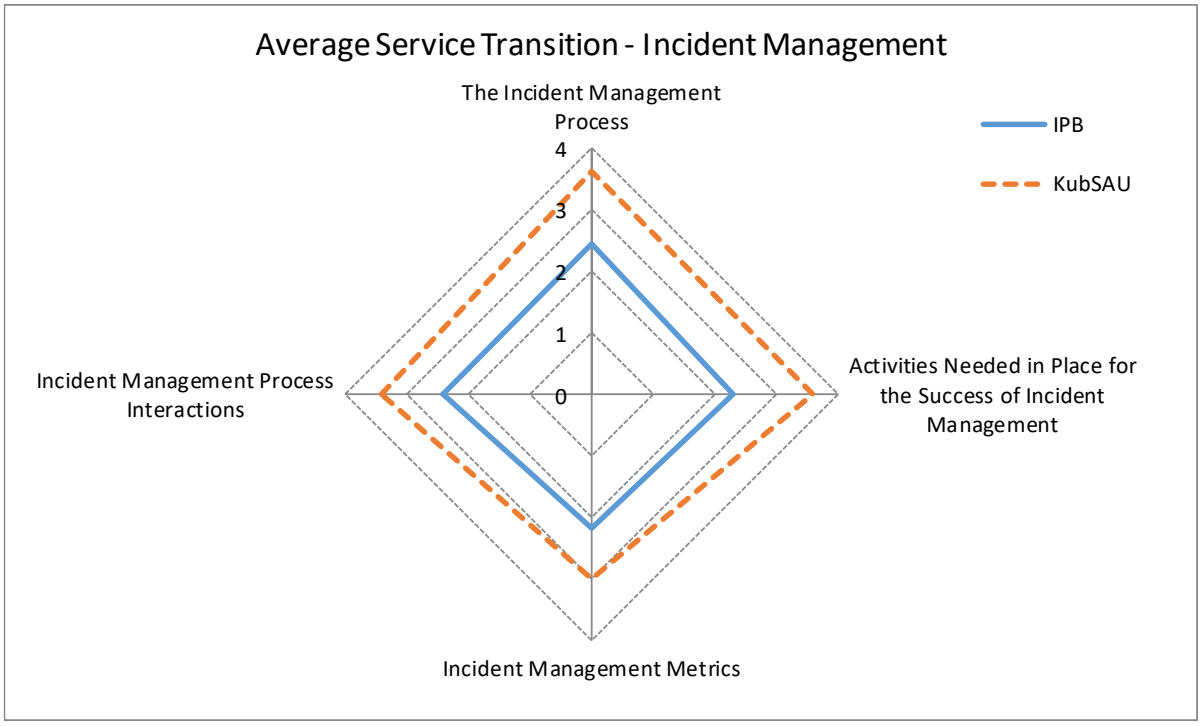

Figure 15: Average of the processes for Service Transition

B. Request Fulfilment Management processes - Service Operation

Next table shows the results from the section “Request Fulfilment Management”. For the question 1, 2, 3 the leadership from both universities has the answers “Agree”, so they have clear roles and responsibilities for the Request Fulfilment Process which have been identified, defined, documented and appointed. The employees are actively working towards replacing manual, repeatable IT tasks with technology solutions that can automate the tasks. The employees understand and have the mind-set that a request fulfilment is about providing timely and effective access to standard services.

		IPB					KubSAU					Avg	
Request Fulfilment Management		1	2	3	4	5	1	2	3	4	5	IPB	KubSAU
1	We have clear roles and responsibilities for the Request Fulfilment Process which have been identified, defined, documented and	25%	25%	0%	50%	0%	0%	0%	0%	100%	0%	2,75	4

	appointed.												
2	The employees are actively working towards replacing manual, repeatable IT tasks with technology solutions that can automate the tasks.	0%	0%	25%	25%	50%	0%	0%	0%	100%	0%	4,25	4
3	The employees understand and have the mind-set that a request fulfilment is about providing timely and effective access to standard services.	0%	0%	50%	50%	0%	0%	0%	0%	100%	0%	3,5	4
4	We have a clearly defined, repeatable Request Fulfilment process for effectively delivering normal service requests from request to delivery. This process helps us satisfy users' requests in an effective and timely manner. We have clearly defined process goals, objectives, policies and procedures for the Request Fulfilment Process.	0%	50%	50%	0%	0%	0%	0%	100%	0%	0%	2,5	3
5	The process helps us to replace manual, repeatable IT tasks and processes with technology solutions that can automatically carry out steps and check for any issues or errors that might have occurred in the process.	25%	0%	50%	25%	0%	0%	0%	100%	0%	0%	2,75	3
6	Service request records are maintained for all reported service requests.	0%	75%	25%	0%	0%	0%	0%	0%	100%	0%	2,25	4
7	The definition of a service request is clearly understood and is applied across the organization. A service request is understood as different from an incident.	0%	50%	50%	0%	0%	0%	0%	0%	100%	0%	2,5	4
8	We have a tool that accommodates the necessary fields for capturing the Request details. E.g., the service, who raised the request, who the request will be assigned to, priority, status, closure details.	25%	25%	25%	25%	0%	0%	0%	0%	100%	0%	2,5	4
9	The tool provides the capability to establish self-help access to predefined lists of services.	25%	25%	25%	25%	0%	0%	0%	100%	0%	0%	2,5	3
10	We have a tool that includes automation/workflow capabilities, so that easily repeatable tasks can be approved and	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3

	implemented without intervention of IT staff.												

Table 17: ITIL process – Request Fulfilment Management results

In the area Request Fulfilment Management IPB has majority of answers "Neutral", it means that it has Defined maturity level. KubSAU has majority of answers "Agree", it means that it has Quantitatively managed maturity level.

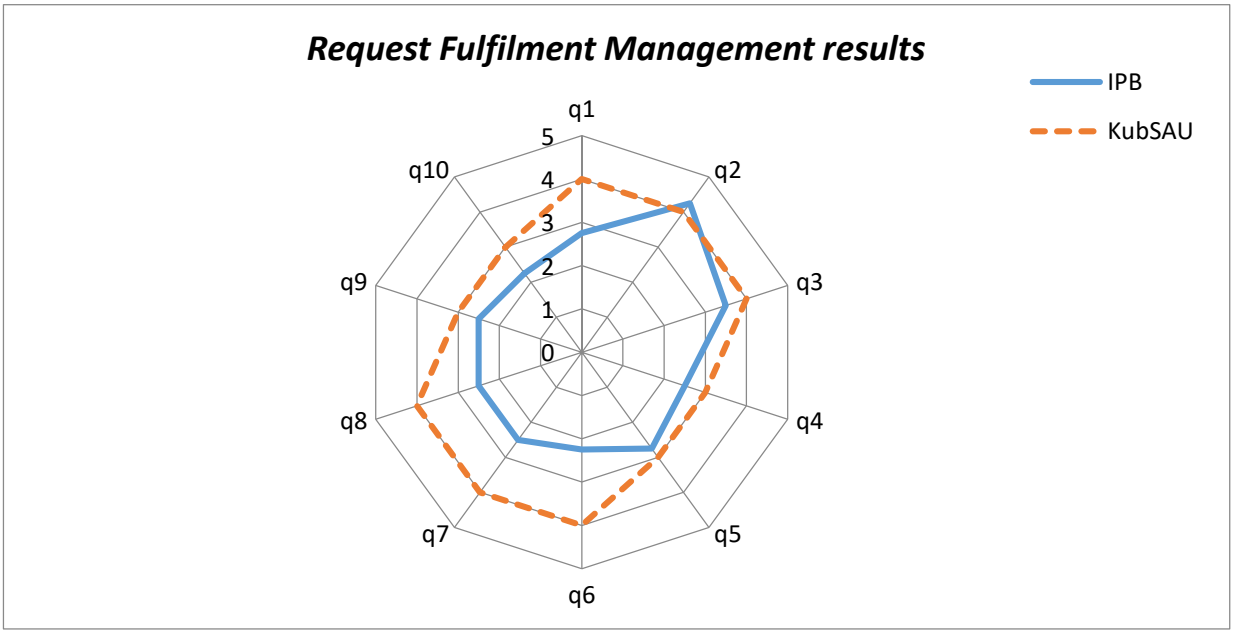

Figure 16: Request Fulfilment Management results

C. Problem Management process - Service Operation

Next table shows the results from the section "Problem Management". Leadership of IPB and KubSAU has a mechanism for tracking problem resolution. Both universities can't agree or disagree with the statement that they have a clearly defined, repeatable Problem Management process to prevent incidents from happening and to minimize the impact of incidents that cannot be prevented, clearly defined process goals, objectives, policies, and procedures for the Problem Management Process; the tool allows the linking of Incidents to Problem records.

		IPB					KubSAU					Avg	
Problem Management		1	2	3	4	5	1	2	3	4	5	IPB	KubSAU
1	We have a role that is responsible for analyzing incident records, incident trends, and for reviewing the problem records.	25%	25%	25%	25%	0%	0%	0%	100%	0%	0%	2,5	3
2	We have clear roles and responsibilities for the Problem Management Process which have been identified, defined, documented, and appointed.	25%	25%	25%	25%	0%	0%	0%	0%	100%	0%	2,5	4
3	There is management commitment to support staff allocation in sufficient time for problem solving activities.	25%	25%	50%	0%	0%	0%	0%	0%	100%	0%	2,25	4
4	We have a clearly defined, repeatable Problem Management	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3

	process to prevent incidents from happening and to minimize the impact of incidents that cannot be prevented.												
5	The definition of a problem is clearly understood and is applied across the organization.	0%	25%	75%	0%	0%	0%	0%	0%	100%	0%	2,75	4
6	There is a procedure by which potential problems are classified in terms of category, urgency, priority and impact and assigned for investigation	25%	25%	50%	0%	0%	0%	0%	0%	100%	0%	2,25	4
7	We have a mechanism for tracking problem resolution.	25%	25%	25%	25%	0%	0%	0%	0%	100%	0%	2,5	4
8	A measurement framework has been established for Problem Management that identifies, measures and reports on metrics aligned to KPIs.	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
9	There is a tool supporting problem management reporting. We have a shared repository.	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
10	There is a problem database maintained to record details for all reported problems.	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
11	The tool allows the linking of Incidents to Problem records.	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3

Table 18: ITIL process – Problem Management results

In the area Problem Management IPB has mostly “Disagree”, some of them are “Neutral” answers, there is Managed maturity level. KubSAU has majority of answers “Neutral” and some answers “Agree”, it means that there is Defined maturity level.

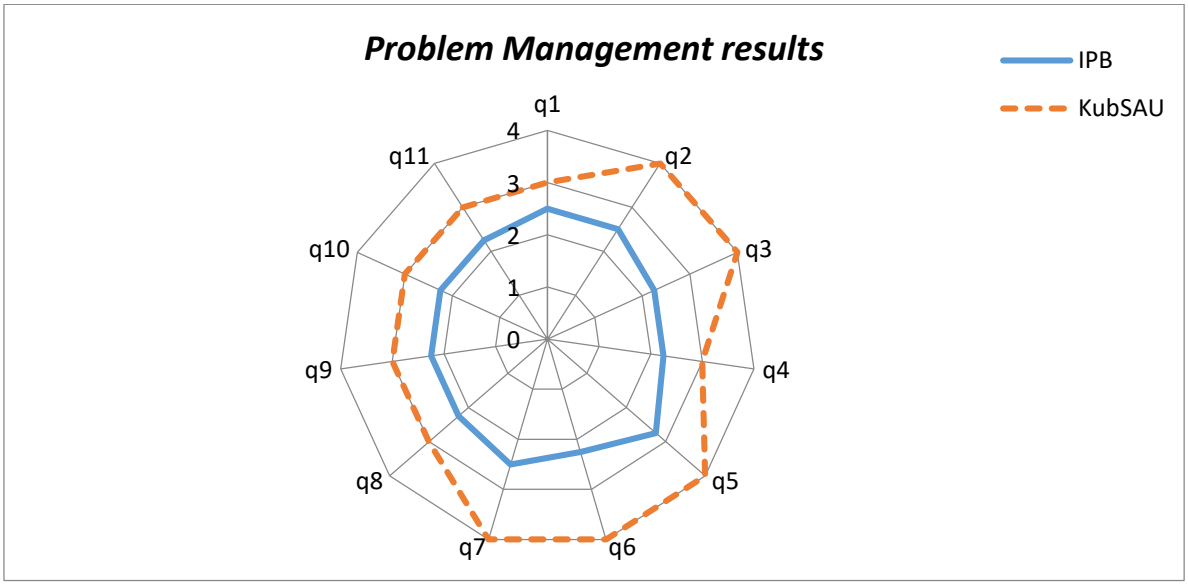

Figure 17: Problem Management results

D. Change Management process – Service Transaction

Next table shows the results from the section "Change Management". Answers from IPB and KubSAU are very similar and most of them are "Neutral", especially for KubSAU almost all of them are "Neutral". For the 1st question leadership of IPB can't to agree, answers are more close to "Disagree". In KubSAU leadership has the answer "Agree" and it means that the purpose, goal and objective for the Change Management process is defined.

		IPB					KubSAU					Avg	
Change Management		1	2	3	4	5	1	2	3	4	5	IPB	KubSAU
1	The purpose, goal and objective for the Change Management process is defined	25%	25%	50%	0%	0%	0%	0%	0%	100%	0%	2,25	4
2	The scope for change management is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
3	The policies, principles and basic concepts for change management are defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
4	We have defined the types of change requests	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,5	3
5	We have defined standard (pre-authorized) changes	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
6	Remediation planning for changes is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
7	Planning and controlling changes is an integrated activity of change management	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
8	Change and release scheduling is an integrated activity of change management	25%	50%	25%	0%	0%	0%	0%	100%	0%	0%	2	3
9	Ensuring there are remediation plans is an integrated activity of change management	25%	50%	25%	0%	0%	0%	0%	100%	0%	0%	2	3
10	Measurement and control of changes is an integrated activity of change management	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
11	Management reporting is an integrated activity of change management	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
12	Understanding the impact of change is an integrated activity of change management	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
13	Continual improvement is an integrated activity of change management	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
14	Raising and recording changes is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
15	Assessing and evaluating the Change is defined	0%	50%	25%	25%	0%	0%	0%	100%	0%	0%	2,75	3
16	Authorization of all types of Changes is defined	0%	50%	25%	25%	0%	0%	0%	100%	0%	0%	2,75	3
17	Coordinating change implementation is defined	0%	50%	50%	0%	0%	0%	0%	100%	0%	0%	2,5	3
18	Reviewing and closing change records is defined	0%	50%	50%	0%	0%	0%	0%	100%	0%	0%	2,5	3
19	Change process models and workflows are defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3

20	The Change advisory board is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
21	Emergency changes are defined	25%	50%	25%	0%	0%	0%	0%	100%	0%	0%	2	3
22	Triggers, Input and output and inter-process interfaces are defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
23	Key performance indicators and metrics are defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3

Table 19: ITIL process – Change Management results

In the area Change Management both organizations IPB has mostly “Neutral” or “Disagree” answers, and the maturity level can not be recognized exactly, it is between “Managed” and “Defined”. KubSAU has majority of answers “Neutral”, it means that they have Defined maturity level.

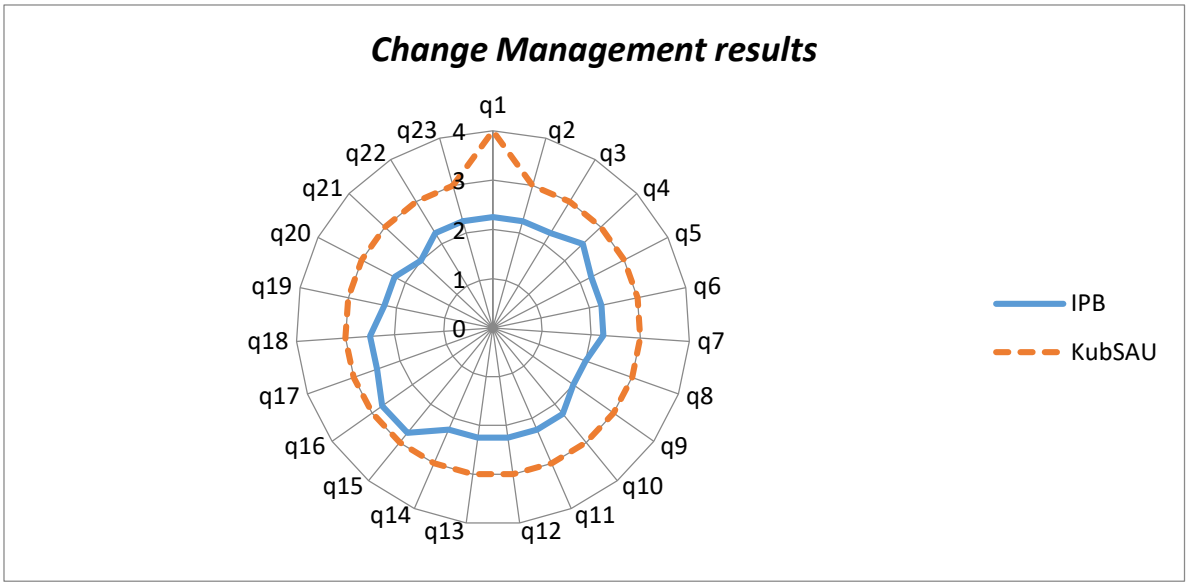

Figure 18: Change Management results

E. Service Asset and Configuration Management processes – Service Transaction

Next table shows the results from the section “Service Asset and Configuration Management”. IPB and KubSAU have majority of answers “Neutral”. In IPB no one “Agree” or “Strongly Agree”. It means that leadership of IPB disagree or can not agree/disagree with the questions. In KubSAU no one answer “Strongly Disagree”, “Disagree” or “Strongly Agree”. It means that leadership of KubSAU can not agree/disagree with the majority of questions, but agree with the statements: “The purpose, goal and objective for the Service Asset and Configuration Management process is defined”; “Verification and audit is defined”.

		IPB					KubSAU					Avg	
Service Asset and Configuration Management		1	2	3	4	5	1	2	3	4	5	IPB	KubSAU
1	The purpose, goal and objective for the Service Asset and Configuration Management process is defined	25%	25%	50%	0%	0%	0%	0%	0%	100%	0%	2,25	4
2	The scope for SACM is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
3	The policies, principles and basic concepts for SACM are defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3

4	The Configuration Management System is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
5	Asset and Configuration Management activities are defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
6	Management and planning for SACM is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
7	Configuration identification is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
8	Configuration control is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
9	Status reporting is defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
10	Verification and audit is defined	25%	25%	50%	0%	0%	0%	0%	0%	100%	0%	2,25	4
11	Triggers, Input and output and inter-process interfaces are defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
12	Key performance indicators and metrics are defined	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
13	The purpose and benefits of configuration management has been disseminated with the organization	25%	25%	50%	0%	0%	0%	0%	100%	0%	0%	2,25	3
14	The organization uses some tools to support the configuration management process	25%	0%	75%	0%	0%	0%	0%	100%	0%	0%	2,5	3
15	Do you check with the customers (students, teachers, etc.) that they are happy with the services provided?	0%	25%	75%	0%	0%	0%	0%	100%	0%	0%	2,75	3
16	Are you actively monitoring trends in customer (students, teachers, etc.) satisfaction?	0%	50%	50%	0%	0%	0%	0%	100%	0%	0%	2,5	3

Table 20: ITIL process – Service Asset and Configuration Management results

In the area Service Asset and Configuration Management both organizations IPB has mostly "Neutral" or "Disagree" answers, and the maturity level can not be recognized exactly, it is between "Managed" and "Defined". KubSAU has majority of answers "Neutral", it means that they have Defined maturity level.

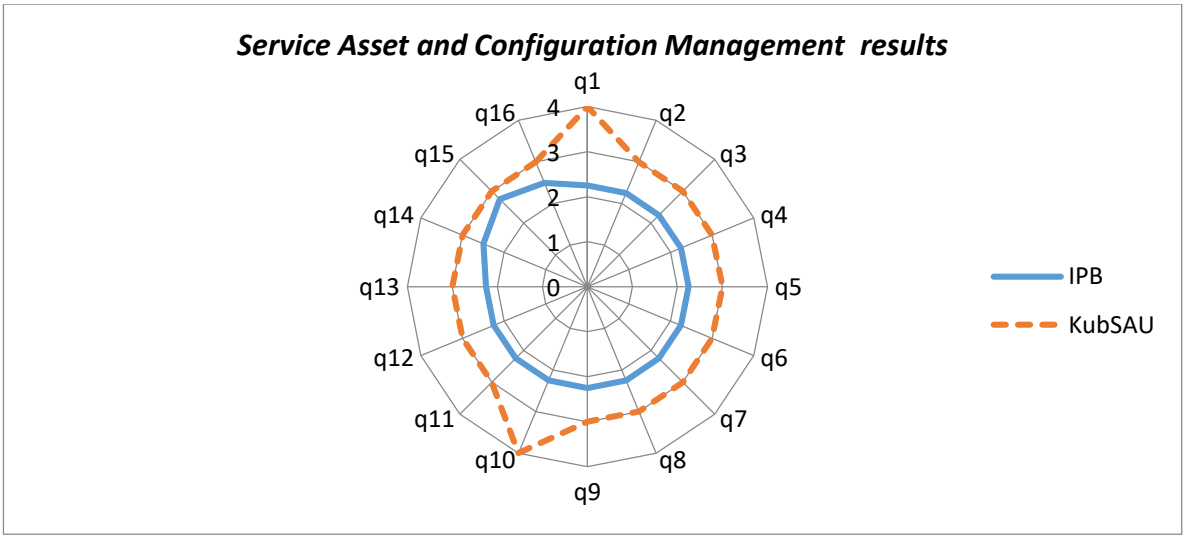

Figure 19: Service Asset and Configuration Management

The final chart Assessment results shows the relationship between all five services, for which the study was conducted: Incident Management, Request Fulfilment Management, Problem Management, Change Management, Service Asset and Configuration Management. Looking at the diagram, it can be seen that the level of maturity of the IPB in the Incident Management is between the second and third levels (Managed and Defined). In the Request Fulfilment Management the level of maturity tends to the third (Defined). In the Problem Management, Change Management, Service Asset and Configuration Management the level of maturity is closer to the second level (Managed). The level of maturity of the KubSAU in the Incident Management is between the third and fourth (Defined and Quantitatively managed) , in the Request Fulfilment Management and Problem Management it tends closer to the fourth level (Quantitatively managed). In the Change Management and Service Asset and Configuration Management the maturity level is clearly at the third level (Defined).

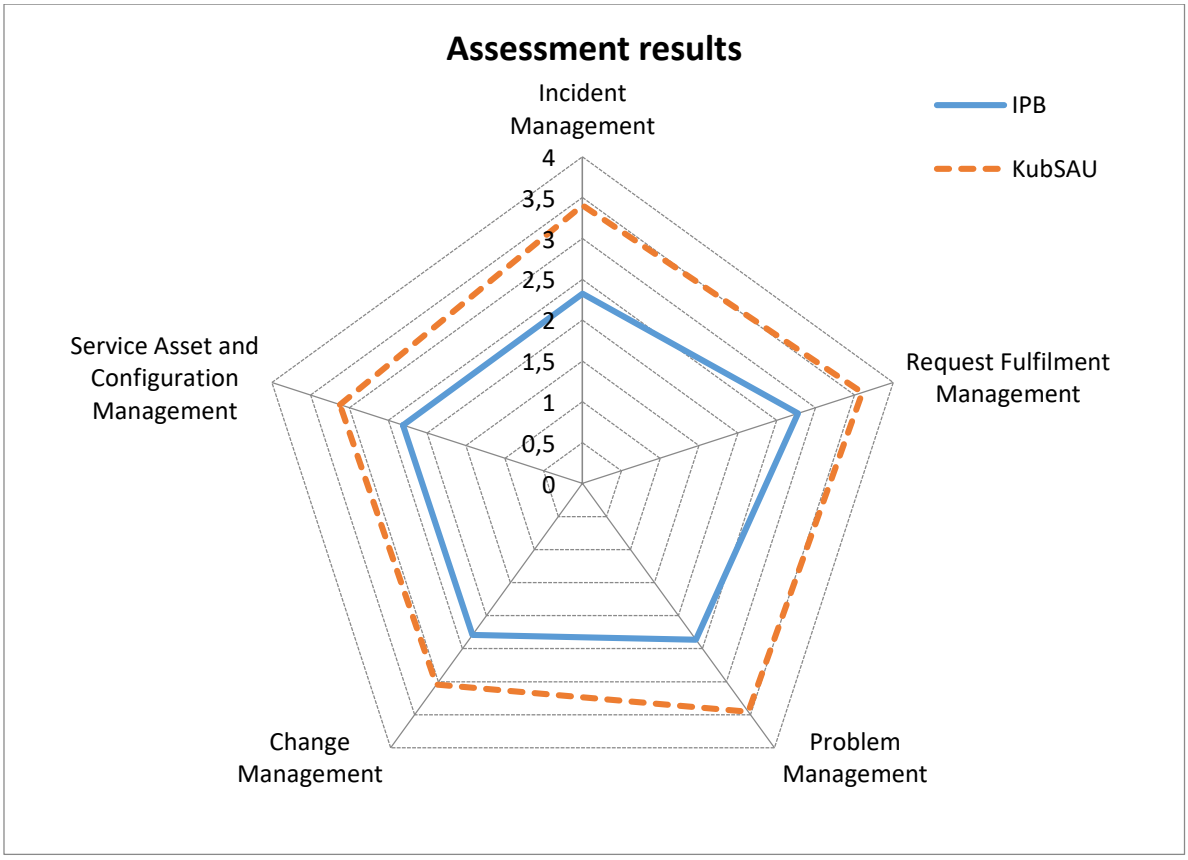

Figure 20: Assessment results

Summarizing the foregoing, it can be concluded that, based on management responses, both higher education institutions have defined level of maturity, which suggests the process is defined/confirmed as a standard business process. It is characteristic of processes at this level that there are sets of defined and documented standard processes established and subject to some degree of improvement over time. These standard processes are in place (i.e., they are the AS-IS processes) and used to establish consistency of process performance across the organization.

3.3.2.2 Teaching staff

Also was asked the teaching staff. There is the Table 21, where we can see the answers of the teaching staff of IPB and KubSAU:

1. Is there access to the Internet in the academic buildings?	IPB	KubSAU
Yes	100%	100%
No	0%	0%
2. Are you satisfied with the speed of cable Internet in educational buildings?	IPB	KubSAU
Yes	100%	43,75%
No	0%	43,75%
Not sure	0%	12,50%
3. Do the academic buildings have Wi-Fi?	IPB	KubSAU
Yes	100%	81,25%
No	0%	12,50%
Don't know	0%	6,25%
4. Are you satisfied with the speed of Wi-Fi in educational buildings (if there is)?	IPB	KubSAU
Yes	100%	18,75%
No	0%	56,25%
Not sure	0%	25%
5. Is there a university website?	IPB	KubSAU
Yes	100%	100%
No	0%	0%
6. Is there a university's student portal?	IPB	KubSAU
Yes	100%	75%
No	0%	18,50%
Refrained from responding	0%	6,25%
7. Is there access to the teacher's schedule on the university's website or on the university's virtual portal?	IPB	KubSAU
Yes	100%	100%
No	0%	0%
8. Is there a personal account of the teachers on the university's website or on the university's virtual portal?	IPB	KubSAU
Yes	100%	12,50%
No	0%	75%
Other	0%	12,50%
9. Are you satisfied with the state of the university's website or the university's virtual portal?	IPB	KubSAU
Yes	40%	75%
No	33,33%	25%
Not sure	26,67%	0%
10. Is there a specialized software?	IPB	KubSAU
Yes	66,66%	87,50%
No	0%	0%
Don't know	33,33%	12,50%
11. Are you satisfied with the package of application systems covering the business architecture of the university?	IPB	KubSAU
Yes	73,33%	18,75%
No	0%	25%
Not sure	26,67%	56,25%
12. Is there network equipment?	IPB	KubSAU
Yes	100%	100%
No	0%	0%
13. Are you satisfied with the state of the network equipment?	IPB	KubSAU
Yes	73,33%	18,75%
No	0%	25%
Not sure	26,67%	56,25%
14. Is the server protected against unauthorized access to it?	IPB	KubSAU
Yes	73,33%	75%
No	0%	18,75%
Don't know	26,67%	6,25%

15. Is the software updated?	IPB	KubSAU
Yes	73,33%	25%
No	0%	6,25%
Partly	0%	56,25%
Not sure	26,67%	12,50%
16. Are there licensed products purchased by the university?	IPB	KubSAU
Yes	33,33%	87,50%
No	0%	6,25%
Not sure	66,66%	0%
Refrained from responding	0%	6,25%
17. Are you satisfied with the work of purchased licensed products (if there are)?	IPB	KubSAU
Yes	33,33%	75%
No	0%	6,25%
Not sure	66,66%	12,50%
Refrained from responding	0%	6,25%
18. Are you satisfied with the state of computer equipment?	IPB	KubSAU
Yes	100%	18,75%
No	0%	50%
Not sure	0%	31,25%
19. Is the equipment updated in classrooms?	IPB	KubSAU
Yes	100%	18,75%
No	0%	31,25%
Not sure	0%	50%
20. Is the equipment updated in the offices of the teaching staff?	IPB	KubSAU
Yes	0%	56,25%
No	100%	43,75%
21. Is there enough personal computers to train students?	IPB	KubSAU
Yes	100%	31,25%
No	0%	68,75%
22. Are there enough classrooms for training?	IPB	KubSAU
Yes	100%	68,75%
No	0%	31,25%
23. Are there enough projectors and screens for the projector?	IPB	KubSAU
Yes	100%	37,50%
No	0%	62,50%
24. Is the number of hours of training sufficient?	IPB	KubSAU
Yes	100%	75%
No	0%	18,75%
Refrained from responding	0%	6,25%
25. Is there an electronic library?	IPB	KubSAU
Yes	100%	87,50%
No	0%	12,50%
26. Is copyright protection provided for benefits in the electronic library?	IPB	KubSAU
Yes	0%	37,50%
No	0%	6,25%
Not sure	100%	50%
Refrained from responding	0%	6,25%
27. Does the university have scientific journals in which students and teachers can publish their works?	IPB	KubSAU
Yes	0%	100%
No	100%	0%

Table 21: Questionnaire of the teaching staff - Results

Analyzing the table, we can see that both higher education institutions IPB and KubSAU have access to the Internet, in IPB teachers more satisfied with the speed of the Internet. Both organizations have the official website and the university's student portal with the access to the teacher's schedule. Major amount of teachers are satisfied with the state of the university's website or the university's virtual portal. IPB and KubSAU have a specialized software and network

equipment. In IPB teachers are more satisfied than in KubSAU with the state of the software, network equipment and computer equipment. The teachers in IPB and in KubSAU suppose that there enough number of hours of training. There is an electronic library in both universities and KubSAU have also the scientific journals in which students and teachers can publish their works.

3.3.2.3 Students

Students of IPB and KubSAU were also interviewed. There is a table with their results:

1. Is there access to the Internet in the academic buildings?	IBP	KubSAU
Yes	100%	98,25%
No	0%	1,75%
2. Are you satisfied with the speed of cable Internet in educational buildings?	IBP	KubSAU
Yes	100%	68,42%
No	0%	10,53%
Not sure	0%	21,05%
3. Do the academic buildings have Wi-Fi?	IBP	KubSAU
Yes	100%	84,21%
No	0%	12,28%
Refrained from responding	0%	3,50%
4. Are you satisfied with the speed of Wi-Fi in educational buildings (if there is)?	IBP	KubSAU
Yes	61,23%	28,07%
No	14,29%	36,84%
Not sure	24,49%	29,82%
5. Is there a university's website?	IBP	KubSAU
Yes	100%	100%
No	0%	0%
6. Is there a university's student portal?	IBP	KubSAU
Yes	100%	61,40%
No	0%	38,60%
7. Is there a student account on the university's website or on the university's student portal?	IBP	KubSAU
Yes	100%	26,31%
No	0%	71,92%
Refrained from responding	0%	1,75%
8. Can a student follow his progress on the university's website or on the university's virtual portal?	IBP	KubSAU
Yes	100%	36,84%
No	0%	61,40%
Refrained from responding	0%	1,75%
9. Is there access to the student's schedule on the university's website or on the university's virtual portal?	IBP	KubSAU
Yes	100%	98,24%
No	0%	0%
Refrained from responding	0%	1,75%
10. Are you satisfied with the state of the university's website or the university's virtual portal?	IBP	KubSAU

Yes	32,65%	87,71%
No	42,86%	1,75%
Not sure	24,49%	10,52%
11. Is there a student identification number?	IBP	KubSAU
Yes	100%	31,57%
No	0%	66,67%
Refrained from responding	0%	1,75%
12. Does each student have a mailbox in the university's database?	IBP	KubSAU
Yes	100%	12,28%
No	0%	85,96%
Refrained from responding	0%	1,75%
13. Are you satisfied with the state of computer equipment?	IBP	KubSAU
Yes	71,43%	52,63%
No	0%	15,79%
Not sure	28,57%	31,58%
14. Are you satisfied with the package of applied systems involved in the learning process?	IBP	KubSAU
Yes	32,65%	49,12%
No	14,29%	26,31%
Not sure	53,06%	24,56%
15. Is the software updated?	IBP	KubSAU
Yes	32,65%	47,37%
No	0%	10,53%
Not sure	67,35%	42,11%
16. Is there an electronic library?	IBP	KubSAU
Yes	100%	98,25%
No	0%	1,75%
17. Does the university have scientific journals in which students and teachers can publish their works?	IBP	KubSAU
Yes	0%	85,96%
No	100%	10,53%
Refrained from responding	0%	3,50%

Table 22: Questionnaire of the students - Results

Based on the results of the questionnaire, we can see, that IPB and KubSAU have the access to the Internet and most student are satisfied with it's speed. Both universities have official website and the university's virtual portal. In IPB students have the access to the student's account on the university's website or on the university's student portal, in KubSAU most students consider that they haven't the account. In IPB all the students can follow their progress on the university's website or on the university's virtual portal, in KubSAU not all the students suppose that they can do it. Students in both universities can see the schedule of their classes on the university's website or on the university's virtual portal. Most students are satisfied with the computer equipment and with the package of applied systems involved in the learning process. Both universities have the electronic library.

Summarizing the above, we can conclude that both the IPB and KubSAU are the universities with a high level of maturity. Based on the study, we see that both universities have the Defined

maturity level and they are trying to achieve the next level of maturity. Students are trained in well-organized conditions and receive a high quality education.

4. Conclusions and Future works

The problem Maturity assessment of IPB and KubSAU is solved. The goals and objectives are achieved in the thesis. Definition of Maturity, Maturity Models and main characteristics of Maturity Models is reviewed. One of the domain architectures of the enterprise is considered namely business architecture. This domain describes the activities of the organization in terms of its key business processes. Diagrams of business processes of IBP and KubSAU are constructed and analyzed. Portfolio of applications that covered the business architecture of IPB and KubSAU is considered.

There is developed the questionnaire for the leadership, teaching staff and for the students and they are interviewed. Based on the results of the questionnaire charts are built. Most of the responses of the leadership of the information centers of the IPB and KubSAU are assigned to a Defined level of maturity. It means that the process is defined/confirmed as a standard business process. It is characteristic of processes at this level that there are sets of defined and documented standard processes established and subject to some degree of improvement over time. These standard processes are in place (i.e., they are the AS-IS processes) and used to establish consistency of process performance across the organization. The main conclusion is that both higher education institutions have approximately the same high level of maturity and they are able to train and graduate specialists in different fields in accordance with all standards and requirements in the field of education.

The received results can be used by the people working in the field which was studied. Some aspects in the work of universities can be improved due to the conducted research.

The direction of further research will concern the remaining domains of the enterprise architecture:

- Information architecture (data). Defines what data is needed to support business processes (for example, a data model), and to ensure stability and the ability to use this data in applications for a long time.
- Application architecture. Determines which applications are used and should be used to manage data and support business functions (for example, application models).
- Technological architecture (infrastructure or system architecture). Determines which supporting technologies (hardware and system software, networks and communications) are needed to create an application environment that, in turn, manages data and provides business functions. This environment should ensure the operation of application systems at a given level of service delivery to their users.

The current activity of IT services is usually organized and managed as a process system. Those that are aimed at managing the quality of IT services are called IT Service Management (ITSM) processes. Together, IT management processes-whether related to service management or unrelated-provide an effective application of information technology to meet the needs of customers. "Effectiveness" in this case implies the following:

- Information technologies form value for customers (they benefit, increasing the productivity of business processes and / or reducing the restrictions on these processes).
- The costs of information technology are rational and controlled.
- Risks associated with the use of information technology are controlled and reduced to an acceptable level.

A process usually refers to a set of activities that have a common purpose and are jointly aimed at achieving certain goals.

These activities are combined and sent using a management system that implies:

- certain goals and objectives;
- fixing responsibility for a certain person for the functioning of the process;
- documented policies, plans and procedures to ensure repeatability of the process;
- clearly distributed roles and responsibilities;
- systemic activities to improve the efficiency of the process.

In cases where the listed process controls are implemented in practice, they speak of a "mature process". It is believed that the higher the level of maturity of the process, the more stable its work, and, consequently, the higher the probability of achieving the purpose and achieving the goals - at an agreed level of costs and risks. Processes are assessed in order to get an idea of either the potential of the processes (what they can) or the actual achievements (what they could).

The evaluation of the potential and effectiveness answers the questions "What can the process do?" And "What the process did?" Evaluation of maturity and rationality - on the questions "How are processes managed?" And "How did they work?" And as a result - to plan and implement an effective IT management system.

5. References

[1] D. Proença, "Methods and techniques for maturity assessment," in *Information Systems and Technologies (CISTI), 2016 11th Iberian Conference on*, Las Palmas, Spain, 2016.

[2] F. Manager, "http://www.fox-manager.com.ua/urovni-zrelosti-organizacii.html," [Online]. Available: http://www.fox-manager.com.ua. [Accessed 17 May 2017].

[3] J. R. P. D. G. I. Egan, "https://link.springer.com/chapter/10.1007%2F978-94-017-0161-7_1," [Online]. Available: https://link.springer.com. [Accessed 15 May 2017].

[4] D. Proença and J. Borbinha, "http://www.sciencedirect.com/science/article/pii/S1877050916324486," 09 2016. [Online]. Available: http://www.sciencedirect.com. [Accessed 15 May 2017].

[5] N. T. A. S. a. F. H. Mohammad H. Yarmohammadian, "https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4113986/," 23 June 2014. [Online]. Available: https://www.ncbi.nlm.nih.gov. [Accessed 15 May 2017].

[6] "http://dictionary.cambridge.org/dictionary/english/maturity," [Online].

[7] I. C. Vicente Aceituno, A. S. Edward Stansfeld, D. Krishna Kumar, S. Gustavo Lozano and S. osé Pedro Arroyo, ISM3 - Information Security Management Maturity Model, 28923 Alcorcón (Madrid) Spain: CREATIVE COM MONS ATTRIB- NOD ERIVS 3.0 LIC ENSE, 2007.

[8] "http://en.wikipedia.org/wiki/ CapabilityMaturityModel.," [Online]. Available: http://en.wikipedia.org. [Accessed 3 March 2017].

[9] "http://en.wikipedia.org/wiki/MaturityModel.," [Online]. Available: http://en.wikipedia.org. [Accessed 3 March 2017].

[10] "MSEE - Manufacturing SErvices Ecosystem," 2012.

[11] M. MSF Team, "Microsoft Solutions Framework," *White Paper,* 2002.

[12] d. B. M. e. a. I. e. a. Becker, "Maturity models in business process management," *Business Process Management Journal,* 2009.

[13] "https://en.wikipedia.org/wiki/Capability_Maturity_Model.," [Online]. Available: https://en.wikipedia.org. [Accessed 3 March 2017].

[14] "https://en.wikipedia.org/wiki/ITIL.," [Online]. Available: https://en.wikipedia.org. [Accessed 11 March 2017].

[15] AXELOS, ITIL Service Design., The Stationery Office, London, 2011.

[16] "http://www.itinfo.am/eng/information-technology-infrastructure-library-guide/," [Online]. Available: http://www.itinfo.am. [Accessed 11 March 2017].

[17] AXELOS, ITIL Service Operation., The Stationery Office, London, 2011.

[18] AXELOS, ITIL Continual Service Improvement, The Stationery Office, London., 2011.

[19] AXELOS, ITIL Service Strategy., The Stationery Office, London, 2011.

[20] AXELOS, ITIL Service Transition, The Stationery Office, London, 2011.

[21] C. a. f. w. o. b. a. WordPress.com., "Afurrukh's Blog," 2009.

[22] C. M. University, CMMI® for Development, Version 1.2, Pittsburgh: PA 15213-3890, 2006.

[23] C. University, "http://dictionary.cambridge.org/dictionary/english/maturity," [Online]. Available: http://dictionary.cambridge.org. [Accessed 05 04 2017].

[24] C. M. University, CMMI for Services, Version 1.3, CMU/SEI-2010-TR-034, 2010.

[25] "https://en.wikipedia.org/wiki/Capability_Maturity_Model_Integration.," [Online]. Available: https://en.wikipedia.org. [Accessed 12 March 2017].

[26] C. M. University, Capability Maturity Model®Integration (CMMI®) Version, 2007.

[27] R. K. (MD), "CMMI Consultant Blog," 2017.

[28] "https://en.wikipedia.org/wiki/COBIT.," [Online]. Available: https://en.wikipedia.org. [Accessed 14 March 2017].

[29] U. o. V. Letzte Änderung, A SOA Maturity Model for the Financial Services Industry, Vienna, 2009.

[30] "https://www.quora.com/How-can-COBIT-benefit-an-organisation.," [Online]. Available: https://www.quora.com. [Accessed 1 April 2017].

[31] "http://itsm-in-ua.blogspot.pt/2014/07/isoiec-15-504-isoiec-33-000.html," 07 2014. [Online]. Available: http://itsm-in-ua.blogspot.pt. [Accessed 03 April 2017].

[32] "https://en.wikipedia.org/wiki/ ISO/IEC_15504.," [Online]. Available: https://en.wikipedia.org. [Accessed 27 March 2017].

[33] GmbH, GmbH IT Maturity Services, Wibas, 2003.

[34] "http://www.brighthubpm.com/monitoring-projects/72298-differences-in-cmmi-vs-itil/," [Online]. Available: http://www.brighthubpm.com. [Accessed 30 March 2017].

[35] I. R. H. David A. Richards, Complex Interventions in Health: An Overview of Research Methods, New York: Oxon OX14 4RN, 2015.

6. Annexes

6.1 Description of Polytechnic Institute of Bragança (IPBI) IT processes

6.1.1 Detailed description of the main IT centers

6.1.1.1 Communications and Systems Management Center

The main objective is to provide communications services to the Central Services and to all the schools of the IPB. Main functions:

- Provide all the communications services in IPB
- Define, manage, operate and develop the common communications infrastructure
- Organize and maintain the data center equipment and spaces.
- Manage infrastructure of servers and services installed in the datacenter.
- Manage the logical and physical infrastructure of the data network.
- Perform the maintenance and configuration of servers and network equipment.
- Manage IPB networks and systems
- Propose procedures that aim at the physical security of equipment and data.
- Propose the acquisition of equipment for the modernization and expansion of the infrastructure.
- Propose and implement projects to expand and modernize the physical and logical infrastructure of the network.
- Register and execute activities related to the operation of equipment and lines of data communication.
- Monitor and evaluate the execution of equipment maintenance, performed by external companies.

6.1.1.2 The communication infrastructure of the IPB includes:

- Computer communications transmission and routing networks that interconnect the different organizational units with each other and with the Datacenter;
- IPB wireless network (eduroam);
- Ipb.pt DNS and corresponding public IP address;
- IPB network connection ports to the outside;
- Email, www, VoiP, etc. services

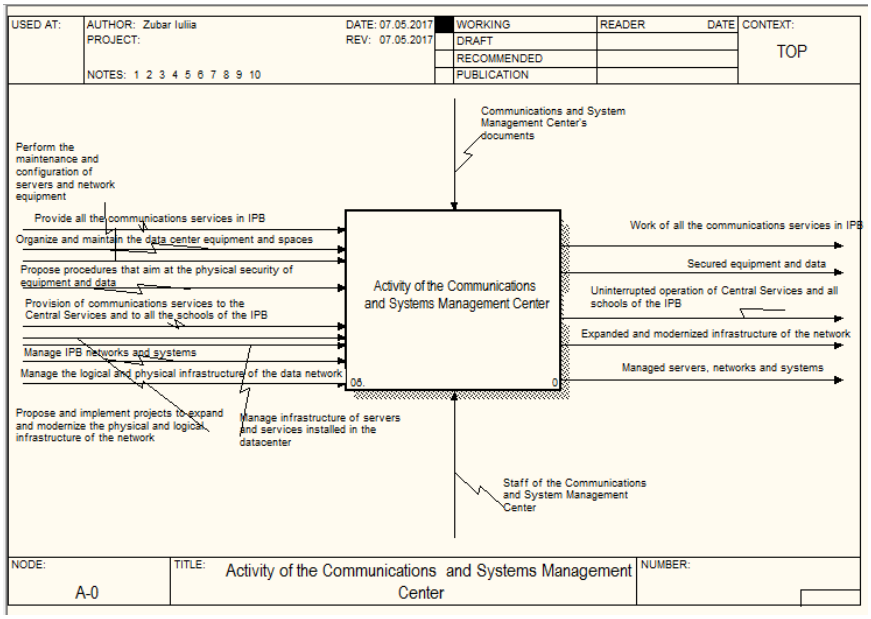

Figure 21: Activity of the Communications and System Management Center

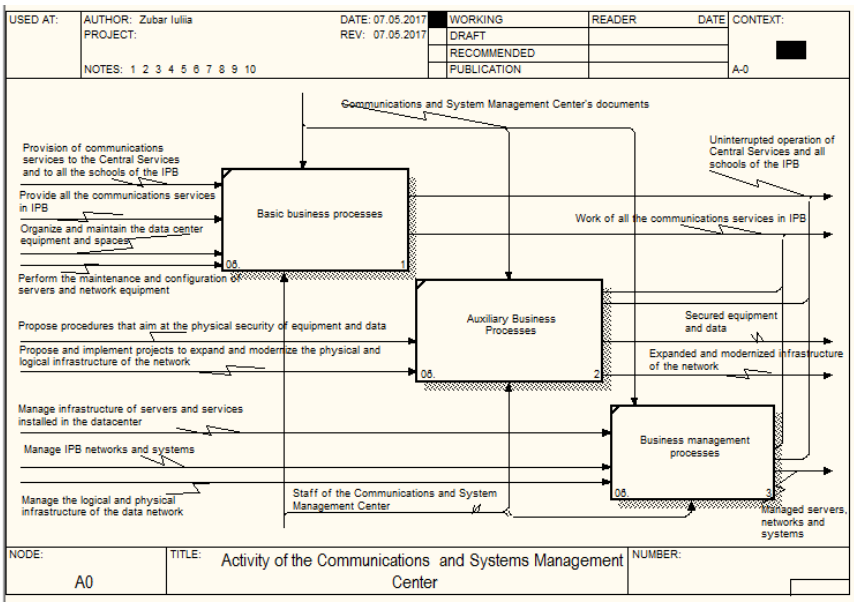

Figure 22: Business processes of the Communications and System Management Center

6.1.1.3 Development and Data Management Center

The main objective is the application development. Main functions:

- Develop, adapt and maintain the information systems requested by the Institution.
- Identify, define and validate processes and information flows in the IPB.
- Perform systems analysis and software requirements engineering.
- Plan, coordinate and execute the activities pertaining to the analysis, programming, documentation and implementation of systems.
- Implement and maintain applications for the Academic Services.
- Evaluate information systems provided by external companies and verify the convenience of their installation in the IPB.

- Configure and maintain the availability of databases.
- Control the access of programmers and users to databases.
- Define and perform the database backup policy.
- Define and implement information security policies.
- Design and develop software development projects.
- Promote the adaptation of the information systems implemented to the needs of the IPB.
- Define and adopt software development standards, methodologies and processes.

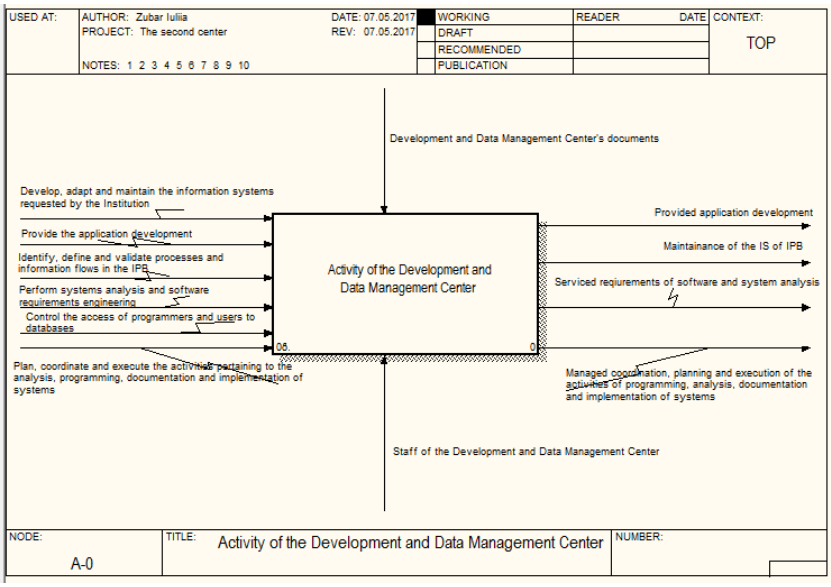

Figure 23: Activity of the Development and Data Management Center

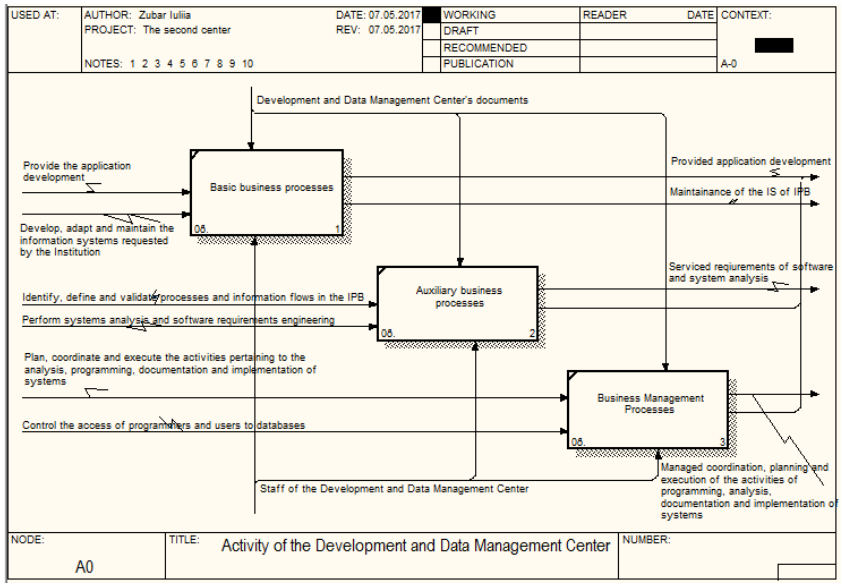

Figure 24: Business Processes of the Development and Data Management Center

6.1.1.4 Innovation and Web Projects Center

The main objective is the development and maintenance of web portals/sites and management of the e-learning platform. Main functions:

- Coordinate organizational innovation actions at the level of the IPB information system.
- Develop short and medium-term work plans for the implementation of innovative systems.
- Design and implement mechanisms to support distance learning.
- Promote the development of e-services.
- Manage the IPB Web Portal.
- Ensure the updating and operation of the IPB Portal.
- Develop the IPB Intranet.
- Create illustrations, graphics and animations to compose and enhance the content of web pages.
- Design Web page standards and develop and maintain interfaces for efficient and intuitive interaction.
- Provide services to the community, within its area of action, through agreements or contracts.
- Study and propose digital models to the official documents.

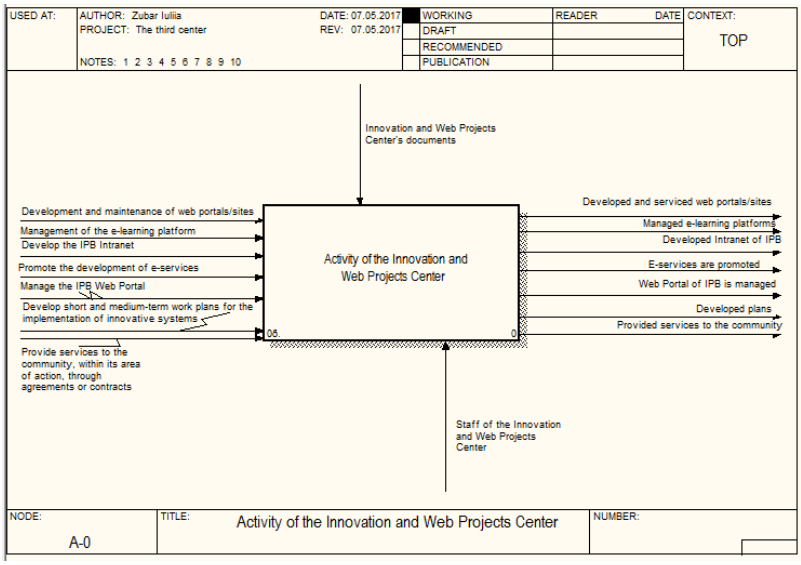

Figure 25: Activity of the Innovation and Web Projects Center

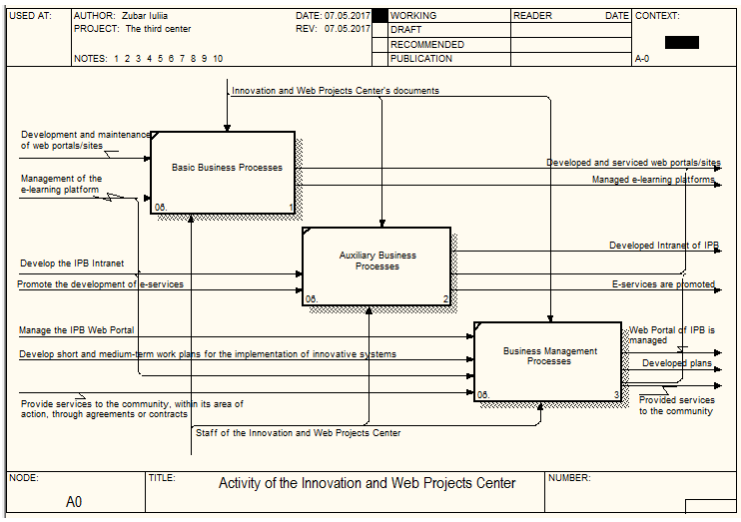

Figure 26: Business Processes of the Innovation and Web Projects Center

6.1.1.5 Informatics Resource Center

- Cabled and wireless network access configuration
- Password change for the IPB-ESTIG domain
- Installation of authorized software
- Solve problems on classrooms, Library, Secretariats)
- Printing Services – quotas/credits management and drivers installation
- Reservation and access to PCs from classrooms
- Virtual Machines deployment and configuration
- Configuration of access trough VPNs
- Format and configuration of PCs (school PCs only)

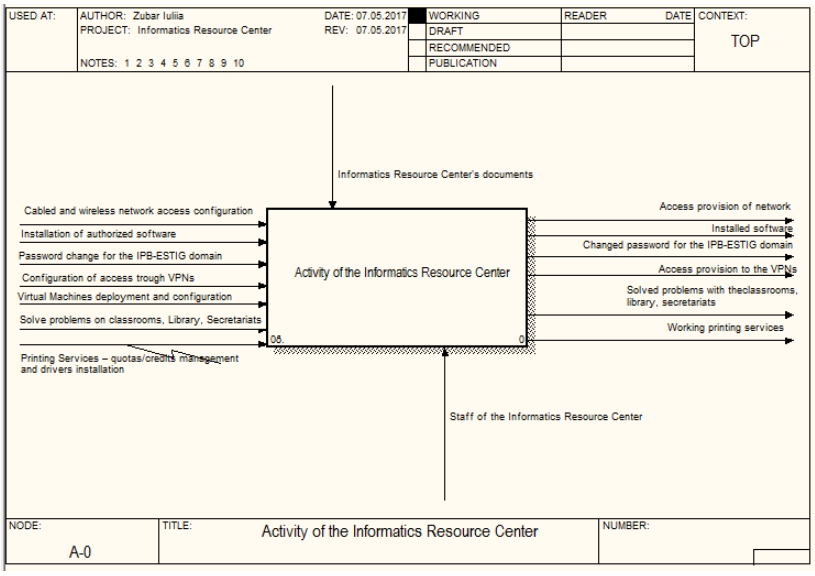

Figure 27: Activity of the Informatics Resource Center

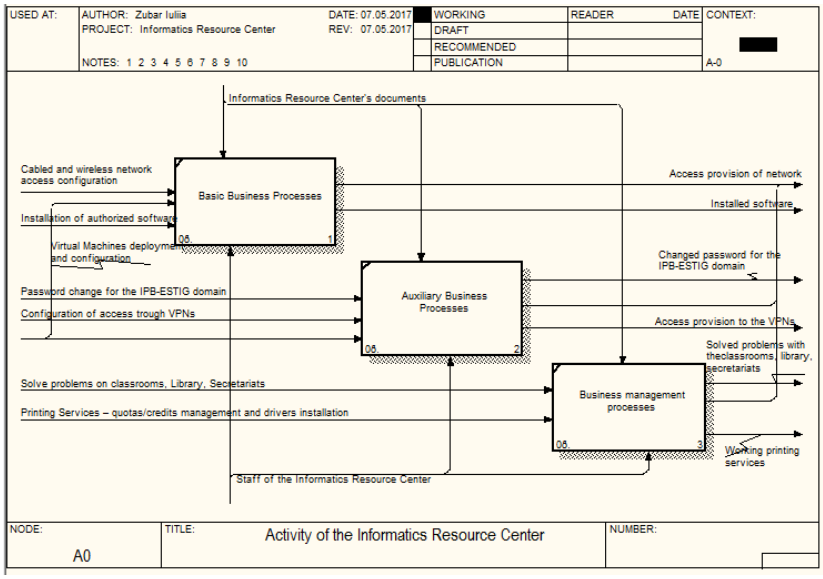

Figure 28: Business Processes of the Informatics Resource Center

6.1.1.6 System Integration and Support Center

The main objective is Management of software/hardware contracts and support to the users of the central services. Main functions:

- Coordinate user support services.
- Promote the integration of the commercial systems used in the Central Services with the rest of the IPB information system.
- Elaborate, disseminate and maintain a knowledge base to solve problems of the users of the Central Services.
- Manage the IPB software licenses.
- Promote, within the IPB, global policies for the use of free software.
- Promote the training of Central Services users through the organization of courses.
- Identify the training needs of Central Services employees.

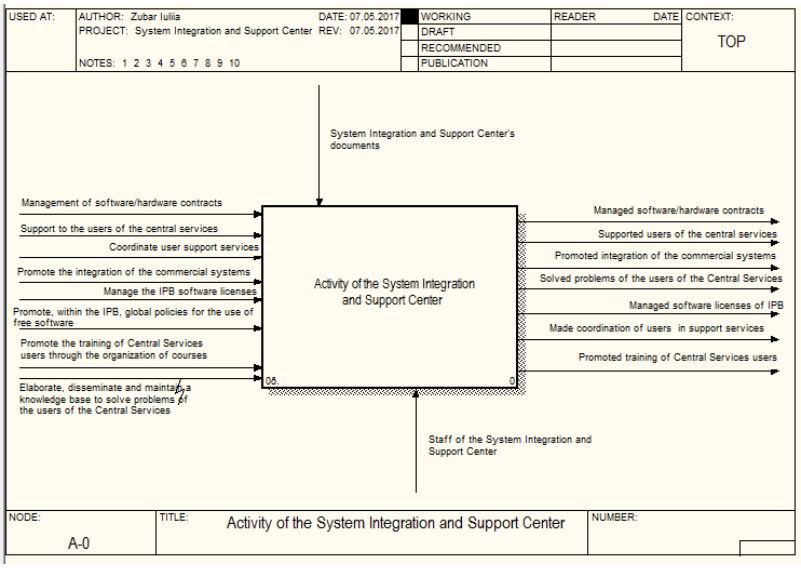

Figure 29: Activity of the System Integration and Support Center

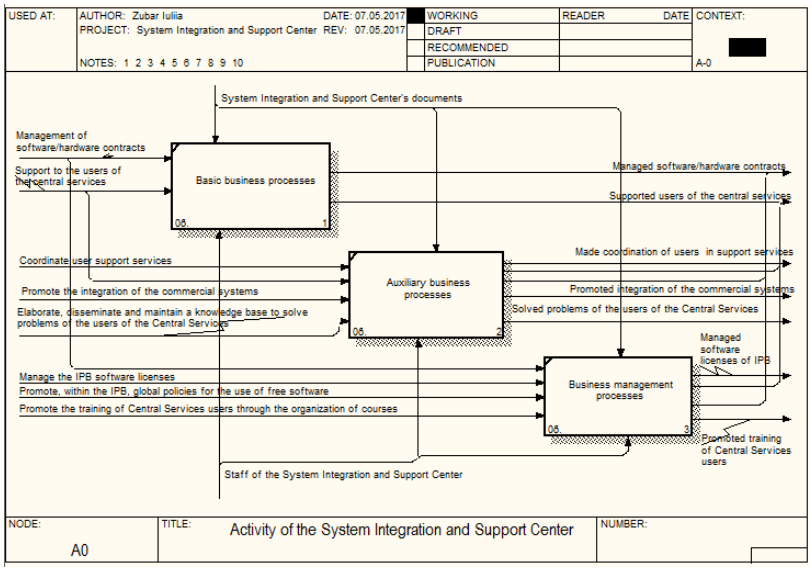

Figure 30: Business Processes of the System Integration and Support Center

6.1.2 IPB Information System

The IPB Information System is currently composed of several products Monoposto and Web platforms, among which stand out the eSIGEduc system (Integrated Management and Financial Management Solution for the ERP, licensed by the company J.Canão) and the systems developed internally, in the IPB, for the academic aspects. The application data is fully stored in Oracle IPB Data Center.

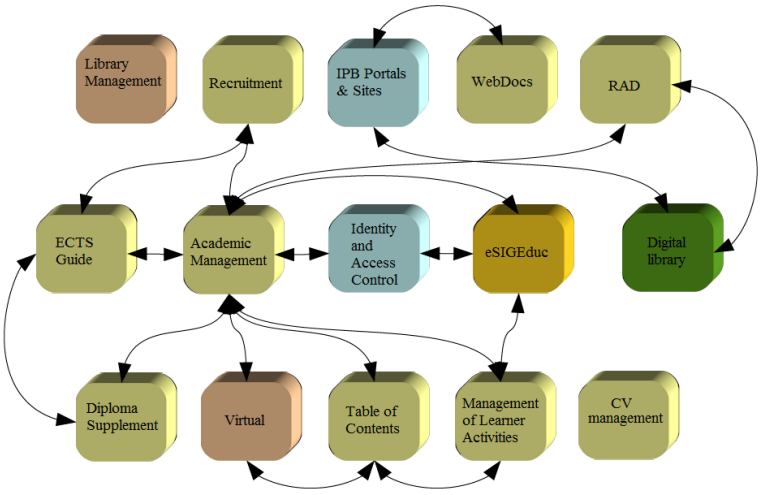

Figure 31: IPB Information System

6.1.2.1 Academic Management

Scope	Functionality	Technology
IPB academic services 10 local users and Web access by all students and teachers 500+ study plans, 28,000+ students, 1,000,000+ enrollments	Course unit programs Student matriculation Inscriptions Evaluation process Certificates	Oracle BD Oracle Forms PL / SQL APEX

	Online services	

Table 23: IPB Information System - Academic Management

6.1.2.2 ECTS Guides

Scope	Functionality	Technology
Leaders and schools of the IPB, responsible of curricular units, department coordinators and course directions Workflow with 350+ stakeholders and about 8000 validation actions, per year 2000+ curricular unit records, updated each academic year	Institutional information Additional characterization of study plans Curricular units Web publication	Oracle BD Java EE 6 GlassFish

Table 24: IPB Information System – ECTS Guides

6.1.2.3 SUPPLEMENT TO THE DIPLOMA

Scope	Functionality	Technology
IPB and schools responsible and academic services of the IPB totality of the courses post Bologna of the IPB	Insertion of information by levels registration of extracurricular activities of each student details of the student's academic record certificate of completion supplements Integration with the ECTS Guide system	Oracle BD Java EE 6 GlassFish

Table 25: IPB Information System – Diploma

6.1.2.4 MANAGEMENT OF READING ACTIVITIES

Scope	Functionality	Technology
Timetable committees of each school total classes taught in the IPB (~ 2000 lessons per week)	computerization of the teaching service based on grids approved at the beginning of the semester with changes / updates throughout the semester resource management spaces (rooms and laboratories) teaching and laboratory	SQLite BD C ++ Qt

	equipment semi-automatic generation of schedules	

Table 26: IPB Information System – Management of Reading Activities

6.1.2.5 HOME

Scope	Functionality	Technology
All IPB teachers and students School leaders totality of classes taught in the IPB	class scheduling integration with the Management of Learner Activities system support for requests to change classes and to justify faults, with validation / approval workflow summary record summary body bibliography student attendance electronic attendance control marking attendance of teachers and students through cards and readers RFID electronic system designed and built in IPB	Oracle BD Java EE 6 GlassFish

Table 27: IPB Information System – Home

6.1.2.6 RECRUITMENT

Scope	Functionality	Technology
Heads of Schools and Selection Boards all those interested in teaching part-time in the IPB (~ 2500 candidates in 2012)	CV bag registration of users (candidates) introduction of CVs definition of profiles, based on the curricular units of IPB pre-selection of candidates definition of filters, according to the recruitment needs making lists of candidates	Oracle BD Java EE 6 GlassFish

	available XML history storage juries association Publication of notices and results Online availability and mailing for registered candidates of public notices With identification of recruitment needs and serialization minutes	

Table 28: IPB Information System – Recruitment

6.1.2.7 RAD

Scope	Functionality	Technology
IPB Evaluation Coordination Board and IPB team of rapporteurs totality of IPB teachers 35000 records of information and 10000+ annexes per evaluation period	operationalization of the staff performance appraisal procedure teacher of IPB collection of self-assessment reports assignment of rapporteurs validation of self-assessment items by rapporteurs generation of evaluation reports records management of teaching activity introduction of data (registers) by each teacher, in the technical, scientific, pedagogical and organizational aspects, in IPB regulation connection to other BDs of the IPB, for automatic import of information link to the RCAAP, for the introduction of publications log validation workflow history of interactions between rapporteur and evaluated, for each record	Oracle BD Java EE 6 GlassFish

Table 29: IPB Information System – RAD

6.1.2.8 WEBDOCS

Scope	Functionality	Technology
Leaders of the IPB and the Schools totality of pdf documents that require Web publishing or storage for creation of history	structure definition for document organization and access control Distributed (multiuser) storage tree creation (Similar to a file system) association of users with each node, to define permissions for effect of creating new nodes or loading files users with access to a given node maintain access on the nodes descendants, regardless of who created them version control document loading with metadata definition possibility of replacing documents or loading of new version publication of documents 3 levels of publication: public; Restricted access; private public and restricted levels with the possibility of web link generation, for use in the various portals of the Institution restricted level download with login / password entry	Oracle BD Java EE 6 GlassFish

Table 30: IPB Information System – WEBDOCS

6.1.2.9 VIRTUAL

Scope	Functionality	Technology
All IPB students and teachers 500+ curricular units (areas) per semester	registration of students and teachers (by area) automatic import of student enrollments automatic association of teachers to areas, based on schedules	Oracle BD Sakai parameterization / adaptation made by IPB Specific modules

	possibility of creation of subgroups by the teacher availability of information (by area), by the teacher content to support student study notices and statements of work collection of practical assignments possibility of scheduling, with indication of deadlines, by the teachers upload of works by students online tests construction of statements control of access and response time Discussion forums clarification of doubts Dissemination of ideas surveys of teachers' pedagogical performance according to a questionnaire approved by the Pedagogical Councils possibility of scheduling by school and course guarantee of anonymity reporting	developed by IPB

Table 31: IPB Information System – VIRTUAL

6.1.2.10 MANAGEMENT OF LIBRARIES

Scope	Functionality	Technology
Libraries of the 5 Schools of IPB the entire IPB community ~ 400000 bibliographic references	cataloging MARC format RFID tags Loan management	Koha parameterization / adaptation made by IPB

	connection to the Academic Services database to import students and Creation of notices of non-compliance use of student's RFID card acquisitions registration of periodicals	

Table 32: IPB Information System – Management of Libraries

6.1.2.11 IPB PORTAIS & SITES

Scope	Functionality	Technology
IPB portals, Schools and SAS Thematic microsites: Academic Services; Libraries; ECTS Guide; Portal of the Candidate; Office of International Relations; Move on Train; Office of Planning and Quality Management; Computer Services; center of Languages	Dynamic pages, with access to different IPB databases content update distributed by multiple users, by levels	Oracle Internet Application Server, Oracle Portal

Table 33: IPB Information System – IPB PORTAIS & SITES

6.1.2.12 IDENTITY AND ACCESS CONTROL

Scope	Functionality	Technology
Leaders of the IPB and the Schools all applications that require identity and access control	creation and maintenance of groups interconnection with other IPB BDs, for automatic creation of groups and Importing entities distributed collection, with the intervention of heads of all schools hierarchical model, with definition of access levels for editing of records history maintenance attribute association dynamic creation of attributes, by group or by member access control web-services for identity and permissions validation making information available	Oracle BD Java EE 6 GlassFish

	web-services for information consultation generation of XML	

Table 34: IPB Information System – IDENTITY AND ACCESS CONTROL

6.1.2.13 RCAAP

Scope	Functionality	Technology
IPB Teachers responsible for the IPB libraries	introduction of scientific production records by teacher workflow for record validation classification of publications web-services for information consultation availability via web portal	www.rcaap.pt UMIC initiative, implemented by the FCCN

Table 35: IPB Information System – RCAAP

6.1.2.14 CVS MANAGEMENT

Scope	Functionality	Technology
IPB officials IPB non-teaching staff	introduction of CV, by each user according to template Defined by IPB Generation of maps, for use by IPB officials	Oracle BD Java EE 6 GlassFish

Table 36: IPB Information System – CVS MANAGEMENT

6.2 Description of KubSAU IT processes

6.2.1 Detailed description of the main IT centers

According to the Regulation "On the Information Technology Center" the main objectives of the IT Center are:

- providing access to educational and other university departments for on-network information services and resources, as well as to the resources of the global Internet;
- implementation and maintenance of automated systems for collecting, processing, storing and transmitting information;
- maintaining the computer facilities of the university, including system software (SO).
- The IT Center, according to the regulations "About the Center of Information Technologies", has the following functions:
- maintenance of functioning, modernization, maintenance and repair of the local computer network (LAN) of the university and computer equipment;

- increasing the effectiveness of IT use in the educational process, research and management of the university;
- organization of centralized software equipment, maintenance and repair of computer facilities of the University;
- issue to university departments recommendations on the choice of hardware and software;
- creation, maintenance of the account and safety of library of the license system and applied ON;
- development and improvement of the library of freely distributed system and application software that have been tested and intended for work at the university;
- advanced training of university staff in the field of information technology and telecommunications systems;
- organization and coordination of works on conducting courses for entrants and students.
- The main tasks entrusted to the IT Center by the Kuban State Agrarian University:
- repair of equipment and installation of software (according to applications of departments or departments);
- maintenance of the local computer network of KubSAU (scheduled maintenance, administration of servers);
- Maintenance of KubSAU site (maintenance of site functioning, fulfillment of applications for filling the site, administration of accounting records of departments and dissertational councils);
- Maintenance of KubSAU educational portal (acceptance of applications and placement of educational materials on the educational portal);
- technical support of distance courses (assistance in conducting webinars, laying out training materials, preparing tests);
- translation of tests compiled by teachers from docx, txt formats to adaptive testing environment (AST) format;
- the creation of automated information systems (AIS) for the university (one of the last colleges was the "Attendance Tracking Log", which, in addition to the "Attendance" module, includes the "Attestation" and "Session" modules);
- introduction of ready-made AIS (one of the major implementations was the support of the commissioning of the electronic document management system DIRECTUM);
- advising users.

6.2.2 Analysis of the architecture of the Information Technology Center

The architecture of an enterprise is the most general and comprehensive representation of an enterprise as an economic entity with short-term and long-term goals of conducting its core business, defined by a mission in the regional and world market and development strategy; External and internal resources necessary for the fulfillment of the mission and the attainment of the set goals, as well as the established rules of conducting the main activity.

Elements of the architecture of the enterprise:

1) Mission and strategy, strategic goals and objectives. Determine the direction of development of the enterprise and set long-term goals and objectives.

2) Business architecture. Describes the activities of the organization in terms of its key business processes.
3) Architecture of information (data). Defines what data is needed to support business processes, and to ensure stability and the ability to use this data for a long time in application systems.
4) Application architecture. Defines which applications are used and which ones should be used to manage data and support business functions.
5) System architecture (infrastructure or technological architecture). Determines which supporting technologies (hardware and system software, networks and communications) are needed to create an application environment that, in turn, manages data and provides business functions.

The critical process for the IT architecture of the IT center is the technical support and maintenance of the IT infrastructure of the Kuban State Agrarian University.

The main result of the process is the operability of the local computer network and equipment of the departments and divisions of the university. According to the division into functional departments within the main business process, the following subprocesses are distinguished:

A1 IT Center Management

A1.1 Elaboration of general principles and directions of the division

A1.2 Approval of service requests

A1.3 Distribution of tasks between departments

A1.4 Preparation of equipment purchase plans

A1.5 Search for service companies, transfer of contracts with them to the accounting dep

A1.6 Approval of employee work plans

A1.7 Control over the execution of contracts with service companies

A1.8 Adoption and reporting on the work of departments and the unit as a whole

A2 Software Development

A2.1 Software development on requests from units

A2.2 Testing of the developed software

A2.3 Implementation of software into departments, departments

A2.4 User support

A2.5 Preparation of documentation and reporting

A3 Maintenance of University Web Resources

A3.1 Maintenance of the official website of the University

A3.2 Maintenance of University Web Applications

A3.3 Reporting

A4 Technical support of the educational process

A4.1 Maintenance of KubSAU educational portal

A4.2 Technical support of distance courses of the Center of pre-university training

A4.3 Reporting

A5 Administration of the local computer network of the University

A5.1 Servicing KubSAU servers

A5.2 Administering Enterprise Email Accounts

A5.3 Reporting

A6 Automation of students testing

A6.1 Consultation of teachers in the preparation of tests

A6.2 Translation of tests into the ACT format

A6.3 Reporting

A7 Repair of equipment

A7.1 Registration of Incoming Requests

A7.2 Load sharing between engineers

A7.3 Repair work

A7.4 Registration of the fact of repair

A7.5 Reporting

Responsibility for the implementation of key business processes is assigned to the functional departments within the IT Center.

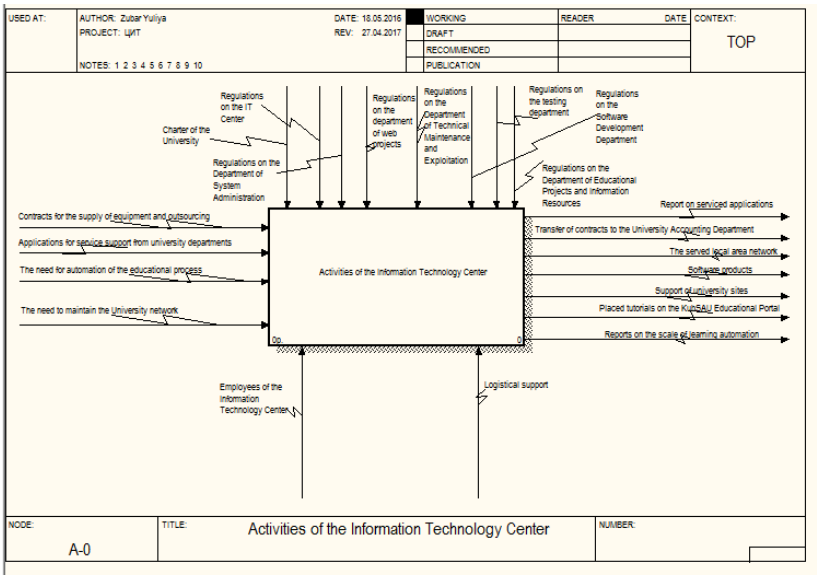

Figure 32: TOP-diagram of the Information Technology Center

Figure 27 depicts the activity diagram of the IT Center, for which the head of the IT Center is responsible, displays interactions with other processes and with the external environment for input, output, and management.

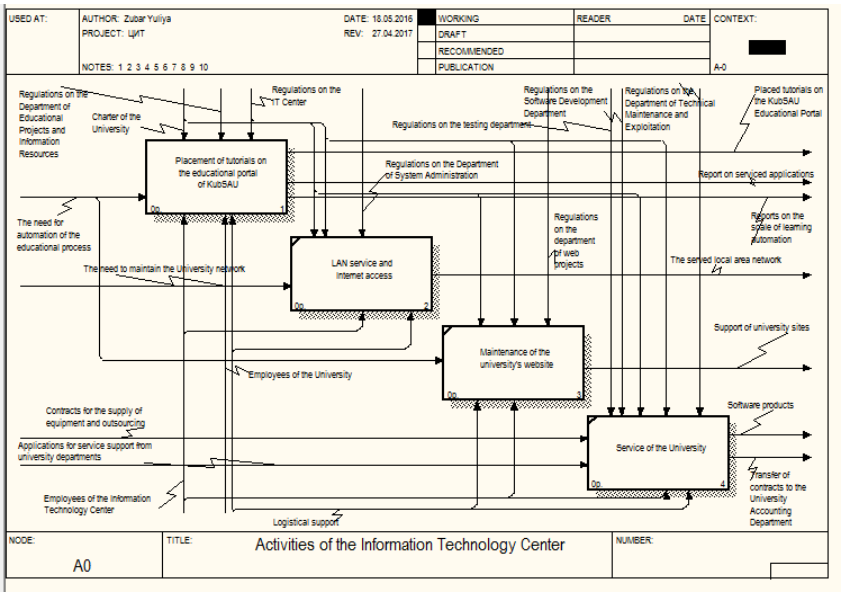

Figure 33: A0 decomposition diagram «Information Technology Center Activity»

Figure 28 shows the decomposition diagram A0 "Activity of the Information Technologies Center", which in more detail shows the processes taking place in the Information Technologies Center.

A1 IT Center Management

Process Owner

№	Position	Subdivision	Activity subject
1	Head of IT Center	IT Center	Control

Process executors:

№	Organizational unit	Subdivision	Activity subject
1	IT Center	-	IT Infrastructure

OUTPUT interaction

№	Output	Objects	Consumer	
			Process / object of the environment	Executor
1	Contracts in the accounting department of the University	Contracts in the accounting department of the University	Suppliers	Head of IT Center
2	The served local area network	Servers of KubSAU Corporate e-mail of KubSAU	Chairs/Units	Department of System Administration
3	Software products	Software products	Chairs/Units	Department of Software Development
4	Support of University sites	University website Other University Web Apps	{Border}	Web Projects Department
5	Reports on the scale of learning automation	Reports on the number of materials posted on the educational portal Reports on the conduct of courses DO Reports on the results of testing students	Head of IT Center	Department of Educational Projects and Information Resources Department of testing and certification
6	Report on serviced applications	Report on serviced applications for equipment repairs	Head of IT Center	Technical support and operation department

Interaction on the INPUT

№	Input	Objects	Provider	
			Process / object of the environment	Executor
1	Contracts for the supply of equipment and outsourcing	Contracts for the supply of equipment and outsourcing	Providers	Head of IT Center
2	Requests for service from the units of the University	Requests for service from the units of the University	Chairs/Units	Technical support and operation department
3	The need for automation of the educational process	Materials on the educational portal Courses Testing of students	Chairs	Department of Educational Projects and Information Resources Department of testing and certification
4	The need for the maintenance of the University network	Servers of KubSAU Corporate e-mail of KubSAU	Chairs/Units	Department of System Administration

Process control

№	Input	Objects	Provider	
			Process / object of the environment	Executor
1	Regulations on the IT Center	Regulations on the IT Center	University	Human Resources Department
2	Charter of the University	Charter of the University	University	Human Resources Department
3	Regulations on the functional departments of the IT Center	Regulations on the functional departments of the IT Center	University	Human Resources Department

A1 Technical support of the educational process

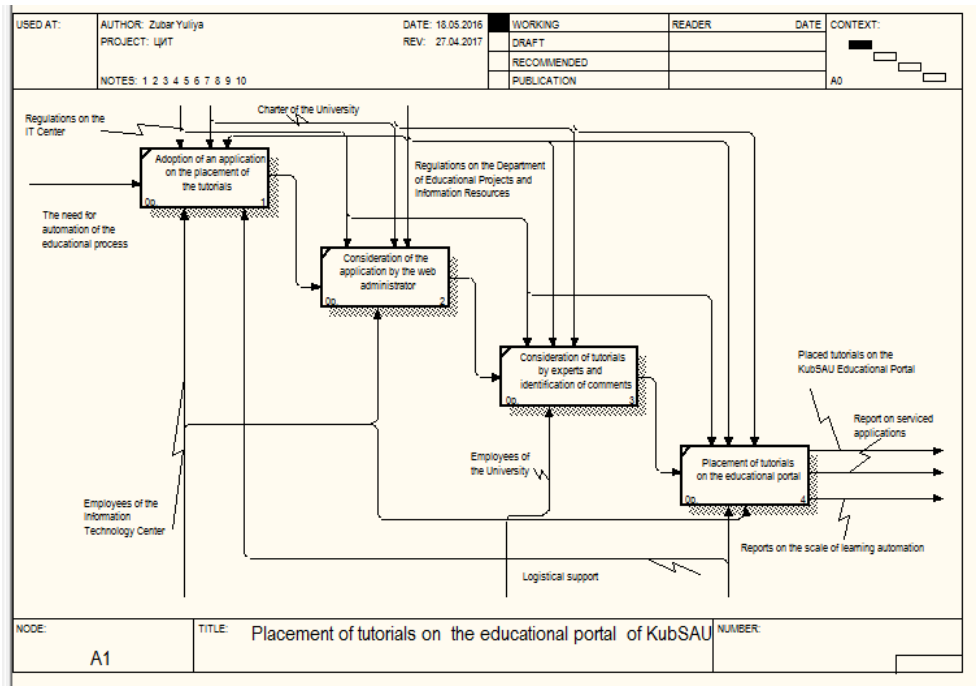

Figure 34: Work of the Department of Educational Projects and Information Resources

Figure 29 shows the activity diagram of the department of educational projects and information resources, in particular, the process of placement of benefits on the KubSAU Educational Portal is shown.

OUTPUT INTERACTION

№	Output	Objects	Consumer	
			Process / object of the environment	Executor
1	Reports on the scale of learning automation	The work of the educational portal	Chairs, Head of the IT Center	Department of Educational Projects and Information Resources

Interaction on the INPUT

№	Input	Objects	Provider	
			Process / object of the environment	Executor
1	The need for automation of the educational process	The work of the educational portal	Chairs	Department of Educational Projects and Information Resources

A1 Software Development

Process Owner

№	Position	Subdivision	Activity subject
1	Head of Software Development Department	IT Center	Apps

Process executors:

№	Organizational unit	Subdivision	Activity subject
1	Department of Software Development	-	Apps

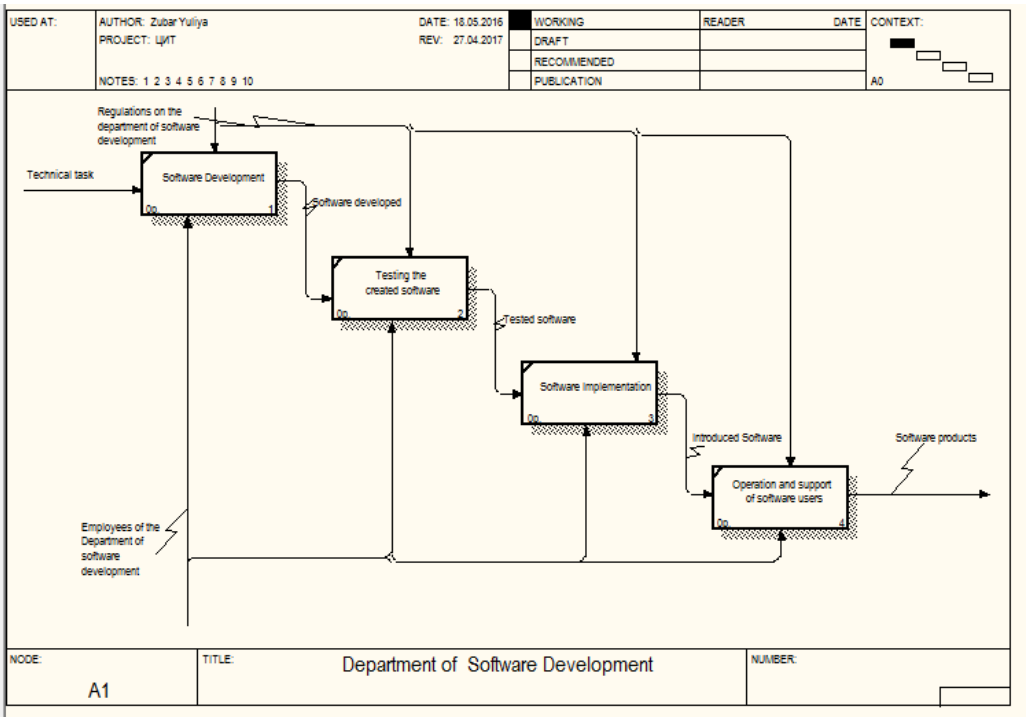

Figure 35: Diagram «A2 Software Development Department»

Figure 30 shows a diagram of the activities of the software development department, displays interactions with other processes and with the external environment for input and output.

OUTPUT INTERACTION

№	Output	Objects	Consumer	
			Process / object of the environment	Executor
1	Software products	Apps	Chairs / Departments	Department of Software Development and Operations

Interaction on the INPUT

№	Input	Objects	Provider	
			Process / object of the environment	Executor
1	Technical task	Apps	Chairs / Departments	Department of Software Development and Operations

Figure 17 depicts the activity diagram of the web project department, displays interactions with other processes and with the external environment for input and output.

A2 Maintenance of University Web Resources

Process Owner

№	Position	Subdivision	Activity subject
1	Head of Web Projects Department	IT Center	Web Resources

Process executors:

№	Organizational unit	Subdivision	Activity subject
1	Web Projects Department	IT Center	Web Resources

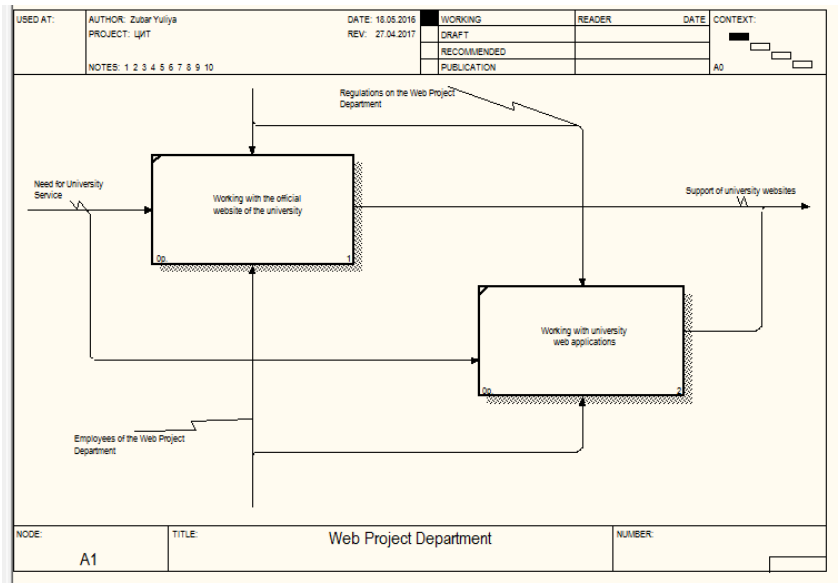

Figure 36: Diagram «A3 Web Project Department»

OUTPUT INTERACTION

№	Output	Objects	Consumer	
			Process / object of the environment	Executor
1	Support of University sites	Official site of KubSAU Web Applications KubSAU	Chairs / Departments	Web Projects Department

Interaction on the INPUT

№	Input	Objects	Provider	
			Process / object of the environment	Executor
1	The need to maintain the University network	Official site of KubSAU Web Applications KubSAU	Chairs / Departments	Web Projects Department

Figure 18 shows the activity diagram of the system administration department, displays interactions with other processes and with the external environment for input and output.

A5 Administration of the local computer network of the University

Process Owner

№	Position	Subdivision	Activity subject
1	Head of System Administration Department	IT Center	IT Infrastructure

Process executors:

№	Organizational unit	Subdivision	Activity subject
1	Department of System Administration	IT Center	IT Infrastructure

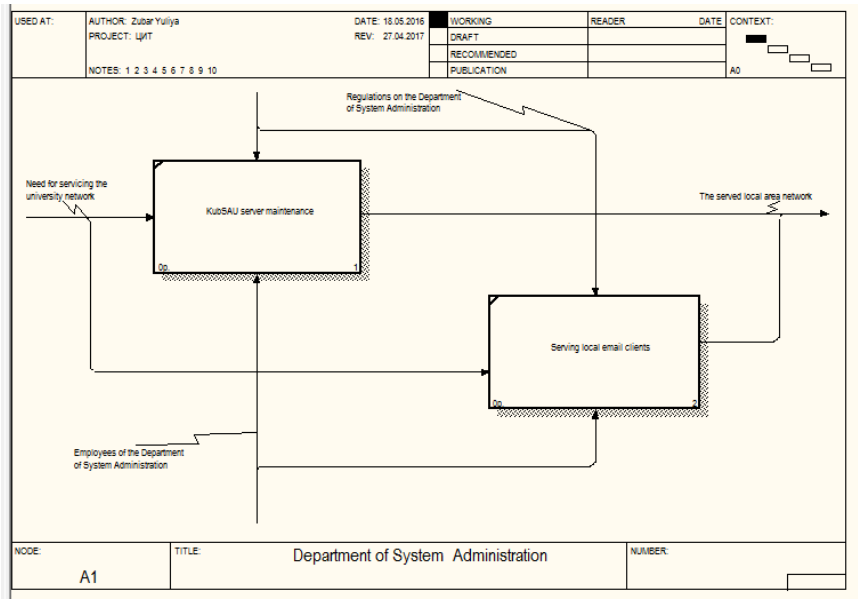

Figure 37: Diagram «A5 Department of System Administration»

OUTPUT INTERACTION

№	Output	Objects	Consumer	
			Process / object of the environment	Executor
1	The served local area network	Servers Mail client Physically extended LAN	KubSAU	Department of System Administration

Interaction on the INPUT

№	Input	Objects	Provider	
			Process / object of the	Executor

			environment	
1	The need to maintain the University network	Servers Mail client Physically extended LAN	KubSAU	Department of System Administration

Figure 33 shows a diagram of the activities of the testing and certification department, displays interactions with other processes and with the external environment for input and output.

A6 Automation of students testing

Process Owner

№	Position	Subdivision	Activity subject
1	Head of testing and certification	IT Center	Testing

Process executors:

№	Organizational unit	Subdivision	Activity subject
1	Department of testing and certification	IT Center	Testing

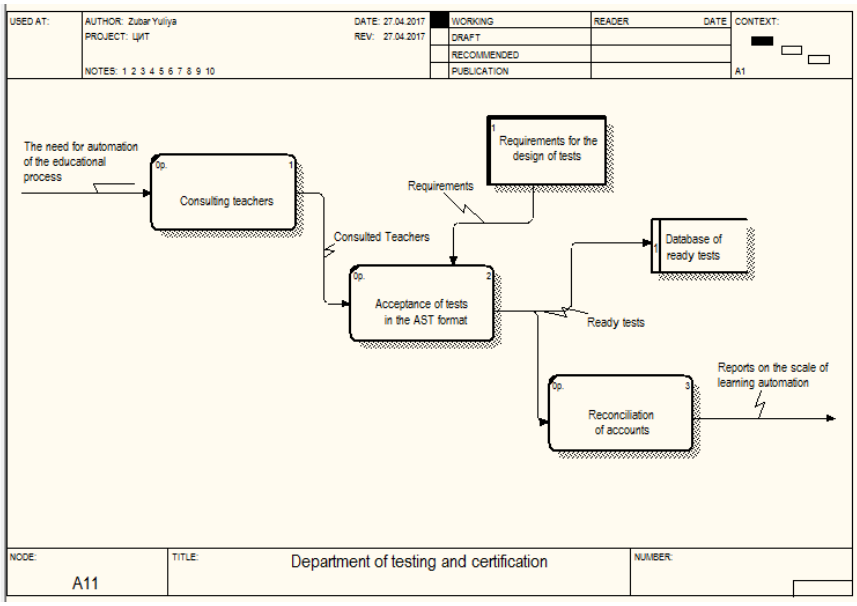

Figure 38: Diagram «A6 Testing and Certification Department»

OUTPUT INTERACTION

№	Output	Objects	Consumer	
			Process / object of the environment	Executor
1	Reports on the scale of learning automation	Test results	Chairs, Head of the IT Center	Department of testing and certification

Interaction on the INPUT

№	Input	Objects	Provider	
			Process / object of the environment	Executor
1	The need for automation of the educational process	Test results	Chairs	Department of testing and certification

Figure 34 shows a data flow diagram (DFD) used to describe the workflow and information processing.

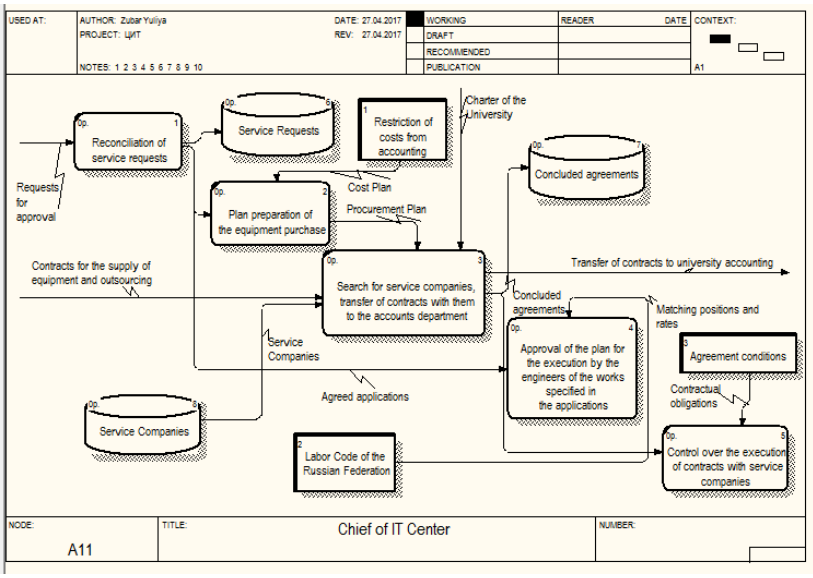

Figure 39: Diagram of data flows «Chief of IT Center»

This diagram contains six function blocks, four data stores and external entities and describes the main information flows of the IT Center management process.

Tables 7 and 8 describe the inputs and outputs of the diagram «A1 Chief of IT Center».

Input	Objects	Provider	Executor
Requests for approval	Requests for approval	Chairs / Divisions	Chief of IT Center
Contracts for the supply of equipment and services	Contracts for the supply of equipment and services	Suppliers	Chief of IT Center
Reports from department heads	Reports from department heads	Heads of departments	Chief of IT Center

Table 37: Inputs of the diagram «A1 Chief of IT Center»

Output	Objects	Consumer	Executor
Contracts transferred to university accounting	Contracts for the supply of equipment and services	Accounting	Chief of IT Center
Technical task	Technical task	Head of the department of software development and operation	Chief of IT Center
External reporting	External reporting	Rectorate	Chief of IT Center

Table 38: Outputs of the diagram «A1 Chief of IT Center»

6.3 Questionnaires

6.3.1 Questionnaire for the Leadership

Please answer each question for each **Service Operation** area:

1. Initial - processes and activities are adhoc or chaotic or undefined
2. Repeatable - basic processes and activities are established and there is a level of discipline and adherence
3. Defined - All processes and activities are defined, documented, standardized and integrated together
4. Managed - Processes are measured by collecting detailed data on the processes and their quality and appropriately improved
5. Optimizing - Continuous process improvement is adopted. Process and activities are mature

Answer	Maturity level
1 – 'Strongly Disagree'	Initial
2 – 'Disagree'	Managed
3 – 'Neutral'	Defined
4 – 'Agree'	Quantitatively managed
5 – 'Strongly Agree'	Optimizing

	The Incident Management Process	1	2	3	4	5
1	We have clear roles and responsibilities for the Incident Management Process which have been identified, defined, documented, and appointed.					
2	Employees have the understanding that an incident has to be resolved fast, without the need for root cause investigation.					
3	The personnel responsible for Incident Management are suitably trained.					
4	We have a clearly defined, repeatable incident management process across the organization to manage the life cycle of incidents from their inception to closure. This process helps us to restore the service, so that it can be used again by users, as quickly as possible. We have clearly defined process goals, objectives, policies and procedures for the Incident Management Process.					
5	The definition of an incident is clearly understood and is applied across the organization. An incident is understood as being different from a problem.					
6	Incident records are maintained for all reported incidents.					
7	All incidents are analyzed and classified by the Global Service Desk prior to handing them over to backbone support.					
8	All Incidents are assigned a priority based on impact and urgency.					
9	We have defined Incident Management's Information Management reporting					
10	Incident Management Process review procedure is in place					
11	An incident database is maintained to document details for all re-ported incidents, including resolutions and workarounds. We have a shared repository of Incident					
12	There is a searchable Knowledge Database that contains workarounds, resolutions and known-errors, as well as work instructions regarding how to apply these resolutions.					
13	Resolved and closed incidents are updated and clearly communicated to the Global Service Desk, customers, and other parties.					
	Activities in Place needed for the Success of Incident Management					
1	The Service Desk function is defined					
2	The Service Desk is aware of their role Incident Management					
3	External Suppliers are aware of their role in Incident Management					
4	Knowledge Bases are in place to support Incident Resolution at the Service Desk					
5	Workarounds are document and in the Knowledge Base					
	Incident Management Metrics					
1	Incident Management's KPIs and metrics are defined and in place					
2	Incident Management Reports have been identified and put in place					
3	Metrics have been defined and are in place for Major Incidents					
	Incident Management Process Interactions					
1	Service Asset and Configuration Management is in place and available to support Incident Resolution					
2	The relationship between Incident Management and Problem Management is					

	understood					
3	A Root Case Procedure is in place as Problem Management as a process does not exist yet					
4	The Incident Manager/The Incident Process is consulted as part of Change Management (post implementation reviews)					
5	Incidents related to releases are reported to the Change/Release Manager					

Request Fulfilment Management		1	2	3	4	5
1	We have clear roles and responsibilities for the Request Fulfilment Process which have been identified, defined, documented and appointed.					
2	The employees are actively working towards replacing manual, repeatable IT tasks with technology solutions that can automate the tasks.					
3	The employees understand and have the mind-set that a request fulfilment is about providing timely and effective access to standard services.					
4	We have a clearly defined, repeatable Request Fulfilment process for effectively delivering normal service requests from request to delivery. This process helps us satisfy users' requests in an effective and timely manner. We have clearly defined process goals, objectives, policies and procedures for the Request Fulfilment Process.					
5	The process helps us to replace manual, repeatable IT tasks and processes with technology solutions that can automatically carry out steps and check for any issues or errors that might have occurred in the process.					
6	Service request records are maintained for all reported service requests.					
7	The definition of a service request is clearly understood and is applied across the organization. A service request is understood as different from an incident.					
8	We have a tool that accommodates the necessary fields for capturing the Request details. E.g., the service, who raised the request, who the request will be assigned to, priority, status, closure details.					
9	The tool provides the capability to establish self-help access to predefined lists of services.					
10	We have a tool that includes automation/workflow capabilities, so that easily repeatable tasks can be approved and implemented without intervention of IT staff.					

Problem Management		1	2	3	4	5
1	We have a role that is responsible for analyzing incident records, incident trends, and for reviewing the problem records.					
2	We have clear roles and responsibilities for the Problem Management Process which have been identified, defined, documented, and appointed.					
3	There is management commitment to support staff allocation in sufficient time for problem solving activities.					
4	We have a clearly defined, repeatable Problem Management process to prevent incidents from happening and to minimize the impact of incidents that cannot be prevented. We have clearly defined process goals, objectives, policies, and procedures for the Problem Management Process.					
5	The definition of a problem is clearly understood and is applied across the organization. A problem is understood as being different from an incident.					
6	There is a procedure by which potential problems are classified in terms of category, urgency, priority and impact and assigned for investigation and root cause analysis.					
7	We have a mechanism for tracking problem resolution.					
8	A measurement framework has been established for Problem Management that identifies, measures and reports on metrics aligned to KPIs.					
9	There is a tool supporting problem management reporting. We have a shared repository of Incident Management documentation in place.					
10	There is a problem database maintained to record details for all reported problems.					
11	The tool allows the linking of Incidents to Problem records.					

Change Management		1	2	3	4	5
1	The purpose, goal and objective for the Change Management process is defined					
2	The scope for change management is defined					
3	The policies, principles and basic concepts for change management are defined					
4	We have defined the types of change requests					

5	We have defined standard (pre-authorized) changes					
6	Remediation planning for changes is defined					
7	Planning and controlling changes is an integrated activity of change management					
8	Change and release scheduling is an integrated activity of change management					
9	Ensuring there are remediation plans is an integrated activity of change management					
10	Measurement and control of changes is an integrated activity of change management					
11	Management reporting is an integrated activity of change management					
12	Understanding the impact of change is an integrated activity of change management					
13	Continual improvement is an integrated activity of change management					
14	Raising and recording changes is defined					
15	Assessing and evaluating the Change is defined					
16	Authorization of all types of Changes is defined					
17	Coordinating change implementation is defined					
18	Reviewing and closing change records is defined					
19	Change process models and workflows are defined					
20	The Change advisory board is defined					
21	Emergency changes are defined					
22	Triggers, Input and output and inter-process interfaces are defined					
23	Key performance indicators and metrics are defined					

Service Asset and Configuration Management		1	2	3	4	5
1	The purpose, goal and objective for the Service Asset and Configuration Management process is defined					
2	The scope for SACM is defined					
3	The policies, principles and basic concepts for SACM are defined					
4	The Configuration Management System is defined					
5	Asset and Configuration Management activities are defined					
6	Management and planning for SACM is defined					
7	Configuration identification is defined					
8	Configuration control is defined					
9	Status reporting is defined					
10	Verification and audit is defined					
11	Triggers, Input and output and inter-process interfaces are defined					
12	Key performance indicators and metrics are defined					
13	The purpose and benefits of configuration management has been disseminated with the organization					
14	The organization uses some tools to support the configuration management process					
15	Do you check with the customers (students, teachers, etc.) that they are happy with the services provided?					
16	Are you actively monitoring trends in customer (students, teachers, etc.) satisfaction?					

6.3.2 Questionnaire for the Teachers

1. Is there access to the Internet in the academic buildings?
- Yes / No
2. Are you satisfied with the speed of cable Internet in educational buildings?
- Yes / No / Not sure
3. Do the academic buildings have Wi-Fi?
- Yes / No
4. Are you satisfied with the speed of Wi-Fi in educational buildings (if there is)?
- Yes / No Not sure
5. Is there a university website?
- Yes / No
6. Is there a university's student portal?
- Yes / No
7. Is there access to the teacher's schedule on the university's website or on the university's virtual portal?
- Yes / No
8. Is there a personal account of the teachers on the university's website or on the university's virtual portal?
- Yes / No / Other
9. Are you satisfied with the state of the university's website or the university's virtual portal?
- Yes / No /Not sure
10. Is there a specialized software?
- Yes / No
11. Are you satisfied with the package of application systems covering the business architecture of the university?
- Yes / No /Not sure
12. Is there network equipment?
- Yes / No
13. Are you satisfied with the state of the network equipment?
- Yes / No / Not sure
14. Is the server protected against unauthorized access to it?
- Yes / No
15. Is the software updated?
- Yes / No / Partly / Not sure
16. Are there licensed products purchased by the university?
- Yes / No / Not sure
17. Are you satisfied with the work of purchased licensed products (if there are)?
- Yes / No / Not sure
18. Are you satisfied with the state of computer equipment?
- Yes / No / Not sure
19. Is the equipment updated in classrooms?
- Yes / No / Not sure
20. Is the equipment updated in the offices of the teaching staff?
- Yes / No
21. Is there enough personal computers to train students?
- Yes / No
22. Are there enough classrooms for training?
- Yes / No
23. Are there enough projectors and screens for the projector?
- Yes / No
24. Is the number of hours of training sufficient?
- Yes / No
25. Is there an electronic library?
- Yes / No
26. Is copyright protection provided for benefits in the electronic library?
- Yes / No /Not sure
27. Does the university have scientific journals in which students and teachers can publish their works?
- Yes / No

6.3.3 Questionnaire for the Students

1. Is there access to the Internet in the academic buildings?
- Yes / No
2. Are you satisfied with the speed of cable Internet in educational buildings?
- Yes / No / Not sure
3. Do the academic buildings have Wi-Fi?
- Yes / No
4. Are you satisfied with the speed of Wi-Fi in educational buildings (if there is)?
- Yes / No /Not sure
5. Is there a university's website?
- Yes / No
6. Is there a university's student portal?
- Yes / No
7. Is there a student account on the university's website or on the university's student portal?
- Yes / No
8. Can a student follow his progress on the university's website or on the university's virtual portal?
- Yes / No
9. Is there access to the student's schedule on the university's website or on the university's virtual portal?
- Yes / No
10. Are you satisfied with the state of the university's website or the university's virtual portal?
- Yes /No / Not sure
11. Is there a student identification number?
- Yes/ No
12. Does each student have a mailbox in the university's database?
- Yes / No
13. Are you satisfied with the state of computer equipment?
- Yes / No /Not sure
14. Are you satisfied with the package of applied systems involved in the learning process?
- Yes / No / Not sure
15. Is the software updated?
- Yes / No / Not sure
16. Is there an electronic library?
- Yes / No
17. Does the university have scientific journals in which students and teachers can publish their works?
- Yes / No