Monitoring the Performance of University Curricular Student

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Abstract

With the economic crisis in which we live, it becomes urgent to capture the high development of an enterprise, being academic or industrial profile. In an academic context, the practice of dashboards turns to the management and/or performance monitoring of the users, while university students that may hold positions in the senior executives of a company of any industry, when in an industrial context; or as teachers and/or researchers in the portuguese public university education. This work aims to create a specification for the development of a dashboard for monitoring the student's educational performance, in this case, from Instituto Superior Técnico (University of Lisbon), an educational institution where the tests were designed and projected for the proposed solution. The same language was designed in ArchiMate 2.1 and UML 2.0 and includes all modeling of the technological architecture, domain model, context diagrams, use cases (including the various existing views) and activities, and the modeling of some test scenarios, with examples of application of the solution, in which the drawn mockups are included, as well as the screens of a static testing dashboard. To this end, we followed the guidelines of the Design Science Research methodology, due to the production of artifacts, in the validating of the work.

Keywords: Actor, Dashboard, Key Indicator, Modeling, Monitoring, Performance.

1 Introduction

The aim of this paper is to present a practical model, based on the Fénix system, for monitoring the academic achievements of students using an online platform.

The solution presented comes from the opinion of various types of users which were gathered and treated statistically. Secondly we define the control, performance and risk indicators, and explain the conceptual model of the dashboard that was put in practice. Finally we give examples of prototypes for each scenario.

To support the test scenario, we developed a static operational dashboard, developed in Microsoft Excel, which simulated the prototype developed for the database system in question. Sometimes the curricular performance of a student of the university does not meet the objectives originally established by himself, the teachers of the course, or by the faculty itself. Our goal is to develop a research paper which consists in the projection and development of a dashboards' tool to monitor student's performance through analysis indicators (KPIs - key performance indicators, KRI's - key risk indicators and KCI's - key control indicators), using the concept of Business Activity Monitoring (BAM) [1]. With these tools we were able to focus on the monitoring in due time and the analysis of the performance of the activities carried out, in a business setting. The academic platform chosen was the FénixEDU system, an integrated system of academic management and teaching aid, developed by IST and used, not only by this institute, but also in other faculties, namely the Instituto Superior de Ciências do Trabalho e da Empresa and the Instituto Superior de Agronomia. The development of this project involved the modeling of all the business that lies behind the student's academic performance in general. We based our analysis on the evaluation points of the analytical present in the coordinator portal as well as the of Instituto Superior Técnico's (IST) Quality of Curricular Units (QUC) questionnaires. The questionnaires in question are anonymous and conducted every six months, electronically, through the personal account that each student has in the Fénix. We took into account certain points, such as the rate of attendance of the various types of class each course entails and in each course, in which grade range the student's final score is located. This modeling will include all diagrams of practical scenarios, described in UML 2 language, which involves a model of technological architecture, the domain model and use-case diagrams. The dashboard we propose to implement, consists of mockups (see example in figure 1) using the Balsamiq 1.6.69 so as to represent the various interfaces contemplated and required features. To model the entire business, described in the previous paragraph, we use the Enterprise Architect 10 tool, having been projected using the Design Science Research's methodology, for the creation of artifacts. Nowadays, the dashboard is not only a visual tool that uses business intelligence (BI) technology to manage business processes, but also a powerful interactive and diagnostic tool, which shows an overview of a company, so that its objectives can be better achieved [2].

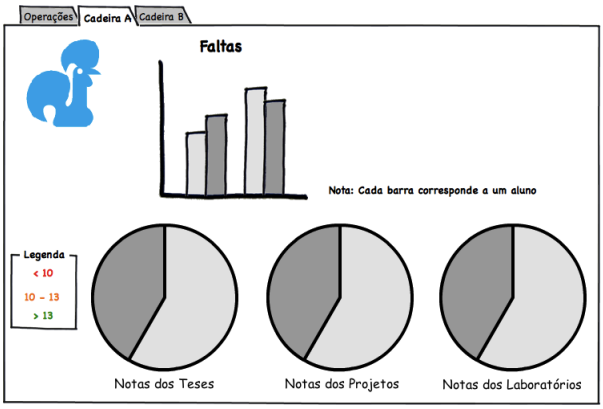

Figure 1: Example of a mockup of the prototype in a given scenario

This document comprises five sections, the first, which we just described, is the introduction. In the following sections we will make reference of the previous work done in this field, the process of developing a conceptual tool for monitoring a student's performance, the case study and our final conclusions.

2 Related Work

2.1 Historical Perspective

The concept of dashboard first appeared in the early twentieth century, in France, in the car market as board computers. It's no surprise that nowadays french cars first of the low to middle price range vehicles to have high-tech driving technology. The first dashboards in the business area appeared in 1980, just like executive information systems. During a decade the dashboards was partly forgotten, having made its comeback in the market when the data warehouses and OLAP systems became famous [3].

Currently, the dashboards are diagnostic tools with great potential, enabling the use of business intelligence. They play an important part in the concept of business process management (BPM), because they enable the monitoring of a company's activities [3]. As such, they also have requirements such as the coordination between business processes and constantly updated information, intuitive visualization for the delivery of information to busier users (with less time to lose on data analysis) and the option of auditory navigation for a better user context [4]. Although the purpose of using dashboards can vary, it does not stray from certain purposes such as monitoring, consistency, planning and communication. Its main function is to evaluate, depending on the metric used for the proposed action, while ensuring the coordination between the various measures used in different departments. To exemplify this we provide some scenarios with the corresponding results, taking into account the chosen measures. These measures are indicators defined in different contexts and in different dashboards. A dashboard is a tool capable of analyzing different scenarios with a flexible format of presentation, providing the ability to drill down on different types of samples submitted [2].

2.2 Dashboards' Market

Although there is very little information about dashboards, with the exception of the academic context, we will focus on two types of companies: those developing and using dashboards for monitoring and/or management of their business activity [3]. For the former type, we have brands such as Pentaho, SpagoBI to the Palo, the JasperSoft, the iDashboards, Microsoft and MicroStrategy, among others. According to MicroStrategy, a tool dashboard is something that must be developed in order to be user friendly, have an easily understood interface, both for the business and information technology areas, in order to allow the growth of the organization in question. The same brand further underlines that developed dashboards should extend to all levels of the business to ensure the coordination of the organization, thus facilitating joint decision making. To ensure the increase in performance and greater scalability, both operators and executives leaders share the same performance indicators, allowing all workflows to be included in the dashboard [5]. TAP, VISA and Abril are some of MicroStrategy's customers, some of the dashboards' users at a business level in order to monitor the operations of flights, the performance of the organization (figure 2) and to elaborate a monthly report of the companie's performance, respectively [6].

Figure 2: Dashboard of VISA with the performance of organization [1]

2.3 Related Projects and Studies

Within the information systems, there is the development of a framework that supports research in this field, as we can see in figure 3, in order to compare the paradigm of behavioral science with the paradigm of science design. In this figure we can also see, the environment, the IS research and knowledge base. The environment defines the problem's surrounding circumstances, which will serve as the motivation for its research. The survey involves the people, the organization where the business resides, and the technology used. The knowledge base provides the support for the research, so that it can use methodologies and create the necessary scientific foundation to become credible [7]. It is with this in mind that we adopted the Design Science Research (DSR) methodology, which is based on the knowledge (and understanding) of a problem, through the knowledge base provided by the framework of figure 3, and the projection of its solution, by producing artefacts that support:

1. Design as an artifact. *The DSR must produce a viable artifact (a model, a method, an instantiation and/or builder).*

2. Relevance of the problem. *The purpose of this methodology is to develop technological solutions to important problems, the business level.*

3. Evaluation of the drawing. *The utility, quality and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.*

4. Contributions of the research. *The efficacy of the methodology is required to provide verifiable inputs in areas of the design artifact, the fundamentals of the design and/or design methodologies.*

5. Rigor of the research. *The DSR depends on the application of rigorous methods in the construction and evaluation of the design artifact.*

6. Desenho de um processo de pesquisa. *Drawing of a research process.*

7. Communication research. *The methodology must be presented effectively both to technology-oriented in a shed as a management oriented strand* [7].

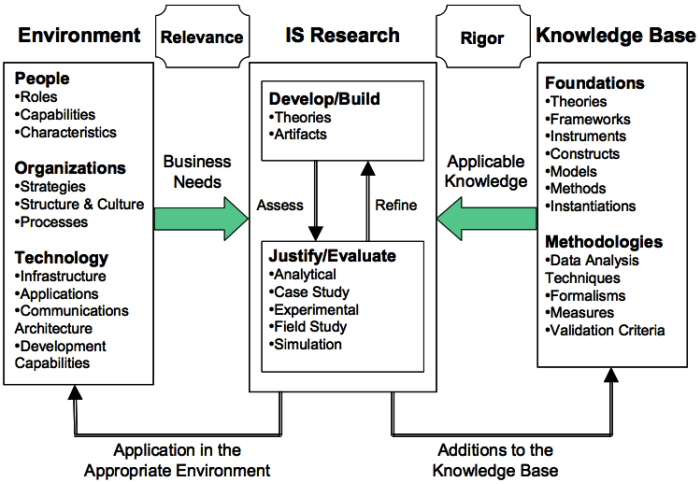

Figure 3: Framework for Research in Information Systems [7]

The Zachman Framework, originally called "Framework for the Architecture of Information Systems", has been used for twenty-five years to design artifacts in the design process. These artifacts

[1] http://www.microstrategy.com/DashboardGallery/Dashboards/customers/visa/ accessed in 31/05/2013, author: MicroStrategy, year: 2010

will allow the linking of roles in the design process, and the abstractions of the product. The main roles are those of the owner, designer and builder. The first is the one who draws and the second creates the process, although there are other intervenients. In this case we are referring to the planner and the subcontractor, which are the ones who plan and implement, respectively. Although this framework can sometimes be impractical due to the large number of cells, let's address the entire company with one table, regardless of the methodologies or tools that are or will be used [8]. With this framework we will describe the conceptual model that we developed, which you will have a chance to see in section three.

One of ranges are the intelligent dashboards, which essentially are a way of showing proactive results of a certain business. In this type of dashboards, we have three basic features, termed look outside, look ahead and look inside. The first allows a better view of the risk as well as the "market". The second allows a view from above, something that the traditional dashboard does not. It does this by allowing the design of predictive models using data mining, which will lead to a better decision making. The last one focuses on the goals, taking into account the identified KPI's [9].

One of theme-related projects is the implementation of a dashboard in REPOX, a tool developed by INESC-ID in order to manage data transfer processes in digital libraries. With the increasing amount of data handled by managers, the use of dashboards is very useful in making decisions and thus a valuable tool in business intelligence. It is the implementation of concepts of a metadata repository, whose main functional features of the dashboard include flexibility in format presentation, alerts and notification in real time, drill down capacity, scenario analysis and external benchmarking. According to the author, after the definition of performance indicators, described below, he makes a quick and brief reference of how to implement of the dashboard, namely, that the design should be very simple and tailored to the screen size. It will contain various types of visualization tools such as maps, pie charts, as well as bar, line and pyramidal graphs. The implementation of a dashboard should include mechanisms for drill down, scenario analysis and flexible presentation [3].

Generally, the dashboards are divided into three types: operational, tactical and strategic, which we will analyze in table 1, according to the goal, the type of information, the rate of updates and its aesthetic.

The type of dashboard is not the only variable, but also the type of information represented, whose correlation should be maintained (e.g. each representation has its own purpose). The graphic presentation consists in a type of spatial information and the tabular representation implies a kind of symbolic information. As a result of the study conducted, it was concluded that the features of dashboards can be of a functional or visual type, because a small size can result in a range of suboptimal decisions and a low quality appearance can lead to confusion and distraction of the user. For this reason, a dashboard should contain simple pages, be moderately colorful, must have different color ratios in the different data and grids can also be used in 3D graphics.

	Operational	**Tactical**	**Strategic**
Goal	Monitoring	Analysis	Collaboration
Information	Detailed	Summary	Summarized
Update	Constant	Daily / Weekly	Monthly / Quarterly
Graphical Aspect	Dashboard	Portal of Business Intelligence	Balanced Scorecard

Table 1: Comparative analysis of different types of dashboards [3]

3 Conceptual development of a Performance Monitoring Tool

This section describes the conceptual development of a tool for monitoring the academic performance of the student curriculum in the public university system (portuguese). To do this, you define the concept of indicator and the various types of indicators for the tool, based on the development, implementation and processing of data from a questionnaire conducted on several students of IST, as well as from other colleges who use the academic FénixEDU platform. Afterwards the Zachman framework is used, to define which system to design, and the DSR methodology is used to develop the conceptual model and implement the method for the evaluation of the work. In addition to these points, we will also present a conceptual map with the concept of dashboard, applied to the environment under study, and a series of mockups of the designed tool.

3.1 Definition and Identification of Indicators

Indicators are performance metrics that work together in order to improve scorecards for information management [10]. A balanced scorecard (BSC) is a very comprehensive methodology for performance management. It is nothing more than a concept to plan, execute and monitor business strategies [11]. Among the existing indicators, we highlight the KPI's, KRI's and KCI's, which can measure the performance, control and risk, respectively.

A KPI is a performance indicator that allows the monitoring of the achievement of goals. In this case, to by the student [4].

A KCI is a control indicator used in organizations in order to monitor the levels of relative control with a certain degree of tolerance [4]. In our case, we will adopt two different perspectives: one from the student's point of view and the other from the teacher's.

A KRI is an indicator that evaluates the risk of a given activity, which is usually associated with the analysis of operational risk. In the case of FénixEDU, it will determine if the student is about to fail. This is an indicator that lets you drill down on a dashboard in order to find the (root) cause of the events [4].

To complete the definition of which indicators to take into account a survey was conducted on the students of the portuguese public higher education system, whose analysis resulted in the following KPI's, KCI's and KRI's been done:

KPI's:

1. Trend of the general point average (GPA) of a student, depending on the total number of courses taken and years at the university;
2. Current GPA of a student in a particular course, above the GPA of other students enrolled in this same course, in that particular school year;
3. Final graduation GPA;
4. GPA of an academic year;
5. Weighted average of the student during his major;
6. Grade in an exam;
7. Grade in a laboratory class;
8. Grade of a project;
9. Grade in a test;
10. Grade of a course completed by the student;
11. Grade in an evaluation component;
12. Grade of an evaluation quizz;
13. Grande in an oral test;
14. Number of courses retaken by the student, according to the number of registrations in the same course and the number of years in the university;
15. Correlation between the number of absences and the GPA of the student in a given course class;
16. Number of absences still allowed according to the total amount of absences of a student in a certain course;
17. Employability rate.

KCI's:

1. Absences in a certain class;
2. Realization of an evaluation component;
3. Minimum grade required in the following evaluation;
4. Grade in an evaluation component;
5. Grade of a course;

6. GPA of the student.

KRI's:

1. Amendment of the planning generated by the ERP (enterprise resource planning) system;
2. Absence in a compulsory class;
3. Failing to complete an evaluation component (test, test, evaluation form, oral or laboratory);
4. Failing to hand in an evaluation component (job, form or project);
5. Failing to deliver proof of a valid absence;
6. Grade 10 (in 20) in an evaluation form;
7. Failing in an evaluation component;
8. Low rate of class attendance(less than fifty percent of the total number of lectured classes).

The most salient indicators on the dashboard are undoubtedly the KRI's because of the wide use of a color map. In a high risk situation, the displayed value will be red; in a low-risk situation the value will be yellow; and in a situation without risk, the color will be neutral or green, being that the green color will correspond to a great situation. Moreover, the performance indicators are largely reflected on the functions that the dashboard has and, as seen in the identification of KCI's, they represent the data that will be used in order to achieve a better management of student performance monitoring.

3.2 Zachman Framework

In order to plan and design our work, we relied on the first row of the Zachman framework matrix, with which we can describe the scope, in a more contextual way, of the data, function, location, people, time and motivation of the work that will be developed, as shown in table 2. Although the main focus of its development is the second row of the matrix, the business model, in conceptual terms, we will describe it in the next subsections, through a conceptual map, which allows you to connect all the concepts involved in this project; diagrams of practical cases, a model of the technological architecture that will be implemented, mockups for the development and testing of the solution, through the description of a business case and a descriptive storyboard, that we'll present in the next section.

	Scope
What? (Data)	Operational dashboard
How? (Function)	Monitoring of students performance
Where? (Location)	Colleges or universities in the portuguese public higher education
Who? (People)	Students, teachers and tutors
When? (Time)	Throughout each semester
Why? (Motivation)	Monitoring and improving the performance of students

Table 2: Application of the Zachman framework to work planning

3.3 The Surroundings of an Academic Dashboard

The conceptual development of our academic dashboard encompasses a number of concepts that relate not only to the dashboard itself, but also all to its surroundings, as we can see in figure 4. In this image, we can still verify the application of the concept of a dashboard, the various types of existing dashboards on the market and type of information presented in each one, all of them working according to the KCI's and KCI's KPIs. In this case, the dashboard is used by teachers to monitor students, which in turn also use the same dashboard. This can contain elements such as BSC's and other types of data representation, material presented and defined by applying the concept of real-time reporting, which is triggered by the concept of BAM. Since the purpose of the dashboard is monitoring, the term BPM is used, and the core is designed using the Zachman framework, where an ERP system is adopted as background and the concept of BI, to infer the database and produce analytical reports.

3.4 Conceptual Proposed Model

The projection of the solution is based on a small functional analysis of the whole platform, which emphasized the domain model, the technology architecture, practical cases, views about these cases, activities, requirements, informational entities and mockups, which will serve as the basis for the implementation of the dashboard for monitoring of the academic performance.

The projected technological architecture, as we can see in figure 5, includes the system (Dashboard), in which we have two services involved (Manager of alerts and Configurator of Indicators), a software system, which is the dashboard itself, two servers (e-mail and SMS (mobile short message service) a user interface and a predictive model, represented by a node. Since the node is a generic entity of a technological architecture, ArchiMate 2.1 standard, often called the technological interface [12], we chose this representation for the predictive model, by relying on business rules defined in an outer scope to Dashboard. The servers of email and SMS are connected to the internet and the database feeds both the dashboard, like the ERP system, where the dashboard itself is integrated. Configurator of indicators are associated with the various types of indicators, described as infrastructural features, as already defined earlier, and with Business Rules which are associated with the various rules for approval in the courses of the majors of the educational establishment where the dashboard is integrated and where the ERP system exists. These business rules will serve as a basis for the prediction model, as they will support the planning automatically generated for each student, a functionality that we will describe in the next paragraphs.

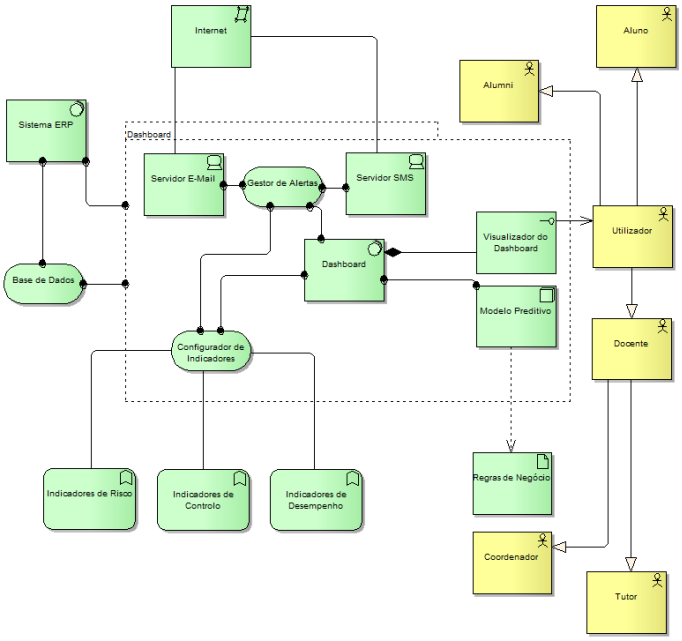

Figure 5: Technological Architecture Dashboard

At a first glance of the technology architecture, we were unable to identify for what kind of business is the designed dashboard intended for, a key idea for the introduction of specification, as it can be applied to any area. However, as our core is the academic context, we can see in figure 6, the description of the entire domain model to design the dashboard.

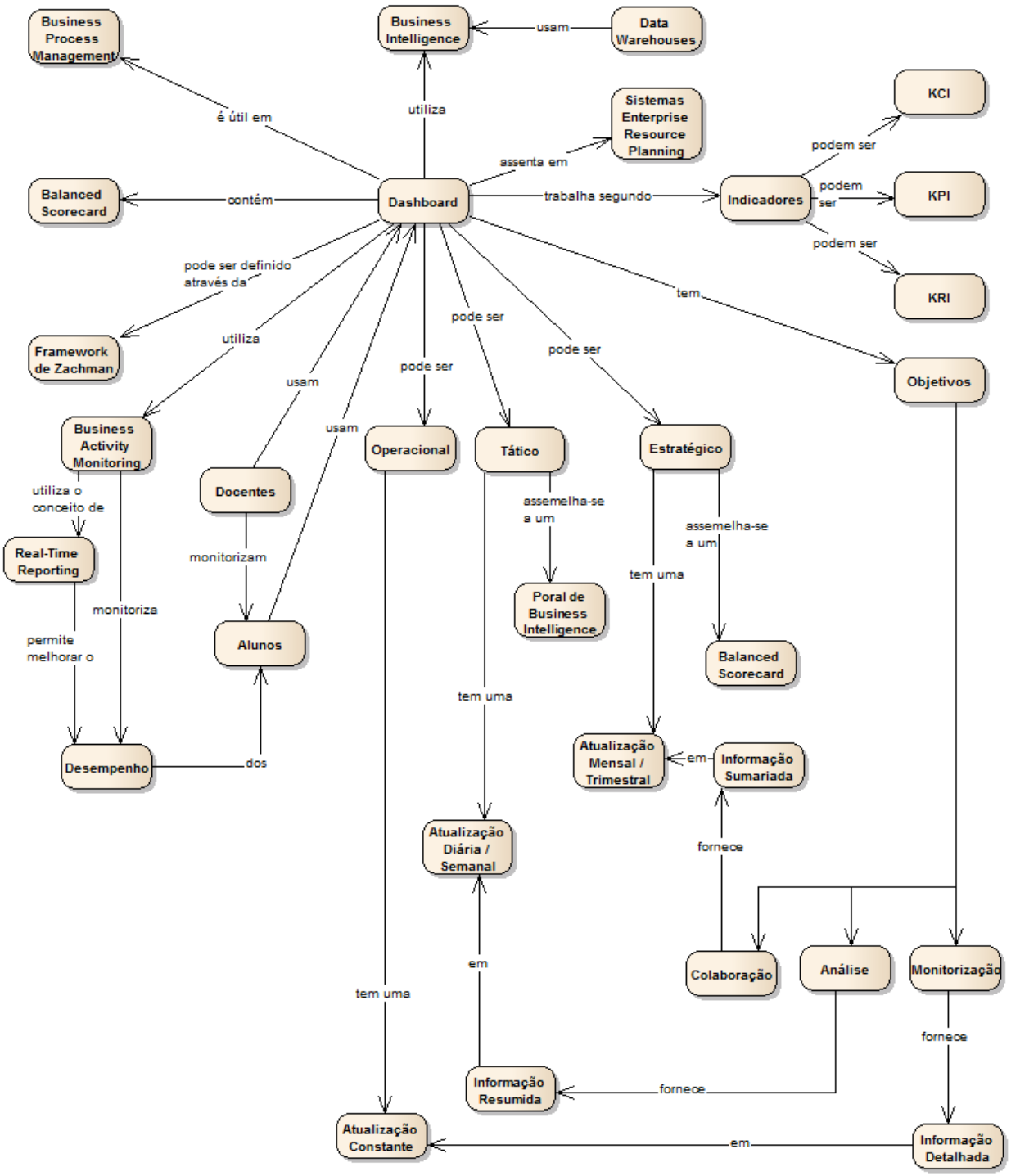

Figure 4: Conceptual map of the Academic Dashboard

As we can see in the domain model, the dashboard design has the analytical tools aggregated, where graphics and other visual elements, typical elements of a dashboard, such as lists and tables for instance, are used. We chose not to develop a scorecard, because the dashboard shows data in tables and graphs, with the objective to visualize the events, while a scorecard shows graphics and comments, with the purpose of summarization of data and the showing of periodic results, measuring the long term progress and not the performance indicators in a reasonable time frame. For the alarm system, we used the concept of traffic light indicators for dashboard reporting, with a color-code equivalent to a set of traffic lights and alert icons. The latter are the indicators of notifications, which are used when there is the need to group the indicators in a visual form, such as KRI 's. Since the executives and customers want a preview of the most critical information, with the minimum space occupied on the screen, the analogy with traffic lights is used, where red light

indicates that there is a problem that affects the time, cost, quality or scope; yellow light indicates the need for caution, for example, there may be a problem in the near future, this sequence; and the green light indicates that the work is going according to plan, and there is no need for the involvement of an extra middleman for the implementation of the use cases of the person conducting the business, that inserts the dashboard screen in question.

Regarding the analytical tools, we used pie charts because they are a very poor way of visualizing data, so they are useful when there isn't the need for a detailed analysis; bar graphs and columns to make categorized analyzes; line charts to show the progress of one or more steps simultaneously; as well as tables and lists to group non-numerical values or relations between data that cannot be easily visualized [13].

Depending on the institution of higher education where the dashboard will be implemented, the evaluation components may be more or less, when compared with what is described in the domain model, and we have chosen to describe in detail its most generic components.

Making an analepsis of the analysis, let us return to the technological architecture diagram to describe the context model. Here, we can see two colors that are represented as two layers of ArchiMate 2.1. The green elements relate to the technological layer and the elements in yellow show the business layer of the application. Since the Dashboard would be used by the users described in the diagram, the individuals conducting the business, we have chosen to include them in the technological architecture.

The proposed tool will contain the features described, albeit in an abstract way, by the practical cases of the figures 7, 8, 9, 10 and 11, referring to the various users: Student, Lecturer, Coordinator, Alumni and Tutor respectively. The identified use cases represent the functional requirements of the application. In particular, the cases regarding Lecturer and Tutor, three non-functional requirements (RNF1, RNF2 and RNF3) were created to identify the necessary dependencies (see figures 8 and 10).

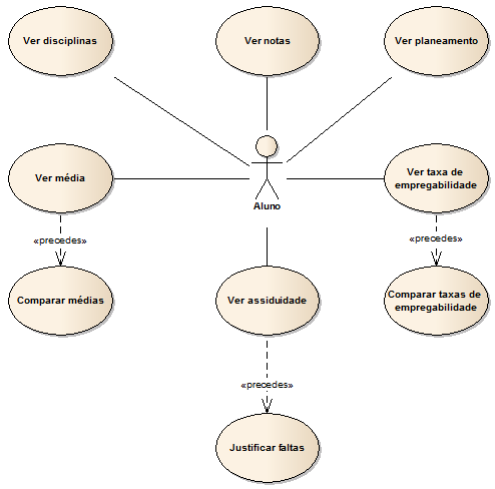

Figure 7: Use cases diagram for the proposed Student

In order to complete the specification, the technology architecture model also mentions the existence of a viewer of the dashboard and a predictive model, as already mentioned, but not detailed. The viewer is associated with a generic user, which specializes in various kinds of user (and even sub-types, as with the Teacher and Tutor). The use case "Contribute to the planning" is key to the functioning of the predictive model. As we shall see in the case study, the planning automatically generated by the ERP system contains the days remaining until the next evaluation of each course in which

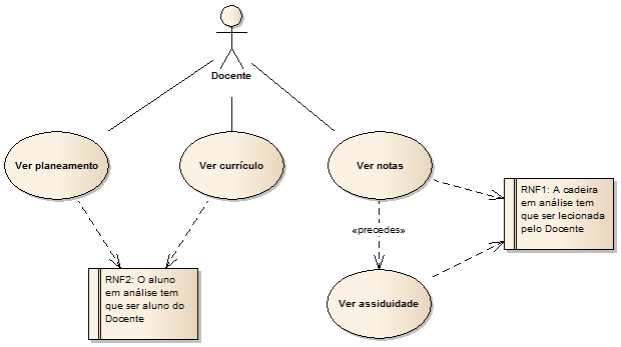

Figure 8: Use cases diagram for the proposed Teacher

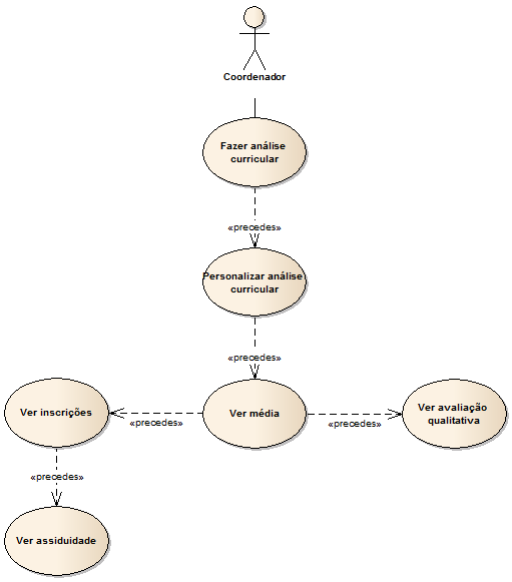

Figure 9: Use cases diagram for the proposed Coordinator

the student is enrolled, the minimum amount of study days recommended for each exam and maximum number of absences recommended for each course. Since the goal of the tutor is the improvement of the student performance, it may contribute by suggesting improvements to the planning itself. The minimum recommended study days are triggered by defined business rules associated with the evaluation rules of each course. Thus, it is possible to adjust the dynamics of the dashboard and make predictive monitoring, without resorting to data mining.

4 Case Study: FénixEDU

The application example of the solution adopted for this dissertation was a platform of academic management, the FénixEDU system designed, developed and implemented by the Direção dos Serviços de Informática at Instituto Superior Técnico, in Universidade de Lisboa. We begin by presenting the case study in question and the objectives of the implementation of the solution.

The FénixEDU system is an ERP system, available in various colleges and institutes of the Universidade de Lisboa. The system not only allows the academic management of the college itself, but also the support of public contests for the admission of faculty members and non-teaching staff, students and researchers with its own technological platform.

The objectives of the implementation of the projected solution

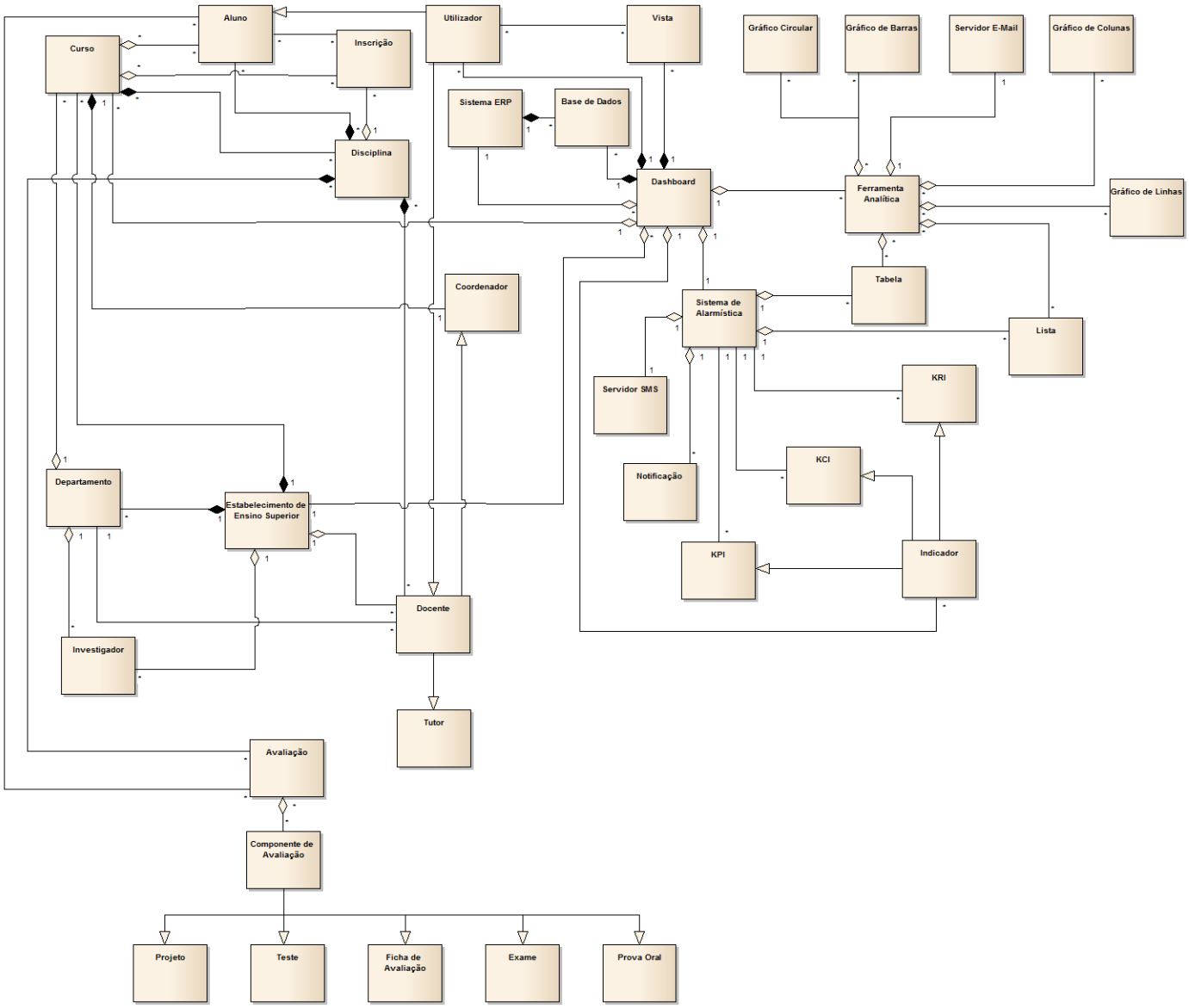

Figure 6: Domain Model of the Academic Monitoring Dashboard

were defined according to the intended research questions:

- Monitor the academic performance of the student curriculum;
- Enable the interaction between the tutor and student;
- Create an alarm system for the student;
- Improving the academic performance of the student curriculum.

The review of the work follows part of the evaluation method suggested by Hevner, with one case study (FénixEDU), applied in a given location (Instituto Superior Técnico - Universidade de Lisboa) and description of the use/application scenarios for the designed solution (described in next subsection) [7].

In the next subsection, we will describe a scenario for implementing the designed solution on the student. Since the validation of the solution methodology is based on DSR, we will also describe its application to the proposal in question in the following section.

The Design Science Research is a methodology that aims to develop solutions that are ”technology-based and relevant to business problems” through artefacts such as an investigation process, [14] which is based in seven guidelines:

1. Design as an artifact. *For this particular case, a series of articles were produced that served as the basis for the answer of the research questions already indicated. A diagram of the technological architecture, use case diagrams, and activitiy diagrams associated with each business intervenient produced, the mockups designed to implement the solution, associated indicators and the definition of scenarios for the test solution.*

2. Relevance of the problem. *The expertise for the development of a dashboard for monitoring academic performance, from a strategic perspective, can be a competitive advantage amongst the various higher education institutions, with the aim of improving the final general point average of their students and to act on them. Nowadays, in most colleges of public universities in Portugal, with more than 2000 students, it is a challenge for the faculty members to keep track of the grades and GPA of its population. In these*

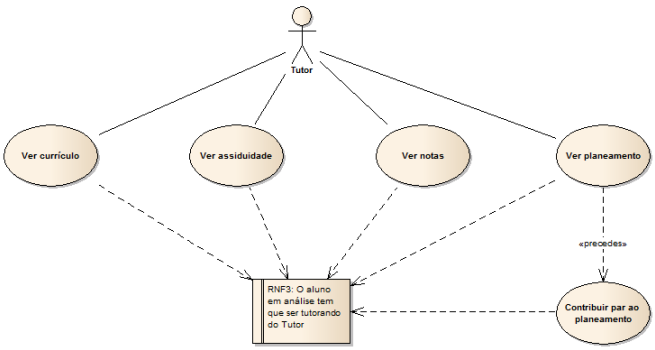

Figure 10: Use cases diagram for the proposed Tutor

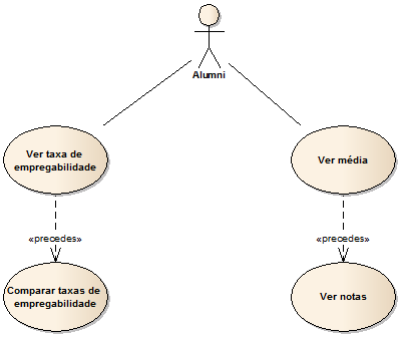

Figure 11: Use cases diagram for the proposed Alumni

cases, a dashboard, be it static or dynamic, which is updated in a timely fashion or in real time, is the key to controlling this type of performance which can result in its improvement.

3. Evaluation of the drawing. *At this point, the methodology for evaluating the work of Hevner, is used to evaluate the artifacts produced, as is detailed in this section, by describing the scenarios and the justifications for the choice of the various types of displays presented on the screens, except use cases that were only mentioned in section three.*

4. Contribution of research. *This study involved a properly validated scientific research method, with the goal of designing a solution that can contribute to the area for conceptual projection of a dashboard. Besides the solid research that was conduct regarding the historical perspective, as we see in section two, a one architecture framework of information systems is used, the Zachman framework, in order to plan the projection of the solution.*

5. Rigor of research. *During this study, the construction and validation of the artifacts produced followed a strict method by surveying indicators, their support for the projection of a solution, and the creation of scenarios for validation and demonstration, applied to a real institution (IST) with real data provided by DSI.*

6. Drawing as a process. *The requirements were defined in order to solve the problem in the current context and all the methods and knowledge available were used with the objective of achieving the solution reached.*

7. Communicating research. *Since the main objective of this study is the improvement of student's academic curriculum, the management component is evident through the established objective of using the dashboard. Alongside this, is the conceptual specification of the concept projection of the latter, regarding technology. Since the thesis is carried out in a business context, the disclosure of the work will be alone at one of the research and development sessions of the Capgemini Group, Capgemini University in Les Fontaines (Paris, France)* [7].

4.1 Application Scenarios of the Solution

The basis of a textual storyboard is an activity diagram, shown in figure 12, where we can see all the steps of the process in an orderly manner, followed by the description of the story.

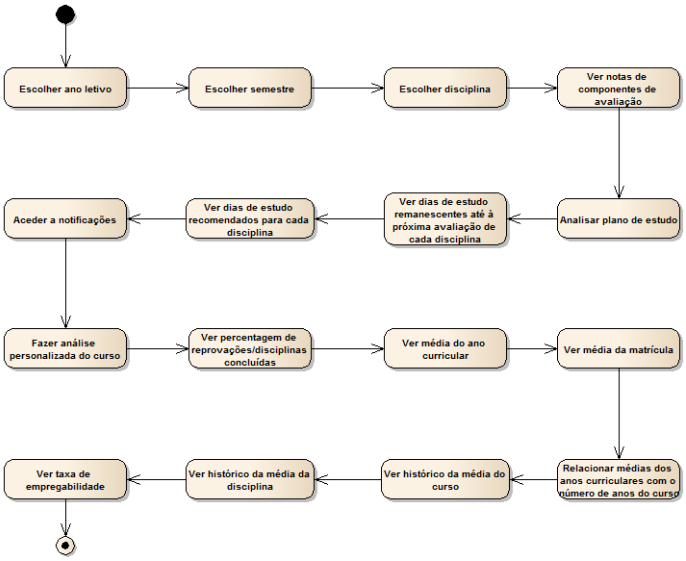

Figure 12: Activity diagram referring to the actor Student, concerning the scene

Rita is a student ad Instituo Superior Técnico, enrolled in four courses of the Masters in Computer Science and Engineering program (Taguspark) this semester. Being a student and having a part-time job, she cannot attend any classes (theoretical or pratical). Thus, she needs a personalized study plan, she can check regularly. But because she couldn't consult the Fénix regularly and did not spend much time in college, the faculty allowed Rita to do the work and projects individually. She would also like to receive periodic notifications reminding her of projects and tasks' deadlines with reference of her failing grades.

After choosing the semester and school year, the first operations necessary in the dashboard, Rita chooses the discipline she wishes to view to see the grades of her evaluation component (see figure 13) and so be able to access her study plan. Here, Rita can see the days remaining until the next evaluation element in the courses she is attending, the days of recommended study time for each course and the latest notifications, as we can see in figure 14.

With some degrees of satisfaction, after evaluating her study plan, Rita returns to the initial screen by rolling up on the dashboard, to the analysis of the course Management and Treatment Information, initially chosen, and clicks MEIC-T, under the first graph in figure 13, to make a personalized analysis of her school year with regard to her curriculum. In the first pie chart, Rita can see the subjects she failed, by curricular year, as well as her GPA over the academic year in which she is. In the second chart, we can have the same perception, but from an enrollment perspective. Since Rita is enrolled for the second time in the first year, these two graphs show different situation. In the third graph, we can see the evolution of her average over the number of enrollments.

In the latter, if adopted by a bar graph display, because we intend to use the notation of traffic lights, in which the color yellow represents a grade close to the negative threshold (for example 10 or 11), and the green color a good or regular value [13].

In this screen, you can still make a new drill down to analyze the history of the course, in the last three academic years, clicking the title bar graph (by referring average), or any of the means of the pie charts. Upon seeing this screen, Rita is disappointed that her average is lower than the historical values represented and therefore wants to see the average of the course she is consulting, by selecting Gestão e Tratamentode Informacão on the drop down of the courses.

Resigned with the situation, Rita concludes her analysis, after seeing the employability rate of the course.

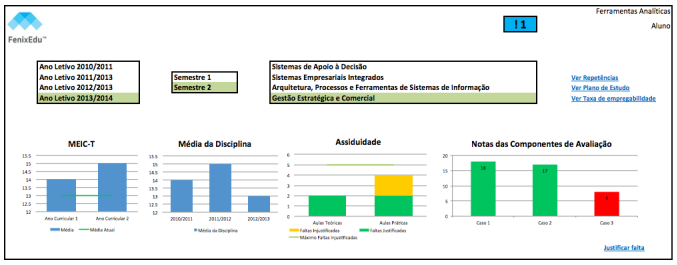

Figure 13: Student dashboard - Choose the school year, semester and discipline

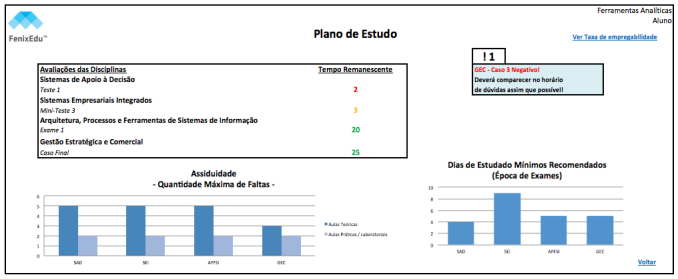

Figure 14: Student dashboard - Plan of study

In this example scenario, we can verify the existence of indicators defined in section three, as well as the use cases identified in several screens associated with the Student actor. Although the current Student Portal already possessed some of these features, in this dashboard other functionalities were developed, such as the possibility of establishing a relation between the number of courses failed and the average of each enrollment or academic year, or the ability to view a study plan automatically generated by Fénix. The absence of these features created some gaps in the previously existing reporting system, which only showed the approvals per school year for each subject and each academic year in particular. The biggest gap is the lack of a monitoring system in a reasonable time frame with the ability to update and generate a study plan, a functionality that can make obsolete the tasks of a tutor.

5 Conclusions and Future Work

This work has enabled the creation of a specification, in conceptual terms, of a tool of dashboards, which can be integrated into ERP system, such as the case study presented, the FénixEDU. The potential to develop the tool resides in the same goals: monitoring the student's academic performance, associated with an alarm system that allows the warning of the student in danger of failing a given course via email or SMS.

The project, in spite of having been applied to a system of academic management, can also be used by any company, in any industry, because conceptually they have the same specification, being that the only difference are the indicators, the emphasis of the use cases and the identified activities.

As shown by the projection of the specification, the research questions, posed with scientific valid method, and the historical perspective, there are some gaps that this research work aims to solve. It reached a domain model and a diagram of technology architecture, supported by diagrams, use cases, activity diagrams and, consequently, by mockups (low and high fidelity), in order to support the specification of the work designed. These were tested in real application scenarios in the case study chosen, with the support of DSI, at Instituto Superior Técnico, and Capgemini Portugal. In the next subsections, we will describe the method of job evaluation and indicate the research questions answered.

5.1 Methodology for Assessing the Work

The adopted evaluation methodology was the work proposed by Hevner [7], when we used the DSR, although only part of the methods were used such as the observational method, through a real case study, and the descriptive method, through scenarios.

The observational method, the case study used, as we have seen in the previous chapter, was the FénixEDU applied specifically to a higher education institution, the Instituto Superior Técnico, Universidade de Lisboa. The field of study in question was the monitoring the events in the ERP system, in which actors were involved users with the role of teacher, tutor, alumni, student and coordinator, the same used in the identification of actors, in chapter three, and actors in the business referred to in section four.

The descriptive method resorted to the construction of scenarios, based on real facts around some of the articles indicated (Indicators, Scenarios, Activity Diagrams, Diagrams of Use Cases and projected Mockups). We used two of the most relevant business actors where there was an urgent need for improvement of the existing analytical tools, a coordinator of a course of IST and a student and part-time worker of the same Institution. For this method, two diagrams were descriptive of custom activities and two dashboards that were implemented in Microsoft Excel were referenced, using real data, the Fénix database, made available by DSI, through a collaboration agreement with Capgemini Portugal, in which I am a consultant.

5.2 Research Questions

The answers to the research questions aim to solve certain gaps in the area, as we can see in the next paragraphs. In order to obtain these answers we will refer to the previously written sections:

1. How to design a dashboard for academic monitoring?

The answer to this question lies at the beginning of the third section of this document, in which all the steps (and subsequent models to design) are listed, which are the following:

1. Identification of the actors of the business;

2. Development of a questionnaire to be applied to existing actors in the context in question;

3. Analysis of the questionnaire data indicated above;

4. Defining KPI's, KCI's and KRI's;

5. Definition of the use cases to be designed;

6. Association of use cases to the actors of the business;

7. Definition of the activities associated with each dashboard;

8. Definition of the domain model;

9. Defining the architecture of the proposed solution through a diagram of the technology architecture;

10. Development of the mockups used, as a reference for the diagram of the technological architecture.

2. How to set the color code to be used on the dashboard?

Through the identification of the risk indicators and the cutoff point between positive and negative, regarding the grades of the courses and of the various evaluation elements in the case study in question, as well as between pass and fail. Take for example the

risk indicators defined in section 3.1. The color code used refers to traffic lights, in which a negative grade will be red; the grades located in a "limbo", as the 10 and 11 (out of 20), or as the values close to fifty percent, will have the yellow color and a good grade will have a green colorm which symbolizes the periodic evaluation.

3. How to identify the features to implement a dashboard?

Through the identification of different use cases and activities associated with each actor, in different swimlanes. Each swimlane corresponds to a different actor and agglomerates the set of features in order of execution, of each dashboard, and each role: Student, Lecturer, Coordinator, Alumni and Tutor.

4. How to determine the actions that can be performed on the dashboards of each actor?

By conducting questionnaires to the population context, so that KCI's, KRI's and KPI's can be defined, as we can see in chapter three. With the defined indicators we can use them to design the actions to implement the dashboard, creating views through KCI's and defining activities through KPI's.

5. How to represent information flows between each date, and each drill down?

By identifying informational entities, the activities associated with each actor and the identified non-functional requirements.

6. How to create a predictive model for the generation of an automated and personalized study plan?

Through a set of predefined business rules to ensure the approval on each course, and through the contributions of each tutor for every student.

7. Who are the actors involved in the design process of the dashboard?

The actors involved were identified through the existing ERP system, where the dashboard will be applied. In our case study, intervening individuals are the Student, the Alumni, the Teacher, the Coordinator and the Tutor, who complete the context.

5.3 Future work

The creation of innovative artefacts, or those that can support the implementation of the designed solution, allows the resolution of some of the gaps in the research conducted. Since it is a type of applied research, the artifacts are not abstract, but rather instances of the modeled context.

In parallel with the scientific contribution, the specification, the fact that the tool chosen to be implemented in the case study system, allows us a better insight into the business in order to create more value. In this light, we were able to align the existing and the required processes, and to achieve this with greater speed and therefore with a higher success rate [15], while still guaranteeing one of the principles of high-performance IT. Since we focused on the business activity, we paved way for a future where a tutor is no longer required [16].

With these considerations in mind, a future development of this research may be able to add an alarm system with a predictive model (data mining), which will enable the reception of feedback, from all the actors in the context, in which the obstacle will be choosing a specific technology, in order to narrow the wide range of possibilities the exist in most dashboards. Thus, we would have a dashboard system developed through the combination of data warehouses with the concept of data mining, using the concepts of business activity monitoring and business intelligence to support the analysis of the activity in question.

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