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Web Platform System for Course Accreditation in Higher Education

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RESUMO

O ensino superior tem evoluído muito ao longo dos anos em todo o mundo. Os países têm sido forçados a adaptar as suas metodologias de ensino ao mercado com novas técnicas e métodos, cada vez mais centrados no estudante. Os governos criaram políticas de acreditação de cursos com normas rigorosas para que o ensino ministrado à população seja de qualidade através de agências de acreditação que supervisionam as instituições de ensino superior que implementam cursos. Esta tese, composta por três artigos, descreve o processo de acreditação em diferentes países do mundo através de uma revisão sistemática da literatura, a criação de uma aplicação web MERN stack desde o seu planeamento até à sua implementação. O pedido visa simplificar algumas das tarefas associadas ao processo de acreditação, tendo alcançado os objectivos propostos com a sua criação.

Palavras-chave: acreditação de cursos, educação superior, MERN stack app

ABSTRACT

Higher education has evolved a lot over the years all over the world. Countries have been forced to adapt their teaching methodologies to the market with new techniques and methods, increasingly student-centered. Governments have created course accreditation policies with strict norms so that the education provided to the population is quality through accreditation agencies supervising higher education institutions implementing courses. This thesis, composed of three articles, describes the accreditation process in different countries worldwide through a systematic literature review, the creation of a MERN stack web application from its planning to its implementation. The application aims to simplify some of the tasks associated with the accreditation process, having achieved the proposed objectives with its creation.

Keywords: course accreditation, higher education, MERN stack app

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ACRONYMS LIST

A3ES	Agência de Avaliação e Acreditação do Ensino Superior
ANECA	Agência Nacional de Avaliação e Acreditação da Qualidade
API	Application Programming Interface
BSON	Binary JavaScript Object Notation
CEA	Certified Evaluation and Accreditation
CNEAI	National Council for Evaluation of Higher Education and Research
CUQAS	Chinese University Quality Assurance System
FOL	First-Order Logic
FUC	Curricular Unit Form
GUQAS	German University Quality Assurance System
HE	Higher Education
HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institutions
HEQC	Higher Education Quality Council
JABEE	Japan Accreditation Board for Engineering Education
JSON	JavaScript Object Notation
JUQAS	Japanese University Quality Assurance System
JVM	Java Virtual Machine
MEAN	MongoDB, Express, Angular, and Node
MERN	MongoDB, Express, React, and Node
MEVN	MongoDB, Express, Vue, and Node
MEXT	Ministry of Education, Culture, Sports Science and Technology
NAAC	National Assessment and Accreditation Council
ODM	Object Data Modeling
OECD	Organization for Economic Co-operation and Development
OOP	Object-Oriented Programming
ORCID	Open Researcher and Contributor IDentifier
PAACES	Platform to Support the Accreditation of Courses in Higher Education
QAA	Quality Assurance Agency
RAM	Random Access Memory
RDMS	Relational Database Management System
RMB	Renminbi
SAC	Course Accreditation System
SQAF	French Higher Education Quality System
SUEQAS	Spanish University Quality Assurance System
SUQAS	Swedish University Quality Assurance System
TQM	Total Quality Management
UKA	Higher Education Authority
UKUQAS	United Kingdom University Quality Assurance System
UML	Unified Modeling Language
UML	Unified Modeling Language
VPS	Virtual Private Servers

INTRODUCTION

This master's thesis presents the state of course accreditation in higher education in various countries worldwide, from its origins to the present day.

It aimed to show how the course accreditation process can be streamlined using a web platform developed in MongoDB, Express, React, and Node stack (MERN).

It results from the creation of three articles. Article I is a literature review of the course accreditation systems in higher education. Article II is the software engineering planning to support accreditation courses in higher education institutions. Article III is implementing a web platform to support accreditation courses in higher education institutions using the MERN stack.

Questions to Investigate

The questions investigated in this master thesis were how the accreditation of higher education courses takes place in different countries worldwide, how can a web platform be implemented to simplify the accreditation process, and how the platform can be implemented using the MERN stack technology.

Motivation

Higher education institutions have difficulty gathering and presenting, in a centralized and easily accessible way, the information required by the accreditation agencies. The creation of this web platform allowed simplifying and speeding up some of these processes, reducing time and costs for higher education institutions.

Document Organization

The present document is organized into three articles.

Article I is a literature review of course accreditation systems in higher education. It reviews the literature on different systems used in Accreditation and Quality Assurance Methods, in Higher Education Institutions (HEI), from other countries, inside and outside Europe.

Article II is about software engineering planning to support accreditation courses in higher education institutions. Describes the essential functions related to the quality and accreditation of courses and services, how the web application model was designed, and which Unified Modeling Language (UML) diagrams were used to create the design of the

web system to support the accreditation of the Institution's courses, the use case diagram, the class diagram, and the activity diagram were presented. The plan addresses two phases of the assessment process: self-assessment and external assessment.

Article III presents the implementation of a web platform to support accreditation courses in higher education institutions using the MERN stack. Describes the creation of the platform to support the accreditation of courses in higher education, PAACES – Plataforma de Apoio Acreditação Cursos Ensino Superior, which allowed grouping the necessary information in a single software, speeding up the accreditation process for easy web-based consultation.

Article I - Literature Review of Course Accreditation Systems in Higher Education

ABSTRACT

This study reviews the literature on different systems used in Accreditation and Quality Assurance Methods, in Higher Education Institutions, from other countries, inside and outside Europe. There are significant differences between institutions and governments within this general pattern related to contextual considerations and assessment methods. This paper reviews course accreditation flows in Higher Education in Portugal, Spain, Germany, Sweden, England, the United States of America, Japan, China, France, and India. It intended to do a literature review in these countries to answer questions about the requirements to accredit a course, what documentation is needed, and what sequence to follow in the quality method.

Keywords: management, academic courses, degree accreditation, quality system, higher education.

INTRODUCTION

Higher Education in developed countries has been growing, with more and more institutions with a substantial increase of courses in higher education. The new paradigm has forced HEIs to bet on the internationalization of services, where they have to focus on academic processes and markets to increase their competitiveness. These new reality forces HEIs to improve their quality and excellence standards in their services to satisfy an increasingly demanding and diversified public. Fundamentally, HEIs invest in quality in seeking excellence, which is critical for survival. Europe established multiple standards, and the Government sustains the rate, where entities responsible for control, accreditation, and auditing course management, faculty, and infrastructure are appointed and must be met. For several years, private higher Education in Portugal needed an entity to regulate the management of its courses and strategies to be implemented. It was challenging to impose procedures familiar to the different educational institutions, ensuring quality certification of student services. This study reviews the literature on different systems used in Accreditation and Quality Assurance Methods, in HEIs, from other countries, inside and outside Europe.

METHODOLOGY

This article used a systematic review as a research method and process to identify and analyze key research findings (Snyder, 2019). A systematic review aims to identify evidence that fits pre-specified eligibility criteria to satisfy a particular research question or possibility. Using systematic and explicit methods in reviewing the articles and existing evidence can minimize bias, thus allowing for credible results to draw conclusions and make decisions (Moher et al., 2009). The author has extensively used articles, official and private documents, research papers, magazines, periodicals, newspapers, and books to prepare this article. The criteria used were the formulation of questions related to the problem addressed in the article. These search articles were relevant in the search for answers to the theme of the present work, having as one of the criteria their citation and publication, the findings were interpreted, having as a guide the questions presented, trying to be as reliable as possible based on the literature researched (Needleman, 2002). The list of reference articles is provided in total and alphabetical order. Thanks are given to all authors and editors.

QUESTIONS TO INVESTIGATE

The purpose of this study comes from the need to verify the differences between the different accreditation systems of Higher Education Institutions in different countries. The questions to be investigated are the requirements and rules to accredit a course in different countries, what documentation is needed for quality implementation, and the sequence to be followed in accrediting a course.

COURSE ACCREDITATION

This article analyzes and verifies the differences between the course accreditation methods in Europe, Asia, and America.

QUALITY ASSURANCE METHODS IN HIGHER EDUCATION

This section will describe the importance of using concrete and accurate techniques for quality assurance and disseminating results in different media. Techniques used in Europe, the United States, and the Asian continent were researched. The studies of Massy (2010) repeat the need for more refined forms of quality assurance for higher education institutions, classifying them into three categories, accreditation, used in the United States. Evaluation,

European education standards, and peer-reviewed processed quality auditings combine performance indicators, self-study, and review.

PROCESS REVIEW AND QUALITY AUDITING

Quality audit, relative to process review, focuses on analyzing the internal quality and adopting improvements in these processes (figure 1). Several studies in various countries have concluded that inducing capacity building can significantly improve learning and teaching methods in Higher Education Institutions (Massy, 2010).

To achieve excellence status, many HEIs have applied the scorecard method to business excellence, allowing them to improve their processes through organizational excellence acquired through crucial elements, organizational learning, and significant improvements in the processes used (Wongrassamee et al., 2003). The quality of the processes must be ensured internally by the institutions and must be continuous to improve the institution's quality.

EVALUATION AND QUALITY

The studies presented in this section contextualize quality and evaluation in Europe, China, Japan, India, and the United States of America. To this end, conceptual mapping of the quality scenario involving Higher Education (HE) in all these countries.



Figure 1 - Illustration of Harvey and Green's five ways of thinking about quality

In Portugal

In Portugal, the accreditation process is carried out by the Higher Education Evaluation and Accreditation Agency (A3ES) (Felix et al., 2017). Higher education courses are evaluated according to the criteria established by the Course Accreditation System (SAC) and, if approved, receive accreditation from A3ES for six years (Guerra & Leite, 2022). For the accreditation process of a new course, it is essential to meet all of the criteria established by SAC and for the institution to provide all required documentation promptly (Guerra & Leite, 2022). The accreditation process in Portugal is generally efficient, with most courses receiving accreditation within a reasonable timeframe. However, the authors also note that the process can be more complex and time-consuming for institutions seeking accreditation for the first time or offering new or innovative courses (Gamboa & Melão, 2012).

The Agência Nacional de Avaliação e Acreditação da Qualidade (ANECA) carries out the accreditation process in Spain. Higher education courses are evaluated according to the criteria established by the Spanish University Quality Assurance System (SUEQAS) and, if approved, receive accreditation from ANECA for six years. The accreditation process in Spain is generally efficient, with most courses receiving accreditation within a reasonable timeframe. However, the authors also note that the process can be more complex and time-

consuming for institutions seeking accreditation for the first time or offering new or innovative courses (de Miguel & Apodaca, 2009). The accreditation process of a new course is essential for the course to meet all of the criteria established by SUEQAS and for the institution to provide all required documentation promptly.

In the United States of America

Accreditation in the United States of America is based on the results achieved in a public process to show whether the Higher Education Institutions respect the defined quality objectives. Innovative methodologies in teaching can be reflected in better outcomes in course accreditation (Kelley et al., 2010). This type of accreditation in the United States of America is unique to education. It is common in undergraduate education, where a comparison is made of the performance of educational institutions against defined metrics determined by the Government or accrediting agency. This process will evaluate if the proposed objectives for the degree to be accredited have been met. This type of certification must be done by agencies external to the HEI. This accreditation is done in stages and will ensure that the minimum requirements related to quality are met. The results must be disclosed and published for the institution to receive the certification (Plummer et al., 2021).

In Germany

Studies have been selected that address the theme's evolution between 1994 and 2015 (Geisinger, 1994), (Harris-Huemmert, 2008), (Orr & Hovdhaugen, 2014), (De Wit & Hunter, 2015). According to (Geisinger, 1994), the analysis of HE assessment has highlighted a deplorable assessment situation in Germany. This situation decreased public investment in the Government's scientific and educational funds. Reports and surveys exposed this reality in the 1980s and 1990s. German students were compared to students in the rest of Europe. It identified that German students needed 3 to 5 additional semesters to obtain their degree (Geisinger, 1994).

There were also severe problems in establishing comparisons between the performance of the universities, which began to follow recommendations for standards suggested by the Conference of Rectors and Presidents of Universities and HEIs, in the annual teaching reports (Geisinger, 1994). The creation of the Foundation of the Center for the Development of Higher Education (Zentrum für Hoch-Schulentwicklung) in Gütersloh was an initiative

to promote the quality of HE at German universities through internal and external evaluations and external evaluations of teaching performance. Although some instruments were developed for course evaluation, their application, significance, and publication of comparable results were controversial (Geisinger, 1994).

(De Wit & Hunter, 2015) explained the complex decision-making in HE concerning legal, administrative, legal requirements, administrative planning, and financial issues in the federal state of Germany. He analyzed the increase in HE privatization and the legal and economic problems. Introducing new financing systems based on performance indicators augurs well for primary status structure and legal management changes. These changes dramatically increased between 1975 and 2000, reaching about 1.8 million (De Wit & Hunter, 2015). While HE vacancies have not kept up with this growth, neither has the number of teachers.

A reform of the German HE system was introduced by calling for greater competition and differentiation through deregulation, performance orientation, and performance incentives. These reforms are part of the policy of increasing the competitiveness of the German HE and provide necessary measures: public funding of HEIs, and allocation of resources at the institutional and departmental levels, to be based on performance indicators (De Wit & Hunter, 2015). (Harris-Huemmert, 2008) research criticizes Germany for not having standards for selecting HE evaluators or evaluating their performance. The analysis contextualized the processes of German HE evaluation through the study in the assessment of science education in Baden Württemberg and explored how experts were selected. The study describes the problems faced and finishes by showing there might be space for introducing standards for determining evaluators in the German- evaluation scenario. A more recent study (Orr & Hovdhaugen, 2014) argues for widening access to HE as proposed by the European policy agenda through a second chance route by removing the criterion of educational attainment in secondary education as the determining factor for access. An analysis compares the approaches of similar routes in Germany, Norway, and Sweden with different forms, principles, and obligations for HEIs. (Orr & Hovdhaugen, 2014) They evaluated the impact of second-route opportunities to widen participation in HE and discussed the contribution of these measures to access to inclusive education in the country.

In the United Kingdom

The Higher Education Funding Council for England (HEFCE) structures the assessment process in England. It is separated into two assessments. One focused on teaching, and the other on research. The goal will be to create quality profiles based on clarity, transparency, efficiency, neutrality, coherence, credibility, continuity, and parity (Mountford-Zimdars et al., 2015). The methods the agencies use to evaluate Higher Education Institutions, such as pedagogical projects, faculty, and course infrastructure, are similar to the techniques presented by Brenan and Shah (John & Tarla, 2000). Government entities, consortiums, or HEIs usually do this process. For HEIs held accountably, the results of the evaluations must be published to be compared with those of other HEIs. These external evaluations occur for five to ten years (Massy, 2010).

The concern with quality standards and assessment applied to HE has been evidenced in several approaches (Athanassopoulos & Shale, 1997), (Sanders & Harvey, 2002), (Pussegoda et al., 2017). The study (Athanassopoulos & Shale, 1997) compares corporate performance in 45 HEIs in the United Kingdom. Government initiatives in this sector have emphasized responsibility, worth for money, and cost regulation encouraged by the concepts of New Public Management (NPM) and its derivation into the official weighting scheme followed by the funding agency, in the sense of establishing measures and criteria for allocation of resources to universities. Quality is evaluated regarding return on investment or expenditure. The value-for-money approach in education can be associated with accountability. Accountability to funding and funding agencies is expected in public services, including education. Focusing on cost control, (Athanassopoulos & Shale, 1997) adopted two distinct models for defining performance: cost minimization and result maximization. The two models can be complementary to measure HEI results' cost efficiency. The universities 'activities' statistics have reached their total potential in defining comprehensive perceptions of execution and objective attainment concepts advised by institutional objectives. According to the proposed methodology, the study rated six universities in the United Kingdom that showed satisfactory individual performance in all tests (Athanassopoulos & Shale, 1997). Research on Total Quality Management (TQM) in HE from the United Kingdom by (Kanji & Tambi, 1999) reports that the progress use of TQM has been slow, with only a few universities adopting it. The HEIs using a TQM method similar to their partners in the United States have shown improved student performance, services, decreased costs, customer gratification, and customer costs (Kanji, 1998). The

authors examined how the fundamental principles and concepts of TQM could be evaluated to evaluate the quality of HEIs in various aspects of their internal processes.

The TQM principles and fundamental concepts constituted critical success factors and reflected the performance of the institutions. The Business Excellence Model (Kanji, 1998) has demonstrated several advantages and has overcome shortcomings over other quality management models. A study performed by external monitoring of HE quality (Sanders & Harvey, 2002) examined the different types of external agencies and their modus operandi. Harvey criticizes using statistical indicators as assessment tools because they have their limitations as quality performance measures. His prerogative is that evaluation legitimizes the status quo and is concerned with the method, ignoring the nature and styles of learning styles. He further contests that self-evaluation forces peer review to occur. In this peer review and, in this specific case, it is a biased, distorted judgment on the search for discrepancies and personal assessment. (Sanders & Harvey, 2002) is quite radical when he proposes that HE monitoring agencies must be concerned with quality, address implications for student learning, change from education, and move from accountability and compliance-oriented agencies to raise important issues of improving student learning.

In a study of quality and standards, English HE, Jackson, and Bohrer (2010) discussed ensuring quality. The study focuses on the attributes of the English system centered on self-regulation and self-governing institutions. The analysis interrogates the process of quality policy transition that occurred during the consolidation of the 2006-2011 evaluation cycle. The history performed by Quality Assurance Agency demonstrated that there was an initiative between institutional evaluations and program evaluations. The institutional assessment took place by audit and was conducted by the Higher Education Quality Council (HEQC). Program evaluations occurred through quality assessment with subjective instruments by HEFCE. Jackson and Bohrer (2010) point out that with the merger in 2006, the Quality Assurance Agency (QAA) absorbed the functions performed historically by HEQC's predecessor agencies, HEQC and HEFCE, demonstrating great vagueness in defining systems and methods currently in use to assess the guarantee of academic values in the United Kingdom. The audit processes are carried out by assessors, namely senior HEI staff instructed by the QAA, who examine documentation and join with staff and learners to assess the efficiency of quality methods. As of January 2010, students joined the audit teams. Their conclusions are available in reports published by QAA.

The evaluation of research work in the research in the United Kingdom The study by Lucas (2014) investigated the academic struggle for quality guarantee methods in HEI. The processes were perceived to monitor and control academic work related to teaching and research in the country's HEIs over the last 20 years. Academics situated in specific contexts have challenged and resisted discourses and positions (THOMAS; DAVIES, 2005) imposed on them.

In China

The core of the Chinese higher education reform, guided and promoted directly by the Government, is the development of content that raises the education quality and the capability to innovate and improve the modern socialist system of a higher system of higher education. The most visible effect of the reform has been a significant movement toward the autonomy of the HEIs themselves, manifested in initiatives in areas such as undergraduate studies, internationalization, and computerization. In addition, prioritizing educational equity and the local values of higher education - to involve all the significant elements of student growth - and thereby develop the content of HEIs to raise education quality.

Improving the quality of education becomes a comprehensive, organized project that depends on a modern university system, progressive ideas on education, a system of internal quality assurance in universities, and efficient, systematized efficient, and systematized management mechanisms that demand attention from the Government, HEIs, and society. For this reason, since the early 1980s, China has conducted undergraduate assessments. In 2003, through the Education Rejuvenation Action Plan (2003-2007), the education (2003-2007), the Ministry of Education proposed a five-year evaluation system of pedagogical work in the HEIs. In August 2004, it created the Center for Evaluation of Education and Teaching, directly subordinated to this Ministry. As a result, the country's evaluation of education and teaching has been pushed forward. Teaching in the country has been gradually systematized, standardized, professionalized, and more scientific. In 2007, the Ministry of Education and Finance proposed another essential project, implemented vertically across the country, to realize educational reform in popularizing higher education. The Quality Reform Project for Teaching and Undergraduate Education Reform Project, also known as the

Quality Project was based on three other projects: the National Renowned Professor and the National Course of Excellence, effective in 2003, and the National Center for Demonstration of Experimental Teaching, from 2005. The Quality Project received input from central government funding of Renminbi (RMB) 2.5 billion during the Eleventh Five-Year Plan (2006-2010).

In 2011, based on the summary of the evaluation experiences of previous years, the Ministry of Education promulgated an opinion on the undergraduate evaluation work of HEIs, determining that the main content of institutional evaluation had to be certification and professional assessment, international evaluation, and control of data on the basic framework of education. In early 2012, this Ministry-certified evaluation program of the new cycle published measures for the implementation of evaluation and approval of the pedagogical work of HEIs. On 16 March 2012, the Ministry published an opinion called 30 Items for Higher Education on considerably increasing quality improvement in higher education. Moreover, it determined that higher education must persist with a stable scale, qualify the structure, fortify the peculiarities, prioritize innovation, and move towards content development, having the elevation of quality as its core. It further determined that "the scale-up of higher education has as its main functions, develop higher vocational education, continuing education, master's degrees, expand private education and cooperative education" and also "look into the creation of a classification system of HEIs, elaborate classification management measures, and overcome the trend of homogenization. Innovative measures are proposed in talent training, scientific research, social service, cultural area, and educational management. One should actively cultivate skills that meet social development needs and limit recruitment into courses with high employability. This initiative by the Ministry of Education will benefit HEIs by respecting their realities and guiding them scientifically to raise the quality of education through this personalized construction (Liu & Liu, 2017).

In Japan

In Japan, a rapidly developing economy after World War II was followed by the growth of HEIs. The development was financed by private companies, which still manage roughly 80% of HEIs. These private HEIs have a good quality of education, with the remoteness of traditional private universities tends to vary constantly among these HEIs. From early on,

the Institution Approval System created by the HEIs is controlled by the Institution Approval System. The Ministry of Education, Culture, Sports Science and Technology (MEXT), 2001, created rigorous parameters and norms to control Quality in HEIs. In the early 1990s, the approval system was set aside, giving institutions more autonomy to structure their courses. New evaluation forms were created, making institutions more directly responsible for assuring Quality. Laws were created so HEIs could evaluate themselves and be evaluated by external companies. The revisions described by the Organisation for Economic Co-operation and Development (OECD) in Japan (Yamaguchi & Tsukahara, 2016) support more autonomy and Freedom in HEIs, allowing Japan to restructure its evaluation standards and education systems more efficiently. The quality control methods in Japan consist of an approval process where HEIs have to evaluate and control themselves using the Certified Evaluation and Accreditation (CEA) process and an evaluation process by the National University Corporation. This specific and rather complicated evaluation method is widely contested for various reasons. Arguably, it has never been perfected, nor is it appropriate. These processes are time-consuming for the faculty and administrative staff involved in these operations, often at the expense of studies and related research and teaching. It is worrisome, especially in national institutions, because there are processes to prepare for the final annual, mid-term, and biannual evaluations (Yamaguchi & Tsukahara, 2016). Japan's accreditation and evaluation program have become more rigorous to increase accountability and improve reforms to be implemented. Therefore, whether this system will make HEIs more competitive and resilient remains to be seen.

In Sweden

The supervision rather than responsibility approach has been dominant traditionally in Sweden in public administration and was implemented in HEIs until the eighties. The assumption was that education was expected to have the exact requirements, conditions, and quality, no matter where it was delivered. From then on, state control and supervision gradually began to give place to institutional independence and growing self-regulation (Askling, 2001). With the gradual democratization of the management of higher education institutions, opportunities were given to various stakeholders to impact the progress of teaching and research. The HEI Reform of 93 allowed this development by decentralizing the funds' studies, assignments, and internal assignments. A new university funding system was established based on achievement, performance, and student numbers to encourage

intensive research, teaching, and administration processes. Every institute oversees its activities' quality and development. The "Swedish model" has developed gradually since the end of the 1980s. Its implementations are now the subject of intensive critical discussion (Nilsson & Wahlén, 2000), resulting in new development. Therefore, the following overview and analysis must be seen as a progressive report of the last years of the 90s. The requirements for the institutional independence and public accounting of HEI activities have significant legitimacy in Sweden, and the debate concerns mainly the trade-off between evaluation and auditing.

The duty of performing evaluations is assigned to the National Agency for Higher Education, which audits and assesses universities on the national evaluation of subjects and curriculum. These assessments cover teacher training, mathematics, medical training, paramedical programs, and doctoral programs in languages. The sites for evaluation, which could also have structural phenomena, are selected based on identity problems or other criteria, accreditation of specific programs and degrees at all institutions, and accreditation of colleges applying for university status. This method has proven to be one of the most effective quality-driving measures to improve college standards. It is carried out based on established criteria for all assessments. Among these criteria are the proportion of faculty with doctoral degrees, the nature, and quality of research, the number and scope of advanced courses, library resources, and other facilities, and quality audit, which looks at institutions' systems to ensure the quality of the research and their operations. Together they intend to create a single system that can guarantee quality throughout the country. Currently, the form of evaluation in force is auditing, which is used to improve and provide ways for the Government to audit the quality processes implemented in higher education institutions. It is a system controlled by the Government and negotiated to promote the growth of the institutions, intending to create routines for undergraduate, graduate, administration, research, and development courses. These audits are carried out in three and four-year cycles, and there is no link to funding. At the end of the audit, a self-assessment is performed by the institution related to the institution's quality improvement, being the most relevant documentation for the auditors. Then there is a peer review in teams set up by the National Agency, each group consisting of 3 or 4 professors, academics, someone from industry or related to government administration, and a student. All materials are analyzed, conclusions are presented, and a two to five-day review begins. When the reports are published, the Chancellors meet with the Swedish educational institutions and their administrations to

discuss what measures should be carried out due to the audit process. One year after the audit, the Chancellor will again visit the institution to discuss measures for developing and publishing the report. All institutions discussed and accepted this model (Nilsson & Wahlén, 2000).

In Spain

Recent academic publications discuss, in Spain, quality assurance in higher education. The topics presented in these publications are related to those in the literature in other European countries on quality assurance. Issues such as the evaluation of student training outcomes (Martín, 2006), (Pierce & del Robisco, 2010), (Ion & Cano, 2011), (Duque et al., 2013), (López-Pastor et al., 2013); accountability (Jiménez & Palmero, 2007), skills and labor market demands (Ion & Cano, 2011), (Lafuente et al., 2012), (Gonzalez et al., 2014), internationalization and mobility, (Salamanca, 2011), educational reform (Carvalho, Elisabete Reis & Pinto, n.d.), and teacher quality (Trullen & Rodríguez, 2013), (Hernández Pina, 2014) are widely mentioned in the literature. In Spain, a frequent topic in academic papers related to higher education quality is the impact of economic factors (Hernández Pina, 2014). The economic recession in Spain has restricted some of the monetary resources available to HEIs. This topic is widely covered in various papers. The commitment to establishing and improving the quality of educational systems is not exclusive to Spain. This characteristic can be observed in various European countries and has been a part of the recent adjustments driven by Higher Education in Europe. The European Association for Quality Assurance in Higher Education has published the Standards and Guidelines for Quality Assurance in the European Higher Education Area (Senats, 2007) 2007. The European Ministers approved these rules during the Bologna Process Summit in Bergen, Norway, in 2005 (Report et al., 2005). The king signs legislative royal decrees and acts.

In France

In France, the Government manages the model of education administered in Higher Education institutions. The state department responsible for higher education does not oversee it entirely. Certain institutions maintain higher education programs (Industry, Cultural Affairs, Agriculture) with specific forms of operation. The non-profit institutions are primarily private institutions of higher education, many Catholic universities. The teachers' unions significantly impact education administration by being part of the advisory

boards that advise the Government. HEIs have some autonomy in the administration of their internal operations. The boards of directors have representation from teachers, students, businesspeople in the industry, and politicians. HEI directors are eligible to serve a single five-year term. The Government, specifically the ministers, appoints the HEI directors (Fortes et al., 2011).

The form of official accreditation is essentially based on diplomas and degrees. An institution can access an accredited degree based on its programs or plans to offer students and the resources it intends to apply to teaching and training. This accreditation process in universities is done every four years. They have to present a development plan to be later submitted for approval by the Ministry of education for higher education. The Ministry is responsible for higher education functions as national accrediting diplomas after a favorable opinion from other entities involved. The contract established with institutions and the Ministry has a list of degrees that the educational institution can grant and a commitment by the Government to finance the courses for the students enrolled in these programs. The Government establishes curricula, program structures, examination regulations, and diplomas. Accreditations are approved after auditing the organization of courses and the qualifications and number of faculty members at each school of higher education that has applied for accreditation (SCHWARZ & WESTERHEIJDEN, 2004).

In India

India's education system originates from the system inherited from Britain in 1947 (Haruna & Jumba, 2011). India's vast educational system is probably the biggest in the world. The poor quality of higher education has always been a significant problem for all stakeholders in this process. While there is good infrastructure and academic programs, there are problems in other areas and poor performance in research (North et al., 2003). However, various quality control methods are already implemented, such as the university affiliation functions or the guidelines of the university grants commission (Pillai et al., 2006). The National Assessment and Accreditation Council (NAAC), In 1994, was established to guarantee and improve quality in higher education and secure a role at the international level as a quality guarantee agency in higher education. India intends to continue implementing a learning education, using best practices, and recognizing institutions with practical methods and features that promote quality in vocational education (Sahay, B. S., & Thakur, 2007). This agency has raised awareness and interaction in academia, at various institutions and

universities, about course evaluation and accreditation. For 18 years, NAAC has been well appreciated by academics and institutions for its work as it seeks to evolve its methods and procedures. The accreditation and quality process in higher education focuses on creating a professional educational system where institutions are like Human Resources salespeople to match the national goals of evolution by skills and economic contributions to the competitiveness and development of society. The accreditation and quality process aims to ensure an educational system where excellence in teaching quality is evident, filling gaps and needs in the labor market.

RESULTS AND DISCUSSION

The accreditation process for higher education courses can vary significantly between countries, with some countries having more streamlined processes and dedicated accrediting agencies. In contrast, others may have more complex systems with multiple accrediting agencies (P. G. Altbach et al., 2019). In this discussion, we will consider the differences and particularities of the accreditation process in Portugal, Spain, the United States, France, China, Japan, Sweden, the United Kingdom, India, and Germany, focusing on the time and bureaucratic burden of the process and how to speed up the accreditation process of a new course. Table 1 presents relevant results by country worldwide.

Table 1 - Principal results by country

Country	Results
China	• Guided and promoted by the Government • The reform movement toward the autonomy of HEIs
USA	• Accreditation is based on the results achieved in a public process • Innovative methodologies in teaching • Certification must be done by agencies external to the HEI
France	• The Government manages the model of education • Official accreditation is based on diplomas and degrees • The accreditation process is completed every four years
Germany	• A reform of the German HE system was introduced by calling for greater competition and differentiation

	through deregulation, performance orientation, and performance incentives • These reforms are part of the policy of increasing the competitiveness of the German HE and providing necessary measures
India	• India has a vast educational system • It is one of the biggest in the world • The poor quality of higher education has always been a significant problem • The accreditation and quality process in higher education focuses on creating a professional educational system
Japan	• The private HEIs have a good quality education • The Institution Approval System controls the Institution Approval System created by the HEIs. • Japan's accreditation and evaluation program have become more rigorous to increase accountability and improve reforms to be implemented
Portugal	• In 2017, the Portuguese Government created the Agency for Evaluation and Accreditation of Higher Education • Quality audit, relative to process review, focuses on analyzing the internal quality and adopting improvements in these processes • The quality of the processes must be ensured internally by the institutions and must be continuous to improve the institution's quality
Spain	• In Spain, a recurrent topic in academic papers related to higher education quality is the impact of economic factors • The economic recession in Spain has restricted some of the monetary resources available to HEIs • The commitment to establishing and improving the quality of educational systems is not exclusive to Spain • The king signs legislative royal decrees and acts
Sweden	• The University funding system was established based on achievement, performance, and student numbers • The duty of performing evaluations is assigned to the National Agency for Higher Education • There is a peer review in teams set up by the National Agency, each group consisting of 3 or 4 professors, academics, someone from industry or related to government administration, and a student

United Kingdom	• English system centered on self-regulation and self-governing institutions • Vagueness in defining systems and methods to assess the guarantee of academic values • In 2010, students joined the audit teams
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ACCREDITATION AGENCIES

In the United States, regional and national accrediting agencies carry out the accreditation process. Higher education courses are evaluated according to the criteria established by these agencies and, if approved, receive accreditation for 5-10 years. The accreditation process in the United States is generally efficient, with most courses receiving accreditation within a reasonable timeframe. However, the authors also note that the process can be more complex and time-consuming for institutions seeking accreditation for the first time or offering new or innovative courses (Eaton, 2015).

The National Council for Evaluation of Higher Education and Research (CNEAI) carries out the accreditation process in France. Higher education courses are evaluated according to the criteria established by the French Higher Education Quality System (SQUAF) and, if approved, receive accreditation from CNEAI for six years. The accreditation process in France is generally efficient, with most courses receiving accreditation within a reasonable timeframe. However, the authors also note that the process can be more complex and time-consuming for institutions seeking accreditation for the first time or offering new or innovative courses (Ponzurick et al., 2000). The accreditation process of a new course is important for the course to meet all of the criteria established by SQUAF and for the institution to provide all required documentation promptly.

The Ministry of Education of the People's Republic of China (2003) carries out the accreditation process in China. Higher education courses are evaluated according to the criteria established by the Chinese University Quality Assurance System (CUQAS). If approved, it receives accreditation for six years. In the accreditation process of a new course, it is essential to meet all criteria established by CUQAS and for the institution to provide all required promptly. The accreditation process in China is generally efficient, with most courses receiving accreditation within a reasonable timeframe. However, the authors also note that the process can be more complex and time-consuming for institutions seeking accreditation for the first time or offering new or innovative courses (Liu & Liu, 2017).

In Japan, the accreditation process is carried out by the Japan Accreditation Board for Engineering Education (JABEE). Higher education courses are evaluated according to the criteria established by the Japanese University Quality Assurance System (JUQAS). If approved, it will receive accreditation from JABEE for six years (Engineering et al., 2015). The accreditation process in Japan is generally efficient, with most courses receiving accreditation within a reasonable timeframe. However, the authors also note that the process can be more complex and time-consuming for institutions seeking accreditation for the first time or offering new or innovative courses (Engineering et al., 2015). To accelerate the accreditation process of a new course is important the course meet all the criteria established by JUQAS and for the institution to provide all the required documentation on time.

Swedish Higher Education Authority (UKÄ) carries out the accreditation process in Sweden. Higher education courses are evaluated according to the criteria established by the Swedish University Quality Assurance System (SUQAS). If approved, it will receive accreditation from UKÄ for six years (Lucander & Christersson, 2020). The accreditation process in Sweden is generally efficient, with most courses receiving accreditation within a reasonable timeframe. However, the authors also note that the process can be more complex and time-consuming for institutions seeking accreditation for the first time or offering new or innovative courses (Lucander & Christersson, 2020). To speed up the accreditation process of a new course is important for the course to meet all of the criteria established by SUQAS and for the institution to promptly provide all required documentation (Lucander & Christersson, 2020).

The Quality Assurance Agency for Higher Education (QAA) carries out the accreditation process in the United Kingdom. Higher education courses are evaluated according to the criteria established by the United Kingdom University Quality Assurance System (UKUQAS). It is important for the course to meet the criteria established by UKUQAS and for the institution to provide all the required documentation (Lucander & Christersson, 2020). If approved, it will receive accreditation from QAA for six years (Lucander & Christersson, 2020). According to a study (Knight, 2013), the accreditation process in the United Kingdom is generally efficient, with most courses receiving accreditation within a reasonable timeframe. However, the authors also note that the process can be more complex and time-consuming for institutions seeking accreditation for the first time or offering new or innovative courses (Knight, 2013).

In India, the accreditation process is carried out by the National Assessment and Accreditation Council (NAAC) (Lim, 1999). Higher education courses are evaluated according to the criteria established by the Indian University Quality Assurance System (IUQAS) and, if approved, receive accreditation from NAAC for five years (Lim, 1999). It is important for the course to meet the criteria established by IUQAS and for the institution to provide all required documentation (Lim, 1999). The accreditation process in India is generally efficient, with most courses receiving accreditation within a reasonable timeframe. The authors also note that the process can be more complex and time-consuming for institutions seeking accreditation for the first time or offering new or innovative courses (Mehra et al., 2021).

Higher education courses are evaluated according to the criteria established by the German University Quality Assurance System (GUQAS). In Germany, the accreditation process is carried out by the German Council of Science and Humanities (Wissenschaftsrat)

(Golowko et al., 2017). If approved, it will receive accreditation from the Wissenschaftsrat for six years (Golowko et al., 2017). The accreditation process in Germany is generally efficient, with most courses receiving accreditation within a reasonable timeframe. However, the authors also note that the process can be more complex and time-consuming for institutions seeking accreditation for the first time or offering new or innovative courses (Fabiana Meijon Fadul, 2019). It is important for the course to meet all of the criteria established by GUQAS and for the institution to provide all required documentation (Golowko et al., 2017).

It is worth noting that the time and bureaucratic burden of the accreditation process may also depend on the specific accrediting agency and the course offered. For example, some accrediting agencies may have more stringent criteria or require more documentation than others, which could result in a longer or more complex accreditation process (P. Altbach, 2015). Similarly, some courses, particularly those that are more specialized or innovative, may require more extensive review and evaluation by the accrediting agency (Harvey, 2004). Institutions seeking to speed up the accreditation process of a new course may want to consider these factors and work closely with the relevant accrediting agency to ensure all necessary criteria are met and documentation is provided promptly.

CONCLUSIONS

Customer satisfaction is a significant concern in education, students, and families. The Government wants to ensure good quality education. The question arises, what makes a good quality education? What is its meaning? This article has found some answers to this question. However, the concept of quality can have different aspects, and it is not always easy to cover all dimensions of the idea of quality, particularly for education. This article presents methods and processes associated with accreditation and quality assurance in higher education worldwide. It was found that governments have a crucial role as higher education regulators, requiring public transparency in quality assurance and competition among higher education institutions. Various quality assurance methods in each country, course rankings, performance indicators, different course evaluation systems, and accreditation were presented. Evaluation and accreditation scenarios and the external review and audit processes were introduced. The primary assessment methodologies and the current situation in each country were presented. The education system depends on public trust, and quality

assessment policies at national and institutional levels are becoming increasingly essential for the functioning of tensions between different values and interests in the future formation of higher education. It can be concluded that implementing external quality assessment systems in most European countries, as well as in other countries around the world, a few years ago was associated with a shift in the allocation of power within higher education. This shift benefited the institutional level and reinforced extrinsic values at the expense of intrinsic values. Managerial concerns, such as market concerns, became more important than academic disciplinary concerns. However, there are significant differences across institutions and countries within this general pattern related to contextual considerations and assessment methods used. Future work will focus on an article about the following sequence in accrediting a course.

Article II - Software Engineering Planning to Support Accreditation Courses in Higher Education Institutions

ABSTRACT

The quality and accreditation of courses in Higher Education institutions are complex, composed of several associated processes, and divided into several phases. **Objective:** This paper describes the essential functions related to the quality and accreditation of courses and services, how the web application model was designed, and which UML diagrams were used to create the design of the web system to support the accreditation of the Institution's courses, the use case diagram, the class diagram, and the activity diagram were presented. The plan addresses two phases of the assessment process: self-assessment and external assessment. **Methods:** a systematic review method was used, where several scientific types of research were done in online reference libraries such as Google Scholar, Ebsco, IEEE, and Springer, in English, Portuguese, and Brazilian, among others. **Conclusions:** Despite institutions being aware that information systems can improve and speed up processes, there is still some resistance to their implementation. It was concluded that the supply of software that helps in the process of accreditation of courses in higher education institutions is very scarce and that there is a need to fill this gap in the market to reduce assessment errors, automate repetitive tasks, delegate responsibilities in data entry, and reduce the time of preparation of documents for assessment of courses in the Institution.

Keywords: management, diagrams, process, quality system, accreditation course.

INTRODUCTION

Quality management systems are created to control and manage the activities that impact the quality of the outputs. The quality of these outputs has two issues, the level of conformity to the requirements provided by distinguishing characteristics. Quality is understood as the way to effectively achieve the desired results within the application of a quality management system in a higher education institution, and this advice related to the very definition of quality assumes significantly diverse opinions that give rise to various proposals for action (Rosa et al., 2012). Regarding the formal implementation of a quality management system, some authors tell us that the themes were designed by faculty, considering, in this way, the students as the main customers of the courses offered. In this case, they will be the service recipients (ISO, 2016). These authors also argue that the themes defined in the standards and 2001 and 2002 can be explored in higher education and other stakeholders. Tishler contends that the 2 points most relevant in traditional quality management are the view that more sustainable processes lead to better services and products and can be continuously improved

(Shenhar et al., 2002). These approaches use a particular culture to develop a continuous sustainable improvement mindset. Most higher education institutions are more concerned with traditional methods than promoting the quality of education. The degrees offered, the professional experience of their professors, and the authorship of research and development activities make them not receptive to pioneering management approaches to a quality management system identified as coming from business and not considered as applied to higher education institutions. Ryan shows academics resist external references to higher education institutions (Plummer et al., 2021). The introduction of new techniques relative to traditional management has persisted due to this successful resistance, surviving the action of several private entities. These ambiguities and paradoxes depend on the typical behavior of solving these problems, which can only have a little impact on all these characteristics. It may be seen as something other than weaknesses that can become advantages as long as higher education institutions assume they must work with these same paradoxes and ambiguities. Leaders must be able to implement and set coherent policies (Ryan, 2012). They show us three significant changes, linear planned change models are inadequate for the present challenges, and drastic and rapid changes democratize global exchange Systems (Bryk & Raudenbush, 1987). Finally, democratizing forces are changing the global networks and demographics themselves. The technical means of quality can be successful when they can drive institutions to higher performance levels. Most higher education institutions' efficiency and effectiveness have become more interactive regarding resources and ethics. Combating waste of materials or resources is fundamental to sustainability, which should be a topic of consensus for the entire academic community. The accreditation process is a process of external quality review and self-study used in higher education institutions to validate that their programs meet quality standards and continuous improvement. This process determines if an institution meets the quality criteria established by an external organization turned into a government or national agency. This process includes a self-evaluation, a peer review, and on-site visits. The success of this process will end in the accreditation of a course for the Institution (Tezcan-Unal et al., 2018).

In Portugal, quality assessment in higher education institutions requires institutions to have their quality assessment system and a national-level entity, A3ES, responsible for auditing, reviewing, and accrediting this process.

MANAGEMENT BY PROCESSES

Process Concept

In a concise description, the concept of the process and technological processes is a process that can be defined as a set of interrelated activities that transforms inputs into outputs ISO 9000. Through these activities, quantifiable results (deadlines, lead times, etc.) are obtained, representing added value to a student, the Institution's recipients, or the Institution itself. An activity can be a set of tasks a machine or person performs. Processes can be subdivided into subprocesses, standard technological processes, and control execution costs. The technical process's effectiveness measures its quality in transforming inputs into outputs. These processes can be hierarchized by teaching-learning, research and development, and service delivery areas down to course units. An HEI must identify the processes through criteria of relevance and impact that will enable it to achieve its objectives (António et al., 2016). These objectives can be completed in two ways: identifying the information flows and determining what information is relevant for correct measurement, monitoring, and management, placing the student flows along with them, and proceeding similarly.

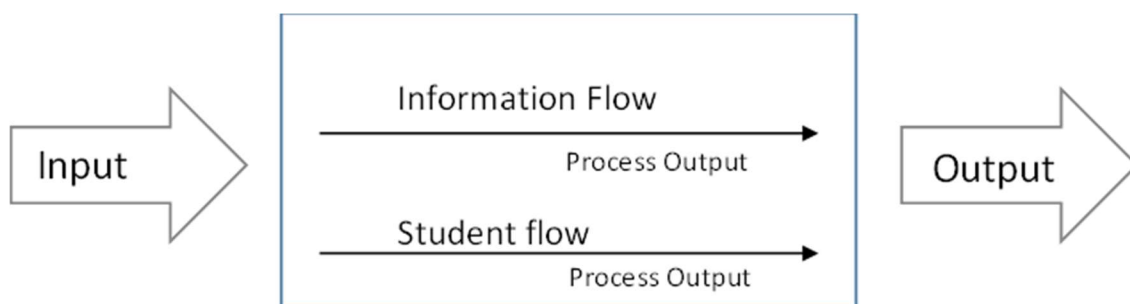


Figure 2 - Identification of processes output

Principal Processes

As an example of processes, Table 1 Presents some of the main methods in an HEI, some of which may constitute operational macro processes.

Table 2 - Core Processes

SECTORS	CORE PROCESSES
SECRETARIAT	Identification, registration, student admission, payments, improvements
DEPARTMENTS	Teaching service, distribution, teaching, monitoring, and improvement measures
SHOPPING	Requisitioning, supplier selection, order placement, receipt, payment
YEAR/COURSE	Annual planning, teaching service, monitoring
COURSE	Needs identification, design, planning, realization, market insertion

Process Classification

The processes, when classified, will facilitate the decision about the forms of control and management, reflecting their importance in adding value to customers and institutions (Marchand & Raymond, 2008). This classification can be done by integrative processes establishing the organization's structure. It allows the transposition of the organization's values relative to society. The operational, critical, and effective methods focus on culture directly linked to the study cycles. Students realize their results, intervening in various functional areas and supporting processes centered on internal customers, subject to internal directives, essential to the organization. The Teaching-Learning operational macro process can be constituted by the sequence of six operational processes, as shown in Figure:

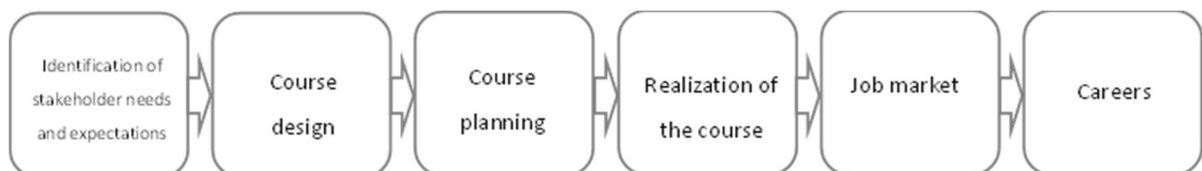


Figure 3 - Teaching-learning operational macroprocess

Characterization of the Processes

Processes can be characterized by their overall objectives and input and output data.

In the process related to the identification of stakeholders' needs and expectations, the objective is to implement, define and manage the services and products from the perspective of stakeholders' needs and expectations, to optimize credibility and customer demand, having as input the identification of stakeholders' needs and expectations and as outputs the training offer, as well as other products and services, generating the credibility plan (Mioduser et al., 1999).

The objectives in planning and designing the courses are to plan, design, and implement the lessons with the required quality, developing the necessary infrastructure and systems. The input will be the strategic plan, the applicable regulations, the study of new technologies, demand estimates, employability data, and curricular programs of the courses. The outputs will be the pedagogical and scientific availability of the technical infrastructure and systems needed for the classes. The course delivery process aims to attract the target students, carry out promotion activities by establishing lasting cooperation relations, and ensure quality and efficient management of relations with society and the partners involved. The inputs are the strategic plan, the cooperation policies, the curricular programs of the courses, and available products, and the outputs are qualified professionals (Scott, 2003).

Software Supported Methods

In these methods, the process concept is identified as the response of institutions to stimuli from outside or inside. These are considered process inputs. Another concept is that of business objects, such as contracts, orders, or customers, so that the process would have an initial state, the stimuli, and a final state, the end of the life cycle of the business-related objects. Despite presenting essential advantages in systematization and comprehensiveness, software-supported approaches and uniform visualization for the entire Institution are time-consuming exercises in small institutions, with a tendency to forget the main processes by treating all processes equally. Modeling enables the creation of a computerized view of business processes (Kamhawi, 2008). Ionita indicates four advantages: a clearer understanding of the business, the ability to assess the current state of operations accurately,

test ideas for improvement, and improved communication of processes and changes (Ionita et al., 2002).

Design of the Quality Support System in Higher Education

The main objective of this paper is to show a possible automated system to help Higher Education institutions in the evaluation and accreditation process. One of the problems institutions face is creating the self-evaluation report and making this report in a specific format. This process should also include the evaluation report performed by the external entity that performs the evaluation. The system should perform these processes automatically (System & Model, 2011). This process is shown in Figure 4

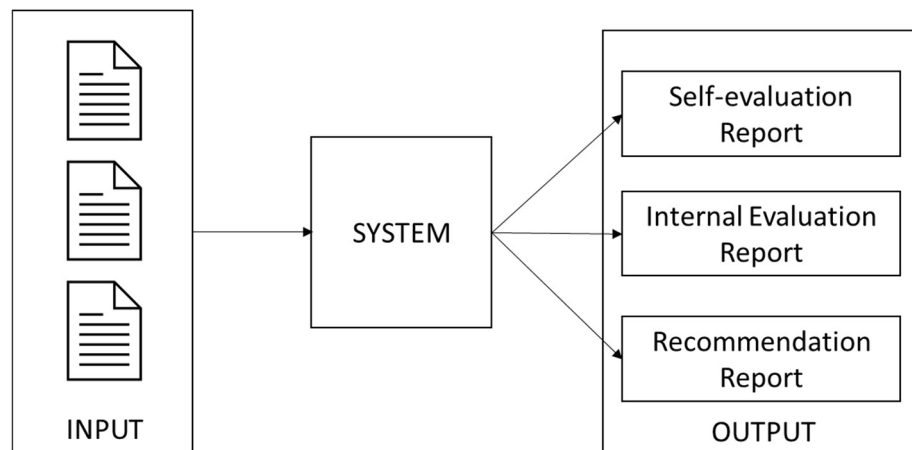


Figure 4 - Teaching-learning operational macroprocess

The inputs into the system are all documents essential to the evaluation process; the outputs are the self-evaluation report, the internal evaluation report, and the recommendation report.

UML Diagrams

Unified Modeling Language (UML) diagrams allow visualizing, specifying, creating, and documenting software systems and modeling process artifacts. These diagrams are widely used in software engineering, revealing efficiency in complex projects, and are also commonly used in developing object-oriented systems (OOP). It is possible to graphically conceive a system through UML, helping teams communicate, develop the design, and validate projects (Koch & Kraus, 2002).

Use Case Diagrams

UML is a standard for object-oriented programming languages, providing a software specification that enables a notation for modeling classes during object-oriented code development. The class diagram is considered a "bridge" between the specification of a given software on the user side and the creation of the software on the programmer's side, requiring precise guidelines for the identification of class objects and notational conventions for the modeling of the class diagram for its future use in the coding of systems. The Use Cases show us the relations between the different actors that will use the software and its functionalities, which permissions exist for different types of actors, and who can interact directly with the System (Gemino & Parker, 2011).

Scenario Description

The PAACES platform is a browser-accessed platform accessed by the actors described in the use case diagram, figure 4. All actors must be registered in the system to access the available functionalities.

The Quality Manager actor logs into the system with permission to enter data, update and delete data for the Institution, upload files, and create review reports. The Reviewer actor logs into the system and rates the information generated by the system and the quality manager. The Lecturer actor logs into the system and is asked to authenticate himself in Orcid so that the system, through an API, downloads his academic information to the system, completes Curricular Unit Form (FUC), and updates his educational data. The System Administrator logs in, creates forms, modifies, and deletes user accounts.

The system generates reports required for the course accreditation process. The "Quality Manager" actor is an employee responsible for entering the Institution's data and evaluation data, sending files to the system, and generating evaluation reports. The "System Admin" actor is responsible for creating forms and creating, deleting, and modifying accounts.

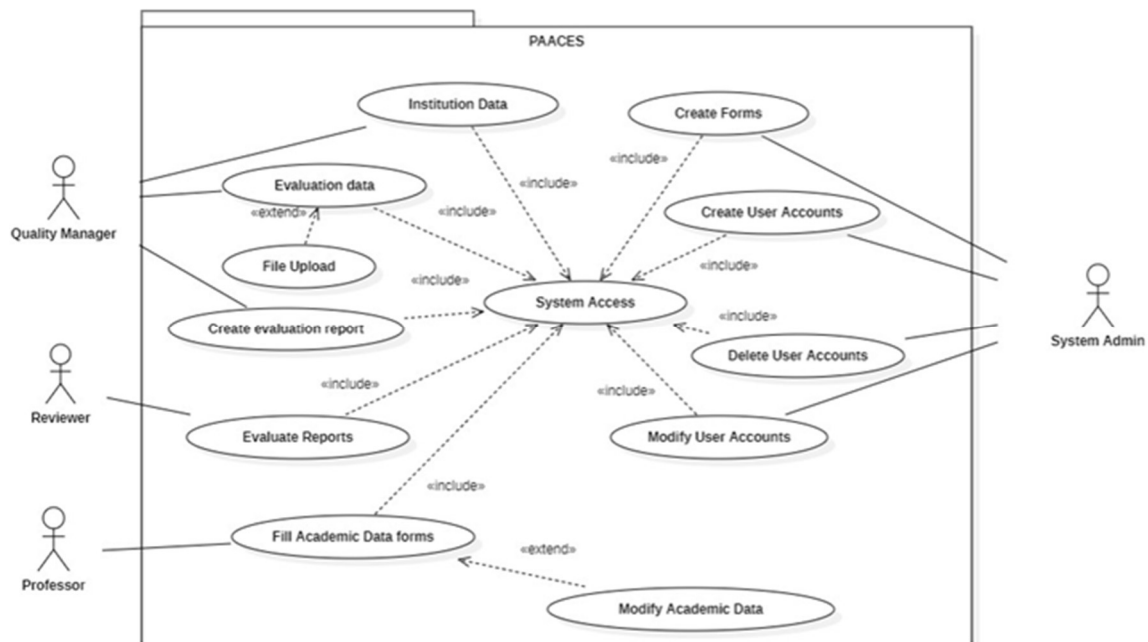


Figure 5 - Use Case Diagram

The "Reviewer" actor is the Evaluating Institution that accredits the courses of the Higher Education Institution, can view the Self-evaluation reports, is responsible for generating the Evaluation Report of the course, and creates a Recommendations Report. The "Professor" actor is allowed in the system to fill in their personal and academic data and the satisfaction form of the curricular unit they taught. The "Administrator" actor can create forms, add questions, and create, modify, and delete user accounts. It is he who controls the whole system, as shown in Figure 5.

Class Diagrams

A class diagram represents the structure and relationships of classes that serve as a model for objects in programming. It is a handy modeling tool for system development since it defines all the system's classes and is the basis for constructing communication, sequence, and state diagrams (Nikiforova et al., 2012). In the class diagram, we tried to show some of the most relevant classes used in creating the system, as shown in Figure 6.

An Evaluation class was created, which contains several methods representing the object operations to be performed, such as printDocuments(), generateReportEvaluation(), and generateReportRecommendation(). The Task class comprises the attributes task, startTask, endTask, and taskComplete. It has the methods completeTask(), which informs the

Institution when the scheduled task is complete, and resultTask(), which tells the Institution whether the job was completed successfully. Moreover, commentTask() allows you to enter improvement comments regarding the task performed. The class Institution is composed of the attributes name, address, numEmployees, numStudents, numLecturer, and presents the methods uploadFiles(), which allows the user institution to upload documents and files needed for the evaluation process, fillForms(), enables the Institution to fill in data about itself, modifyData(), allows changing. Correct data entered by the Institution and seeRecommendations() allows viewing comments and suggestions given by evaluators. The class Lecturer has as attributes lecturerName, positionInInstitution, yearsInInstitution, and has as method fillForms(), which allows the lecturer to fill the forms related to the lecturer's record personal data.

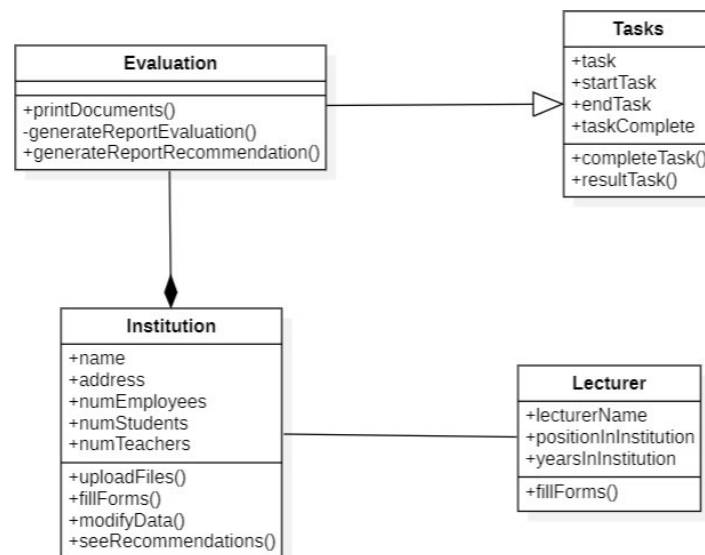


Figure 6 - Class diagram

Activity Diagram

The Activity Diagram is a diagram specified by the Unified Modeling Language (UML) and represents process-driven flows. It is a flow chart showing control flow from one activity to another. Usually, this involves modeling the sequential steps in a computational process. Figure 7 shows the sequence of steps from login to reporting, showing various logical process decisions.

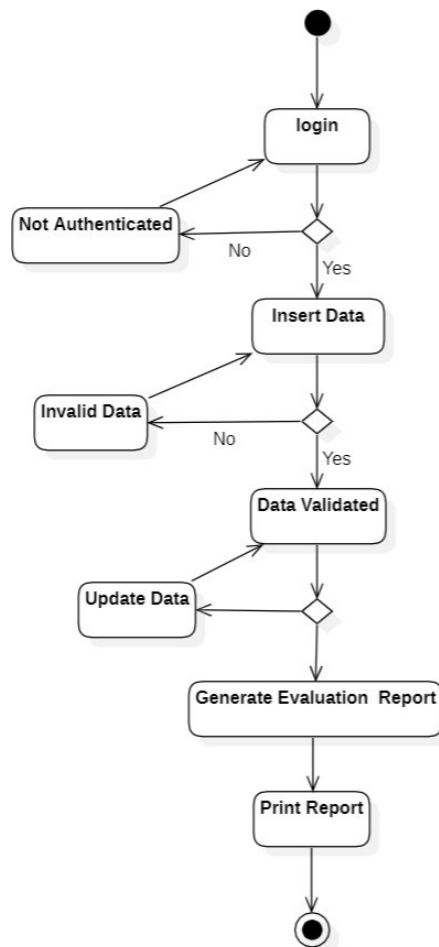


Figure 7 - Evolution activity diagram

DISCUSSION

Higher education is very much stuck to what is traditional, how they handle their data, and how they use it (Wæraas & Solbakk, 2009). PAACES comes to centralize several processes necessary for the accreditation of higher education courses, trying to be generalized in the way it is used. We tried to create a platform that, over time, can dispense with some user interaction. With this platform, the lecturer user no longer needs to enter his academic data into the system. The platform connects to the Open Researcher and Contributor IDentifier (ORCID) Application Programming Interface (API). It automatically fills in his academic data, and the user's intervention is only necessary to provide access authorization to his data. It also allows you to generate reports based on the information required for course accreditation, uploading csv files to the server. The evolution in education has to be global, with all countries working together towards an accreditation system where everyone can improve with each other (Knight, 2013).

CONCLUSIONS

Given the current scenario, many companies face numerous daily challenges and problems that computers and information systems could solve daily. Furthermore, it is worth emphasizing the importance of using information systems efficiently. However, first, it is necessary to understand the organizational, human, and technological dimensions that are part of the whole process. An efficient information system can solve critical organizational problems or challenges (Martins et al., 2012). The UML class diagrams presented allow us to model, in a declaratory way, the static structure of an application domain regarding concepts and relationships between them. This article focuses on UML class diagrams from a theoretical viewpoint. Features relevant to the implementation side, for instance, public, protected, and private qualifiers for attributes and operations, have not been covered. We present each UML class diagram's semantics as a first-order logic (FOL) function. We then define a model of the FOL expressions corresponding to creating a UML class diagram as an instantiation of the diagram (Berardi et al., 2005). The supply of software that helps in the accreditation process of courses in higher education institutions is very scarce; there is a need to develop systems to fill this gap and help in a process that can be complex for institutions. Through these systems, it is possible to reduce assessment errors, automate repetitive tasks, delegate responsibilities in data entry, and reduce the time of preparation of documents for assessment of courses in the Institution.

Article III - Implementation of a Web Platform to Support Accreditation Courses in Higher Education Institutions using the MERN Stack

ABSTRACT

The development of Web systems is constantly evolving, with frameworks associated with languages appearing every day, helping develop applications and systems. There is a need for higher education institutions to try to meet the demands of accreditation organizations, and what currently exists in the market in terms of web platforms that assist in this process do not meet these needs, having more difficulty in organizing and presenting the necessary information for the accreditation of courses. The need for a system led to the creation of the PAACES platform, which allowed the grouping of the necessary information in a single software, speeding up the accreditation process for easy web-based consultation. The methodology used was reading articles and documenting the different technologies used. The frameworks have come to help reduce the programming time and, consequently, the cost of applications. Gathering the necessary information for course accreditation has been accelerated and made easier to consult, reducing costs and time. This publication describes the MongoDB, Express, React, and Nodejs (MERN) stack and discusses the four constituent technologies and how they work together, allowing faster and more scalable development.

Keywords: higher education institute, MERN stack technology, web application development, web framework.

INTRODUCTION

Actual technology provides various options and sectors where it can be applied. One of these technologies is the MongoDB, Express, React, and Node (MERN) stack. There are others that "compete" with MERN, such as the MongoDB, Express, Angular, and Node (MEAN) or MongoDB, Express, Vue, and Node (MEVN) stack, technologies that appear to help full-stack programmers (frontend and backend). The difference between these stacks is the framework used for the part used by the client (frontend), which can be in React.js, Angular.js, or Vue.js. Since the technology adopted for developing the web system to support the accreditation of courses in higher education institutions was MERN, this

technology is discussed in more depth. The MERN stack described a set of technologies developed in JavaScript and used in the development of web applications. It was created to ease the development process. Nowadays, programmers try to optimize user interaction in the application and optimize the process of creating applications to realize time-bound projects and development requirements. Since MERN technology is based on JavaScript, programmers only need to know one programming language, making application development easier. Figure 8 describes the MERN stack Architecture.

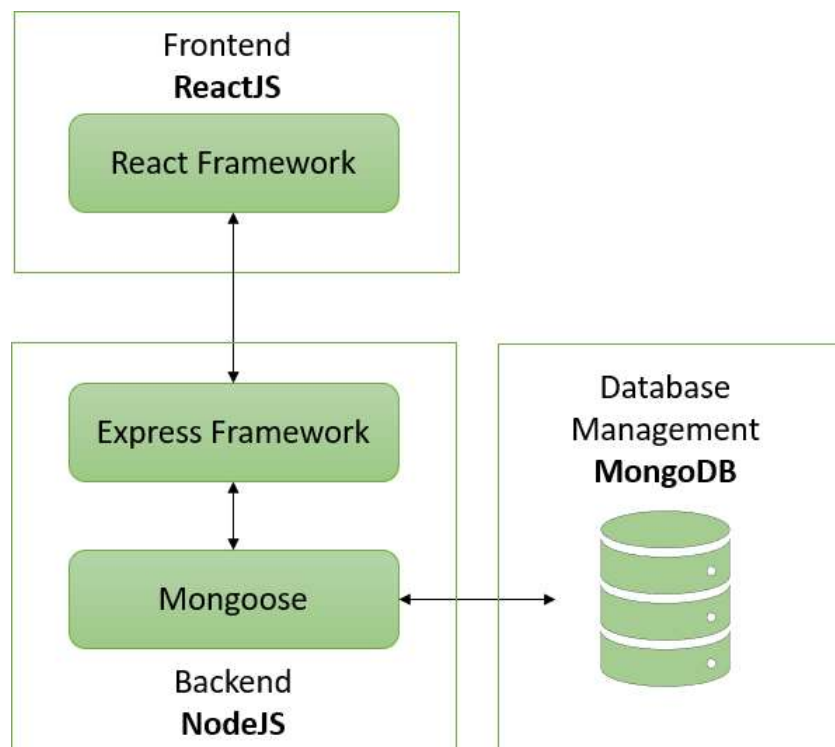


Figure 8 - MERN stack architecture

HOW DOES THE MERN STACK WORK

The MERN stack enables the easy creation of a 3-tier architecture (frontend, backend, database), entirely using JavaScript and JavaScript Object Notation (JSON). The acronym MERN stands for MongoDB, Express.js, React.js, and Node.js. MongoDB is a non-relational database, the Express.js package is a framework that makes it possible to create a web server (along with Node.js), the React.js framework is a javascript library that helps the programmer to build user interfaces, and the Node.js is used for the server-side. The MERN stack integrates four innovative technologies for the client (frontend) and the server (back end). It is heavily supported by complex social media applications such as Facebook, which can be integrated with other programming languages like PHP, .NET, or Java. The MERN

stack is supported by many open-source packages and a large online community dedicated to programmers to help them maintain scalability and their software (Mehra et al., 2021).

ReactJS

ReactJS is a framework that permits create the front end of the application. It is based on JavaScript and is a declarative framework used to program dynamic applications used by the client in HTML markup language. It was created by Facebook and is maintained by them. It is possible to create complex interfaces through simple components, link them to server data, and render them in HTML. ReactJS handles stateful, data-driven interfaces with as few lines of code as possible, providing everything expected from a web framework for browser-driven development. It has excellent documentation on the website providing good support for events, error handling, forms, and more. The basic principle behind ReactJS is the concept of virtual DOM ReactJS effectively uses the virtual DOM The Virtual DOM allows rendering subtrees of accent nodes on state changes and less concentration of nodes on state changes. There is a lower percentage of DOM manipulation to enable its updated components. ReactJS is faster than Angular, has fewer conditions, and eliminates the need to resort to other elements, such as plugins. The Virtual DOM has a tree of nodes that lists elements, attributes, and content as properties and objects. The React render() method, as shown in Figure 1, creates a node tree from React components and updates this tree in response to changes in the data model caused by actions. Each time the underlying data changes in a React application, a new representation of the Virtual DOM is created in the user interface (Fedosejev, 2015). The platform to support the accreditation of courses in higher education (PAACES) application uses ReactJS on the front end, showing the client the interface created and allowing him to interact with the system intuitively and effectively.

NodeJS

NodeJS is a runtime environment that executes JavaScript code outside the browser. The execution of JavaScript occurs due to an engine within the Chrome browser called V8. V8 has proven to be an effective engine developed in C++, allowing V8 to interpret and execute JavaScript code very quickly (Shah & Soomro, 2017). Faced with the appearance of V8, its developers considered separating V8 from Chrome and creating an application capable of executing JavaScript code on the server. In 2009, Node.js was created by Ryan Dahl to achieve this result. Node.js has the same function as the JAVA language's Java Virtual Machine (JVM). Node.js is a platform, like the JVM, an environment that can run code. As

the JVM runs Java code, Node.js runs code from JavaScript. Node.js executes JavaScript code on its platform and can use JavaScript or other programming languages like Typescript. High-level languages, such as Java, Kotlin, Groovy, or Scala, are commonly used, by programmers, to write code when programming on the JVM. This code will be compiled into byte code. The emergence of Node.js revolutionized the programming world, and Javascript frontend programmers quickly adapted to the backend through Node.js. It began to gain popularity, becoming among the top choices of server-side platforms used, and is applied in significant web applications such as Netflix, LinkedIn, and Uber (Shah & Soomro, 2017). Figure 9 shows the most used platforms according to a questionnaire from the well-known Stack Overflow website in 2022.

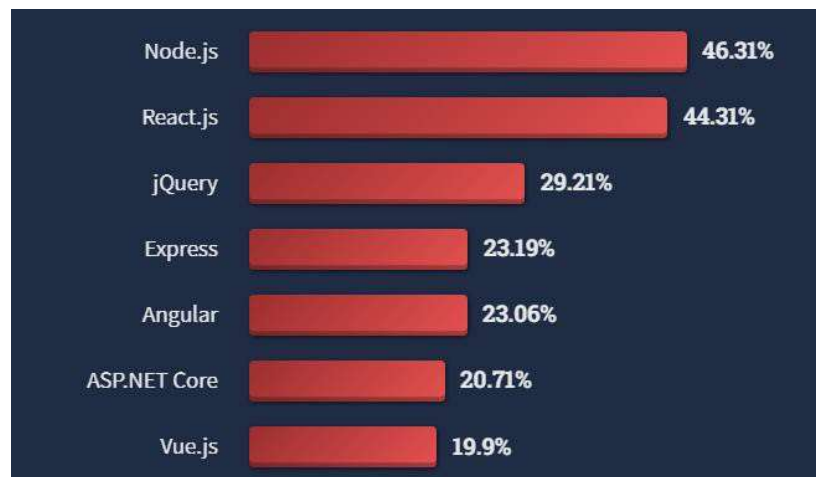


Figure 9 - Most used frameworks in 2022

ExpressJS

The Express framework is one of the most popular Node.js frameworks and the base library for other Node.js frameworks. This framework has libraries for sessions, cookies, user login, URL parameters, POST requests, security header, and a few more (Scalable & Apps, 2018). Express offers services to manage different HTTP requests in different URLs, integrates view engines to insert data into templates, determines web application settings such as what port to use for the connection and which template location to use for the response, and adds new request processes through middleware in the request queue, is very minimalistic. Programmers can create specific middleware packages to solve problems that may appear in the development process of an application.

MongoDB

MongoDB is considered a NoSQL database because it is document oriented. The most common databases are relational databases, created from tables with fields and values. MongoDB does not use the table structure of the relational database to fit all documents in JSON format, available in a very flexible system called Binary JavaScript Object Notation (BSON). MongoDB has unique features that make developers increasingly choose this database over relational databases. MongoDB uses JSON data, each of the collections can have different documents and sizes, is very flexible for archiving, and data is usually not linked together, JOIN queries are not supported as in Relational Database Management System (RDBMS), so when users insert, delete or update, there will not be much time spent checking whether the constraints implemented as in RDBMS are satisfied. It is easy to scale a MongoDB database. The concept of a "cluster" refers to clusters of nodes containing data to communicate with each other. The system can expand quickly when a new node is attached to a cluster. The "_id," a unique identifier in a document, will be indexed automatically, allowing the speed at which information is queried to achieve higher performance consistently. The data query is cached and made available in Random Access Memory (RAM), with low hard disk access, enabling faster read and write speeds. Despite all the advantages mentioned, the MongoDB database also has some drawbacks. It's not used in transaction models that require a high degree of accuracy because it is non-binding, has no transaction mechanisms for banking applications, and the data uses RAM as the focus of the action, which will use a considerable amount when it runs. If data changes are not written to disk immediately, data may be lost due to power failures or other physical disasters. Many developers use Mongoose, an Object Data Modeling (ODM) library with MongoDB and Node.js, to manage relationships between data, allow schema validation, and translate between objects in programming and their representation in the MongoDB database. The curriculum page is populated with the information provided in the Orcid page of each user with the help of Orcid API, where the user must grant authorization to the application to retrieve the data. Figure 11 shows the flow in Object Mapping between Node and MongoDB managed via Mongoose.

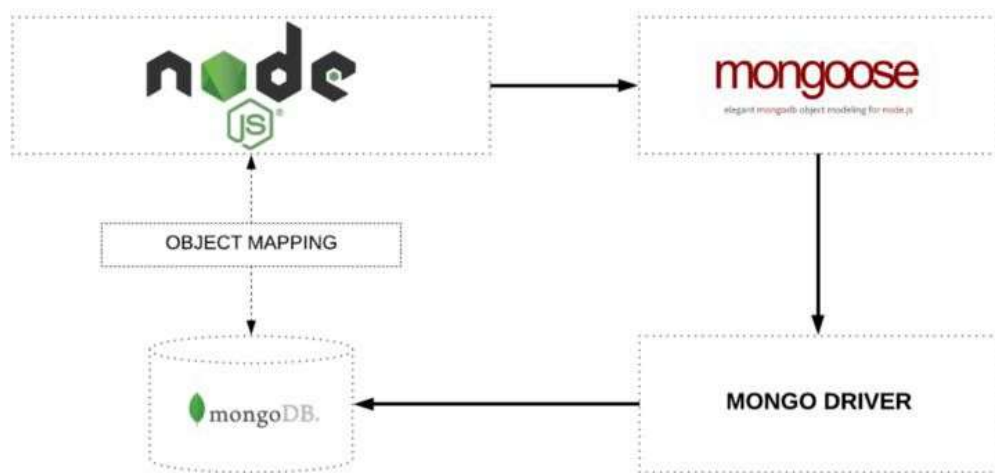


Figure 10 - Object Mapping between Node and MongoDB managed via Mongoose

MERN Stack Project implementation

Implementing a web application with a frontend, backend, and NoSQL database requires time and knowledge. This project was created in three phases. First, the backend was developed, the MongoDB database was created, and finally, the front end. In the end, the application was tested. Due to the number of pages allowed in this document, it will not be possible to describe in detail all the stages developed in the project. However, it was tried to explain it in a way that allows the reader to understand its implementation more broadly.

Server-side

To start a project in node, we use npm (node package manager), typing the command `npm init -y` in the terminal and creating a `package.json` file, where the dependencies (modules) installed in our application will be listed (Pereira, n.d.). The application, in the folder “servidor,” was separated into folders to organize the code better. To implement the backend code, a folder called `server` was created. The `server.js` file is the application's main file, where all the routes are imported, the route endpoints are defined, where the express server is created, the connection to the MongoDB database, and where the middleware is implemented. The routes to the `main.js` file's endpoints are in the `routes` folder. The controller's functions are called in the route file of that specific object. The model's folder is the fields' schema and the types of data in the Database. receives (Krol et al., 2014). The controller functions are defined in the controller's folder, creating a file for each object to

get all the objects (users), get a single object, post an object, update an object, and patch an object. It used the ORCID API to get the data of professors working in the institution.

IMPLEMENTING THE ORCID API

To connect the MERN stack application with the ORCID API is necessary to register the application with ORCID to obtain a client I.D. and secret. In the Node.js/Express backend, the ORCID API handles the OAuth 2.0 authentication flow to obtain an access token. The library "orcid-sdk-node" is used to simplify this process. The access token is used to make API requests on behalf of the user. Can also retrieve their ORCID record, update their information, or read their works. In the React front end, the access token is used to authenticate API requests and display information from the ORCID API to the user. After the user grants permission, the access token and user profile are stored in the user's session. Then the access token can be used to make API requests on behalf of the user. Show the code to set up an Express server and uses the orcid-sdk-node library to handle the OAuth 2.0 authentication flow. The code used is shown below.

```
/* These lines of code are importing the necessary modules for the script. */
const axios = require('axios');
const xml2js = require('xml2js');
const OrcidProfile = require('../models/OrcidProfile');

/**
 * The `getOrcidProfile` function is an asynchronous function that retrieves a
person's ORCID profile
 * information, including their personal details, education history, and works,
using the ORCID ID.
 * @param req - The `req` parameter is the request object that contains
information about the incoming
 * HTTP request, such as the request headers, request parameters, request body,
etc. It is typically
 * provided by the web framework or server handling the HTTP request.
 * @param res - The `res` parameter is the response object that will be used to
send the HTTP response
 * back to the client. It is an object that contains methods and properties for
handling the response,
 * such as `json()` for sending a JSON response, `status()` for setting the HTTP
status code, and many
 */
const getOrcidProfile = async (req, res) => {
```



```

    const { orcidId } = req.params;

    try {

        const personResponse = await
    axios.get(`https://pub.orcid.org/v3.0/${orcidId}/person`);
        const educationsResponse = await
    axios.get(`https://pub.orcid.org/v3.0/${orcidId}/educations`);
        const worksResponse = await
    axios.get(`https://pub.orcid.org/v3.0/${orcidId}/works`);

        const parser = new xml2js.Parser();

        const personJson = await parser.parseStringPromise(personResponse.data);
        const educationsJson = await
    parser.parseStringPromise(educationsResponse.data);
        const worksJson = await parser.parseStringPromise(worksResponse.data);

        res.json({
            person: personJson,
            educations: educationsJson,
            works: worksJson
        });
    } catch (error) {
        console.error('Error fetching ORCID profile:', error);
        res.status(500).json({ message: 'Error fetching ORCID profile' });
    }
};

/**
 * The function `saveOrcidProfileToDb` saves an ORCID profile to a database,
either by updating an
 * existing profile or creating a new one.
 * @param orcidId - The ORCID ID of the profile to be saved.
 * @param personJson - personJson is a JSON object containing the personal
information of the ORCID
 * profile. It may include fields such as name, email, affiliation, biography,
etc.
 * @param educationsJson - The `educationsJson` parameter is a JSON object that
contains information
 * about the education history of the ORCID profile. It could include details
such as the institution
 * name, degree obtained, field of study, start and end dates, etc.
 * @param worksJson - The `worksJson` parameter is a JSON object that contains
information about the
 * works associated with the ORCID profile. It could include details such as the
title, publication
 * date, and type of each work.

```

```

*/
const saveOrcidProfileToDb = async (orcidId, personJson, educationsJson,
worksJson) => {
  try {
    let orcidProfile = await OrcidProfile.findOne({ orcidId });

    if (orcidProfile) {
      orcidProfile.person = personJson;
      orcidProfile.educations = educationsJson;
      orcidProfile.works = worksJson;
      console.log('Atualizando o perfil ORCID existente na base de
dados');
    } else {
      orcidProfile = new OrcidProfile({
        orcidId,
        person: personJson,
        educations: educationsJson,
        works: worksJson,
      });
      console.log('Criando um novo perfil ORCID na base de dados');
    }

    await orcidProfile.save();
    console.log('OrcidProfile salvo com sucesso na base de dados');
  } catch (error) {
    console.error('Erro ao salvar o OrcidProfile na base de dados:', error);
  }
};

module.exports = { getOrcidProfile };

```

After implementing the back-end code, the front end was created to display the ORCID user data on the Curriculum Card. The curricular data sheet fields are not filled through ORCID, having the user complete some information manually. Figures 14 and 15 show some pages of the application where the data are filled.

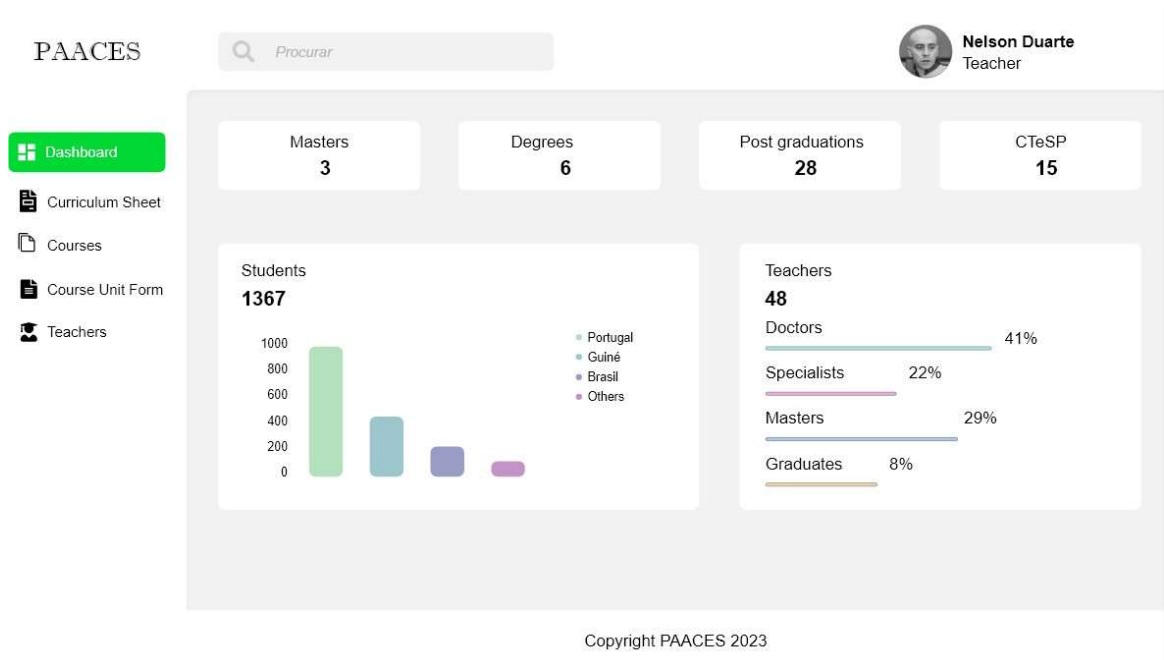


Figure 11 - Personal data of the Curriculum Sheet

PAACES Procurar

Nelson Duarte
Teacher

Dashboard

- Curriculum sheet**
- Courses
- Fucs
- Teachers

Curriculum Sheet [Authorize ORCID](#)

Personal data

First Name(s)	Family Name(s)	Address	Post Code
City	Email Address	Phone	Mobile Phone
Place of Birth	Date of Birth	Nationality	Taxpayer Number
ID Number	Civil Registration	Orcid Code	Cienciavita Code

< 1/5 >

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Figure 12 - Personal data of the Curriculum Sheet

PAACES

Procurar

Nelson Duarte
Teacher

Dashboard
Curriculum sheet
Courses
Fucs
Teachers

Curriculum Sheet

Authorize ORCID

Education

Academic degrees or titles

Year	Institution	Degree or Title	Area	Classification	
					+

Relevant Professional Training and Qualification

Year	Institution	Type	Training or Qualification	Classification	
					+

Registration as Researcher and Professional training

Year	Institution	Type	Training or Qualification	
				+

< 2/5 >

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Figure 13 - Education data of the Curriculum Sheet

LINODE CLOUD

The application was deployed on the Linode website. Linode is a hosting provider that offers virtual private servers (VPS) in the cloud. They provide a variety of Linux-based distributions, as well as the ability to use your custom images. Linode allows customers to create, configure, and manage virtual servers hosted in one of their data centers. They provide a web-based interface, command-line tools for managing servers, and APIs to automate tasks. Linode also offers additional services such as storage and networking, and scaling up resources as needed is possible. It is one of the most popular cloud hosting providers known for its reliability and performance (Han, 2011).

Linux Server Setup & MERN App Deployment

These steps are to set up an Ubuntu server from scratch and deploy a MERN app with the PM2 process manager and Nginx. Was created an account at <https://linode.com>

SSH Keys

There are a few ways to log into the server. There's an area to add an SSH key on the setup page. It can be used for passwords. However, to be more secure, the setting up SSH keys were used, and then disabled passwords. That way can only log in to the server from a P.C. with the correct keys. It generated an SSH key on the local machine to log in to the server remotely. By default, it will create the public and private key files in the **.ssh** directory

on the local machine and name them **id_rsa** and **id_rsa.pub**. It can be changed to the name we want, but it has to have the entire path to the key and the filename. Once that's done, it was needed to copy the public key. It used the `'cat'` command and then copied the key. The key has been copied and pasted into the Linode.com textarea. At some point, the developer will also be asked to enter a root password for the server (Gutmann, 2011).

Connecting as Root

The setup is finished, and the page will return to the dashboard. The status will probably say **Provisioning**. Please wait until it says **Running**, and then open the local machine's terminal and connect as root. It used the server's I.P. address. At this point, passwords are enabled. If the authentication and login work, there will be a welcome message, and the prompt should now say `root@localhost:~#`. It is necessary to update and upgrade the server with `sudo apt update` and `sudo apt upgrade` (Čabak & Gazivoda, 2016).

Create a new user

Logged in as root, creating a new account is a good idea. Using the root account can be a security risk. To add a new user, use the command `adduser admin`. It “enter” through all the questions. The following command was used to see the user info, including the groups it belongs to `id admin`. The user was added to the "sudo" group, giving them root privileges (Čabak & Gazivoda, 2016). The command is `usermod -aG sudo admin`.

Add SSH keys for the new account

Setting up SSH keys for the new account. It was done by adding it to a file called `authorized_keys` in the user's directory. It was created in a `.ssh` directory `mkdir .ssh` and a new file called `authorized_keys` with the command `touch authorized_keys`.

The public key was copied into the `authorized_keys` file and opened in nano with the command `sudo nano authorized_keys`. Disabling passwords can be done as an extra security step, disabling passwords so that only the local machine with the correct SSH keys can log in (Gutmann, 2011).

Node.js setup

Now that the server is provisioned and we have a user setup with SSH keys, it's time to start setting up the app environment. Node.js was installed with curl using the following commands `curl -fsSL https://deb.nodesource.com/setup_18.x | sudo -E bash` and `sudo apt-`

get install -y nodejs (Scalable & Apps, 2018).

Getting files on the server

To get the application files onto the server, Git was used for this. On the SERVER, was made a clone of the repo to deploy with the commands *mkdir PAACES*. And *git clone <https://github.com/nelsonduarte/paaces.git>*.

Application setup

Configuring the setting up of the .E.N.V. file, installing dependencies, and building the static assets for React. Now it was needed to edit the .env file. The NODE_ENV was changed to "production," and the MONGO_URI. There was created a MongoDB Atlas database (<https://mongodb.com>).

Dependencies & Build

It installed the server dependencies. It was done by running from the root of the application folder with the command *npm install*. The frontend dependencies were installed, and the static assets were built. To run the app, we must be the root user and run the following command *npm start*.

PM2 Setup

PM2 is a process manager for Node.js applications. It is designed to make running and managing Node.js apps in production environments easy. PM2 can start, stop, and monitor Node.js processes and restart them automatically in the event of a crash. It also provides log management, clustering, and resource usage monitoring features. PM2 allows you to keep your Node.js application alive forever, reload them without downtime, and facilitate common system administration tasks (Antoniou et al., 1999). To start the command, type *sudo npm install -g pm2*.

Firewall Setup

Open source software for web serving and reverse proxying (NGINX) was installed, a web server and reverse proxy server. It is open-source software and can be used to serve static and dynamic web pages, as well as to act as a reverse proxy for HTTP, HTTPS, and other protocols. It is known for its high performance, stability, and low resource consumption (Dejonghe, n.d.). It is not intended that users have to enter a port of 5000 or any other available. The firewall was configured so it can not directly access ports except SSH, HTTP, and HTTPS ports. The firewall is called Uncomplicated Firewall (UFW), a software

application for Linux systems. It is designed to be easy to use and configure while providing high security. UFW uses a command-line interface and can be used to control access to incoming and outgoing network traffic on a Linux system. It uses a set of predefined rules to determine which packets to allow through and which to block based on factors such as IP address, port number, and protocol. UFW is often a host-based firewall, meaning it can only protect the installed system (Čabak & Gazivoda, 2016). NGINX was installed to serve the application on port 80, the http port, and a proxy was set up. It was enabled with `sudo ufw enabled`. The ports that were needed were 22, 80, and 443, and it can be permitted using `sudo ufw allow ssh` (Port 22), `sudo ufw allow http` (Port 80), and `sudo ufw allow https` (Port 443).

Setting Up SSL

It used a Let's Encrypt certificate. Let's Encrypt is a free, automated, open-source certificate authority (CA). It provides digital certificates that can be used to secure websites. Let's Encrypt makes it easy for website owners to obtain and manage secure certificates, making HTTPS more widely available and helping to improve the overall security of the internet (Aas et al., 2019) with the HTTPS protocol. The certificates are issued and managed using the Automatic Certificate Management Environment (ACME) protocol, which allows for the automated issuance and renewal of certificates.

THE ORCID PLATFORM

ORCID can be seen as a repository of information, enabling authors and reviewers to securely connect to their contributions, allowing them to share information from their ORCID records. The ORCID platform allows researchers to showcase their research articles, establishing a link between people and their research work. You can also access links to jobs, research results, funding, scholarly activities, etc. By using ORCID in the PAACES application, one can uniquely identify the identity of researchers and can find out information about them. To access their information, the users must permit authentication in ORCID (Haak et al., 2012).

DISCUSSION OF THE MERN, MEAN, AND MEVN STACKS

MERN stack stands for MongoDB, ExpressJS, ReactJS, and NodeJS. It is a popular stack for building full-stack web applications. MongoDB is a NoSQL database, ExpressJS is a web framework for NodeJS, ReactJS is a JavaScript library for building user interfaces, and

NodeJS is a JavaScript runtime (Baiskar et al., 2022).

MEAN stack stands for MongoDB, ExpressJS, AngularJS, and NodeJS. MongoDB is a NoSQL database, ExpressJS is a web framework for NodeJS, AngularJS is a JavaScript framework for building dynamic web applications, and NodeJS is a JavaScript runtime (Bakwa D. et al., 2018). It is also a popular stack for building full-stack web applications.

MEVN stack stands for MongoDB, ExpressJS, VueJS, and NodeJS. It is a stack for building full-stack web applications that are gaining popularity. MongoDB is a NoSQL database, ExpressJS is a web framework for NodeJS, VueJS is a JavaScript framework for building user interfaces, and NodeJS is a JavaScript runtime (Stack, 2018).

The MERN stack has several advantages over the MEAN and MEVN stacks. ReactJS, used in the MERN stack, is a more popular and widely used JavaScript library for building user interfaces than AngularJS, which is used in the MEAN stack. That means a larger community and more resources are available for developers using React. React also offers better performance than AngularJS, allowing for a more efficient updating of the user interface. This project has used the MERN stack. The MERN stack allows for using a single language, JavaScript, throughout the entire stack. It is easier for developers to switch between the stack's layers, increasing development efficiency. MongoDB, ExpressJS, and Node.js are standard components in many stacks, not only in MERN, so developers with experience with any of those technologies will find it easier to adapt to MERN (Johnson, 2020). It's worth noting that the choice of a stack will depend on the project's specific requirements and the development team's preferences.

The difference between the three stacks lies only in each framework's language. The MERN stack uses ReactJS, the MEAN stack uses AngularJS, and the MEVN Stack uses VueJS.

CONCLUSIONS

Developing the PAACES application for accreditation and management of Higher Education institutions using React, Node, express, and MongoDB provides many benefits for end users. ReactJS provides a hierarchical structure, which improves the maintainability of the code and serves the goal of streamlining UI development. React also has a flexible architecture consisting of third-party libraries that can be easily accessed. React developers have created components expanding the functionality of these libraries. That is one of the driving forces behind the momentum gained by React in the developer community.

MongoDB is a NoSQL database in which the code defines the schema itself. The ability to get an entirely statistical version based on documents is considered one of the most attractive features of MongoDB. How it implements statistics in the form of BSON (Sterling, 2019), ruby hashes, etc., makes it easier to save the data in a way that is more accessible to maintain in different documents. NodeJS, for those already familiar with JavaScript, quickly learn how to program in NodeJS, creating with ExpressJS an easy-to-implement and secure server. Thus, creating, editing, updating, and managing tasks is easier when implementing the website using the MERN stack (Raju et al., 2021).

CONCLUSIONS

Customer satisfaction is a significant concern in education, students, and families. The Government wants to ensure good quality education. The question arises, what makes a good quality education? What is its meaning? Article I give some answers to this question. However, the concept of quality can have different aspects, and it is not always easy to cover all quality dimensions, particularly for education. This article presents methods and processes associated with accreditation and quality assurance in higher education worldwide. It was found that governments have a crucial role as higher education regulators, requiring public transparency in quality assurance and competition among higher education institutions. Various quality assurance methods in each country, course rankings, performance indicators, different course evaluation systems, and accreditation were presented. Evaluation and accreditation scenarios and the external review and audit processes were introduced. The primary assessment methodologies and the current situation in each country were presented. The education system depends on public trust, and quality assessment policies at national and institutional levels are becoming increasingly essential for the functioning of tensions between different values and interests in the future formation of higher education. It can be concluded that implementing external quality assessment systems in most European countries, as well as in other countries around the world, a few years ago was associated with a shift in the allocation of power within higher education. This shift benefited the institutional level and reinforced extrinsic values at the expense of intrinsic values. Managerial concerns, such as market concerns, became more important than academic disciplinary concerns. However, there are significant differences across institutions and countries in this general pattern related to contextual considerations and assessment methods. Future work will focus on an article about the following sequence in accrediting a course. Given the current scenario, many companies face daily challenges and problems that computers and information systems could solve.

Furthermore, it is worth emphasizing the importance of using information systems efficiently. An efficient information system can solve critical organizational problems or challenges (Martins et al., 2012). However, first, it is necessary to understand the process's organizational, human, and technological dimensions.

The UML class diagrams presented allow us to model, in a declaratory way, the static structure of an application domain regarding concepts and relationships between them. This

article focuses on UML class diagrams from a theoretical viewpoint. Features relevant to the implementation side, for instance, public, protected, and private qualifiers for attributes and operations, have yet to be covered. We present each UML class diagram's semantics as a function of first-order logic (FOL). We then define a model of the FOL expressions corresponding to creating a UML class diagram as an instantiation of the diagram (Berardi et al., 2005). The supply of software that helps in the accreditation process of courses in higher education institutions is very scarce; there is a need to develop systems to fill this gap and help in a process that can be complex for institutions. Through these systems, it is possible to reduce assessment errors, automate repetitive tasks, delegate responsibilities in data entry, and reduce the time of preparation of documents for assessment of courses in the Institution. Developing the PAACES application for accreditation and management of Higher Education institutions using React, Node, express, and MongoDB provides many benefits for end users.

React.JS provides a hierarchical structure, which improves the maintainability of the code and serves the goal of streamlining UI development. React also has a flexible architecture consisting of third-party libraries that can be easily accessed. React developers have created components expanding the functionality of these libraries. That is one of the driving forces behind the momentum gained by React in the developer community. MongoDB is a NoSQL database in which the code defines the schema itself. The ability to get an entirely statistical version based on documents is considered one of the most attractive features of MongoDB. How it implements statistics in the form of BSON (Sterling, 2019), ruby hashes, etc., makes it easier to save the data in a way that is more accessible to maintain in different documents. NodeJS, for those already familiar with JavaScript, quickly learn how to program in NodeJS, creating with ExpressJS an easy-to-implement and secure server. Thus, creating, editing, updating, and managing tasks is easier when implementing the website using the MERN stack (Raju et al., 2021).

The objectives of the thesis were successful, demonstrated through three articles the questions to be investigated. The three articles were proposed for publication, demonstrating their importance for researchers and professors interested in these areas. It is expected to continue the development of the topic as future work, deepening the course accreditation systems in higher education and improving the platform created for accreditation.

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