STUDY OF THE EDUCATION FOR INNOVATION PROGRAM IN DIGITAL INDUSTRY 4.0: AGILE PROJECT METHODOLOGY MULTI-CASE STUDY (ONESUBSEA - FAE)

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ABSTRACT

This article explores the dynamics between academia and industry in the innovation of Industry 4.0, focusing on Production Engineering and Mechanical Engineering courses. As a second phase, considering the previous project "Education for Innovation in the Context of Industry 4.0" (LUZ et al., 2023), the research concentrates on identifying measures taken to improve the ability of educational and corporate institutions to keep up with innovations in Industry 4.0, to incorporate innovation as part of the organizational culture. Furthermore, the research studies the gaps identified in the previous PAIC carried out in partnership with Onesubsea and Centro Universitário FAE, following the requirements of the ISO 56.002 standard and the Agile Project Management Methodology. In parallel, a study will be conducted on the academic market of engineering courses and its compatibility with market demands. The article will benefit academia and companies in their educational, productive, and administrative processes, creating an environment conducive to innovation and implementing Agile Project Management in the face of the challenges of Industry 4.0.

Keywords: Onesubsea, Manufacturing Engineering, Agile Project Management, Risk Assessment, Innovation.

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INTRODUCTION

According to a survey conducted by the National Confederation of Industry (CNI) in 2016, 48% of Brazilian industries have adopted at least one of the ten digital technologies surveyed within the context of the Fourth Industrial Revolution. Thus, Brazil has access to technological innovations but lags behind in updating its industries, and the lack of implementation of new technologies hinders competitiveness when compared to other countries (SILVA-OLAVE, 2020).

The complex global scenario of challenges and uncertainties can be an opportunity for Brazil, according to the National Confederation of Industry (CNI). According to the Industry Recovery Plan presented in 2023 by the CNI, among the keys to boosting the competitiveness of the Brazilian industry are investment in technology, innovation, and education. Based on these keys, the objective of this mapping is to meet the demands and regulations of international markets through structural changes in the private and public sectors that respond to the global market and make the Brazilian business environment more attractive (CNI, 2023).

Brazilian engineering has gained international recognition for its excellence, especially in the area of infrastructure. Works such as the Itaipu hydroelectric plant, the Rio-Niterói bridge, and the construction of Brasília are among the major achievements of global civil engineering. This achievement is intrinsically linked to the quality of engineering education in Brazil, which dates back to the founding of the Royal Academy of Artillery, Fortification, and Design in 1792, the embryo of the Rio de Janeiro Polytechnic School created in 1847. However, the accelerated technological advancement of the fourth industrial revolution, starting in the 1990s, and the growing global awareness of the finiteness of natural resources and the need for equity in the distribution of the wealth generated by these resources, have laid the foundation for a new society. To build on these foundations, there is a need for a new profile of engineers (CNI, 2021).

Based on the understanding of the demand for change in the training of new engineers, this research focuses on identifying measures to improve the ability of educational and corporate institutions to keep up with innovations in Industry 4.0, with the aim of incorporating innovation as part of the organizational culture. As a second phase of the previous project “Education for Innovation in the Context of Industry 4.0” (LUZ et al., 2023), which examined the implementation of projects at Aker Solutions. The research seeks to conduct a case study carried out in partnership with Onesubsea, adhering to the requirements of the ISO 56.002 standard and the Agile Project Management Methodology. In parallel, a study will be conducted on the academic market of the engineering course and its compatibility with the demands

of the market. This will benefit both academia and the company in their educational, productive, and administrative processes, creating an environment conducive to innovation and the implementation of Agile Project Management in the face of the challenges of Industry 4.0.

DEVELOPMENT

1 LITERATURE REVIEW

1.1 INDUSTRY 4.0

The 4th Industrial Revolution is characterized by the integration of tools and automation of systems, concurrent with the second digital revolution, which would be the transition of physical processes to digital tools, taking physical data to the intangible virtual world, creating a cyber-physical system. In a reinterpretation by specialists, more than 60 technologies have been identified and classified into: data and connection, analytics and artificial intelligence, human-machine interaction, and factory automation. In order to meet the market demands of the industrial sector, new information and communication technologies have emerged, which have led to the intensification of automation and digitalization of production within corporations (NETO, 2020).

In the context of the consolidation of the digital environment, Science, Technology, and Innovation are essential to drive the production of Brazilian industry. These factors foster the industrial sector, allowing the strengthening of Industry 4.0 and the emergence of new business models, as well as driving various sectors of the economy, creating opportunities for integration, adaptation, growth, and competitiveness (CNI, 2023). In terms of innovation, Brazil ranked 49th in the Global Innovation Index in 2023, climbing 5 positions compared to 2022, but still below its best score in 2011 with 47th place (WIPO - GII, 2023). In Brazil, companies have the potential to increase their competitiveness through industrial technologies, but not only through tools, the organizational culture and management preparation must accompany these digital transformations. With pillars focused on receiving innovation, it will be possible to meet the constant updating that the market requires (CNI, 2023).

Industry is the convergence point between Research and Development (R&D) and the production sector. The link between these areas occurs through the search for

process improvement and innovation, which impact the competitiveness, development, and growth of an organization. Thus, investment in Research, Development, and Innovation (RDI) enables studies that contribute to identifying threats and opportunities in the industry, such as the creation of new products, process evolutions, and the introduction of new technologies. And as the main source of capital, the CNI's strategic map recommends exploring international and public-private partnerships to stimulate the entry of new investments. With the refinement of the external relationship, the expectation is to leverage Brazil to a position of innovation promoter in international parameters (CNI, 2023).

1.2 PROJECT MANAGEMENT AND AGILE METHODOLOGY

The international context presents itself as a VUCA[3] environment, where four characteristics are highlighted: volatility, the high rate of change that the world is exposed to; uncertainty, as a consequence of the first, it is increasingly difficult to map and predict threats and trends; the complexity of the system, unrelated events affect each other, creating a non-linear network of reactions; finally, ambiguity, which is generated by the exposure of too much content without defining the company's objectives, creating inefficiency and insecurity (CAMARGO; RIBAS, 2019).

In this way, the unstable corporate context requires the ability to create paths, absorb impacts, and manage projects through agile management methodologies (CALVOSA; FRANCO, 2022). Project Management is the activity of managing resources and talent under the guidance of the organization's context, processes, demand, final product, and stakeholders. Managing a team requires transparent and reliable leadership, and each decision made generates a wave of impacts on members and other teams involved (PMBOK® Guide, 2021). Considering the context of your project's change flows, your team's demand, and the volatility of the market, there are several agile methodologies that can be applied. Among so many options that may fit, the ideal methodology is the one that actually works in the project, that fits the company's environment and is compatible with the team (CAMARGO; RIBAS, 2019).

The global trend of tracking the company's impacts, the finiteness of resources, and the harmony of project members are factors that are increasingly weighted in the analysis of management. The project system is formed by a union of interactive and interdependent components, for this reason, companies have adopted a holistic

[3] VUCA - An English-language acronym, originating in the United States, representing the military challenges in a post-Cold War context: Volatility, Uncertainty, Complexity, and Ambiguity (CALVOSA; FRANCO, 2022).

view in their projects, considering the financial, technical, social, and environmental performance in a panoramic way, aligning the organizational and project objectives with the demand and expectations of the stakeholders involved (PMBOK® Guide, 2021).

The high speed of information exchange that occurs in the corporate world provokes stimuli to the team, thus the ability to adapt in the team's approach becomes a competitive advantage in the face of changing conditions. In addition to adaptability, two more factors interfere in the delivery of company value: resilience, the ability to absorb impacts and recover quickly, and focus on results, through holistic thinking teams should seek positive results within the context of their unplanned events, using them as an opportunity (PMBOK® Guide, 2021).

Critical thinking will be the essential skill for carrying out project activities, as explained in the PMBOK®, it is a set of skills, including disciplined, rational, logical, and evidence-based thinking. In addition, critical thinking also requires perception, a certain awareness of one's own cognitive process, and the ability to analyze objectively (PMBOK® Guide, 2021).

1.2.1 About Traditional Planning

To better understand the competitive impact of the agile methodology, the predictive method, known as the traditional project management model, will first be introduced, in which a sequence of steps is followed, so that its linearity is opposed to the agile methodology (MAXIMIANO; VERONEZE, 2022). Also known as the waterfall model, this method first seeks to fully plan the project and then start executing, making only one complete delivery at the end of the schedule. However, the model is not compatible with market volatility, in addition, current projects operate with a collective intelligence that connects the internal team with external teams, counting on the collaboration of stakeholders (CAMARGO; RIBAS, 2019).

1.2.2 Agile Method

Agile methods, a concept in constant evolution, aim to deliver value continuously and early, prioritizing requirements that represent the highest risk or value for the project. Unlike traditional methodologies, agile delivery, which is based on iterative and incremental processes, allows the solution or product to emerge weeks after the start of the project, with most phases occurring in parallel. Small, cross-functional teams release a

functional build each sprint, allowing for project validation and the integration of feedback to increase the value of the solution or product. This approach manages complexity and unpredictability through practices of visibility, inspection, and adaptation, and meets the dynamic needs of digital technologies, allowing for the rapid delivery of final products that meet the needs of users and stakeholders (KERZNER, 2020).

Implementing the project using the agile method will have a reduced time to market for an idea, resulting in a return on investment (ROI) higher than the initial investment. The suitability of the product to market demands will be determined. Product development based on a prioritized backlog minimizes risks and ensures cost-benefit optimization (KERZNER, 2020).

In agile delivery, although a certain degree of discipline is useful, this does not replace the need for the team to take ownership of their work and collaborate intensely to solve the problem together. Collaboration among team members fosters high performance in the project (KERZNER, 2020).

1.2.3 Scrum

Scrum, an agile methodology framework[4] that seeks to deliver a product with the highest possible value. Scrum is a lightweight framework, consisting of three roles, four events, and five artifacts. Its simplicity facilitates understanding and learning, although its mastery requires time. It values transparency, with the Definition of Done (DoD) being a fundamental concept. At the end of each sprint (the smallest unit of project delivery), the team presents the work done, allowing for periodic inspection for continuous improvement. In addition, it allows for adaptation, where the team and stakeholders can make the necessary changes to increase the quality and value of the product under development, as well as the team's productivity (KERZNER, 2020).

1.2.4 Design Thinking

Design thinking presents itself as a mental model of creation and organization, used to study opportunities, or study problems, their causes, and their solutions, aiming for the best possible functionality. Through the collaboration of Design Thinking, the project receives a broader vision, with diverse points of view, enriching the team's

[4] A framework is a supporting structure, a system of rules and ideas used for planning (CARVALHO, 2018).

understanding. The technique is also used to test the stages, part of the concept is that the fast failure in testing becomes cheap with the rapid regeneration of the project (CAMARGO; RIBAS, 2019).

1.2.5 Tailoring

Tailoring is the adaptation of a project, adjusting it appropriately to a specific environment and the work to be done. The methodology seeks to maximize value and manage constraints, and is applied to the project development approach, processes, governance, project life cycles, deliverables, and the selection of collaborators. Tailoring is almost always guided by organizational guidelines; it is a device that requires awareness of the company's goals, demands, and size and requires continuous analysis and critical thinking (PMBOK® Guide, 2021).

The absence of an exclusive approach allows for project flexibility, enabling agile adjustments. The application of the method involves the analysis, verification, and updating of the processes and tools used in the project, with the four stages being: Select the initial approach; Perform organizational tailoring; Perform project tailoring; Implement continuous improvements. The benefits of this method are the more efficient use of project resources and the concentration of efforts on meeting the customer (PMBOK® Guide, 2021).

1.3 ISO 56.002

The Brazilian Association of Technical Standards (ABNT) published ABNT NBR ISO 56.002 in October 2020 with the aim of ensuring superior performance in innovation management and making innovation an integral part of the organizational culture. This standard, which is an identical adoption of ISO 56.002:2019 in terms of technical content, structure, and wording, defines the requirements for certifying organizations as innovative. The implementation of an innovation culture is seen as a key factor for sustainable growth, economic viability, increased well-being, and societal development ("ISO 56002 - Innova Manager ISO 56000", [n.d.]).

An organization's innovation capabilities include the ability to understand and respond to changes in its context, seek new opportunities, and leverage the knowledge and creativity of people within the organization and in collaboration with external stakeholders. According to the standard, an organization can innovate more effectively

and efficiently if all necessary activities and other interrelated elements are managed as a system. The ISO 56002 standard is based on innovation management principles, including value realization, future-focused leaders, strategic direction, culture, idea exploration, uncertainty management, adaptability, and a systemic approach ("ISO 56002 - Innova Manager ISO 56000", [n.d.]).

1.4 RISK MANAGEMENT

Within the managerial vision of a project, risk is an uncertain condition that can have positive effects, such as opportunity, or negative effects, such as threat. Each project works with a degree of uncertainty, and it is up to the responsible team to define the degree of uncertainty that the project can assume. In addition to identifying risks, the team should seek to minimize negative impacts and explore positive ones (PMBOK® Guide, 2021).

In his study, Neto (2020) conducted a survey of over 100 articles to map risk management from the perspective of Industry 4.0. This master's thesis analyzed the approach to safety (risk) throughout the industrial eras and identified three landmark periods in risk management: 1st period focused on infrastructure, large-scale explosions, and accidents; 2nd period focused on human risk on the factory floor, human safety valves, probabilistic studies, development of methods with human reliability analysis; 3rd period focused on the cognitive role in human decision-making, complex and high-risk systems, risk and safety analyses.

The role of risk management has taken on greater proportions, aligning the entire supply chain, from the provision of outsourced services to the delivery of the end consumer, all interactions present risks to be analyzed, exponentially increasing the diversification of risk types. Among the technologies that try to meet the new threats are tools for risk prevention and protection, instruments for crisis management (NETO, 2020).

Risk management is the set of actions and practices that interact with the uncertainty factor of each operation of an organization. Considering the objectives of a company, its positions and decisions expose the company to various uncertainty factors that can represent dangers or opportunities that impact the ability to generate value. Risk management involves implementing the following stages of Risk Management: planning management; identification; qualitative analysis; quantitative analysis; tracking; control; monitoring; responses and implementation of responses. (NETO, 2020; SPÓSITO et al. 2018; VIEIRA; BARRETO, 2019). When risk management is correctly implemented,

in a systematic, structured, and timely manner, it generates benefits that directly impact the organization's productivity, enabling the assertive allocation of resources, supporting high-impact decisions, and optimizing the efficiency and effectiveness of the company's process (VIEIRA; BARRETO, 2019).

1.5 EDUCATION 4.0

Education is the foundation of a society's development and, consequently, a decisive factor in its progress. The combination of vocational education with higher education enables the development of qualified and innovative professionals who have the capacity to drive the country's competitiveness. To meet market requirements, academic curricula must be periodically reviewed to keep skills and competencies relevant to the market up-to-date. Thus, seeking resources for education is investing in the country's prosperity, just as the innovation capacity, productivity, and competitiveness of Brazilian industry reflect the level of vocational and higher education in the country (CNI, 2023).

It was from the COVID-19 pandemic that the need for a pedagogical language suitable for implemented educational technologies became evident. In this context, educational managers were faced with the urgent need to offer an adequate technological information structure to develop and facilitate the virtual learning process. Since then, the central question is no longer whether technology is useful, but which technology to choose and how to use it effectively to meet the individual needs of students and teachers. However, the implementation and maintenance of an excellent technological infrastructure to provide the necessary technical and pedagogical support to teachers and students has been one of the greatest recent institutional challenges. Faced with these challenges, it becomes increasingly important to adopt effective teaching methodologies, understanding their potential and limitations, to achieve learning objectives (NOGUEIRA et al., 2020).

From an academic perspective, during the pandemic, most private higher education institutions already offered distance learning courses and, with financial investments, managed to develop and facilitate virtual learning. However, many public higher education institutions had to suspend activities due to the inefficiency of their servers and educational platforms. Thus, the disparity between higher education institutions and the way in which social inequality directly affects the quality of education becomes evident (NOGUEIRA et al., 2020).

The teaching scenario during the pandemic encouraged debates about the

irreversibility of adopting technologies in education. Research conducted by the Desafios da Educação portal provides reports from academic coordinators and administrators about the lessons learned by educational institutions during the coronavirus pandemic. They state that, once teachers and students have experienced the use of educational technologies and had access to courses in the Virtual Learning Environment (VLE), they will not want to abandon these tools in the future, as they have recognized their potential and the opportunities they provide in the educational environment (KOCHHANN, 2020). It is evident that the application of technology-based teaching requires the understanding that the process involves the integration of students, teachers, institutions (academic managers), technological tools, and course content. The challenge lies in identifying the technical and operational strengths and weaknesses of those involved in the use of technologies (NOGUEIRA et al., 2020).

It is through collaboration between academia and the productive sector that vocational and higher education is aligned with market demands. This interaction is essential to implement industry 4.0 technologies, best management practices, innovation in companies, and increase employability in the sector. Considering training in STEM areas (Science, Technology, Engineering, and Mathematics), investment in available professionals will have a direct return on the development of new technologies, products, and processes. Therefore, the training of qualified professionals is the fundamental element to improve the productivity of companies and, consequently, boost their competitiveness. In addition to conventional training, the scenario of constant transformation requires a curriculum update at the same time, to keep up with new methods and technologies, and the concepts of reskilling and upskilling[5], arising from continuous learning, emerge as strategies for professionals to remain compatible with technological trends (CNI, 2023).

In this sense, the training of qualified professionals who are up-to-date with new technologies and production methods is fundamental for companies to compete in an increasingly globalized and dynamic market. Given the current scenario of technological transformation, it is essential to promote strategies that enable lifelong and continuous learning, through the implementation of educational policies focused on the permanent qualification of all workers. To this end, the country needs to invest in reskilling and upskilling strategies that keep workers' skills and competencies aligned with new technological trends (CNI, 2023).

The digital transformation arising from the fourth industrial revolution urges

[5] Upskilling refers to the professional development of new skills based on existing competencies. Reskilling, on the other hand, involves acquiring new skills to replace obsolete ones, leading to a change in one's area of expertise (SEBRAE, 2023).

the need to prepare professionals for this new digitalized and knowledge-intensive industry. Companies need professionals with a flexible, adaptable, and innovative profile, prepared for the challenges of the market. In this way, the industry seeks a combination of technical knowledge with soft skills[6] such as creativity, entrepreneurship, systemic vision, ability to develop projects, aptitude for interpersonal interactions, communication, and willingness for continuous learning (CNI, 2021).

Among the tools to be developed with new digital technologies are artificial intelligence, big data, machine learning, and advanced robotics. Stimulating this rapprochement between the business and academic worlds is essential. Debating the future of engineering education requires considering the demands of the market, as well as requiring a more optimized integration between universities and companies (CNI, 2021).

1.6 ENGINEERING COURSES

Engineering, crucial for solving global challenges and driving economic development, is taught in Higher Education Institutions (HEIs), which are vital for building a national asset. In the face of rapid global technological and economic transformations, universities recognize the need to adapt their teaching methods and content to adequately prepare their students in a digitalized and connected world, making reforms in undergraduate engineering education a necessity (CNI, 2021).

As a result, the need for qualified professionals in greater numbers at all stages of a product's life cycle intensifies, and the interactions between them become increasingly intricate. A large number of companies operate on a global scale, encompassing a variety of markets, competitors, and collaborators in the development of technologies and products. Additionally, collaborations with entities and corporations from different cultures and locations bring new perspectives to this network (CNI, 2021).

Within this scenario, engineers face unprecedented challenges that demand skills such as continuous improvement, innovation, leadership, and effective communication. In addition to a robust technical background, they need to manage technical and commercial decisions, communicating complex ideas in a direct and understandable manner. Understanding a systemic and integrated vision is essential for the formation of good engineering professionals. This goes beyond specific disciplines, allowing the professional to see the whole and understand the various applications of knowledge

[6] Soft skills are socioemotional abilities that enhance leadership roles through interpersonal relationships. The term first appeared in US Army manuals, guiding behaviors of flexibility and adaptability to promote more friendly relations with civilians of the time (SEBRAE, 2023).

and technologies in real business scenarios. This ability enables making decisions that benefit complex and integrated systems, even if this involves yielding in specific aspects of performance to achieve more competitive products (CNI, 2021).

Competent professionals must move skillfully between the domains of problems and solutions, without being overly attached to either. Although training often focuses on established problems with known approaches, it is essential to go beyond. New challenges arise, demanding innovative solutions. Therefore, the future professional must identify and clearly define problems, allowing other stakeholders to contribute with analyses and solutions (CNI, 2021).

1.6.1 National Curricular Guidelines (NCGs)

In 2019, the new National Curricular Guidelines (NCGs) for Engineering (Resolution CNE/CES No. 2, of April 24, 2019) were approved to modernize engineering education. These guidelines, which provide orientation for curricular planning, were developed to meet global demands in a context of rapid technological transformations, focusing on project-based teaching models and the development of competencies aligned with the market. With the participation of the business sector, they aim to prepare engineers for activities such as managing innovation projects and prospecting new ventures (BRASIL, 2019; CNI, 2021). The NCGs encourage experimentation and integration between theory and practice in the pedagogical process, which must be constantly updated to reflect society. The objective is to train professionals capable of facing contemporary challenges (CNI, 2021).

Advanced engineering schools are committed to institutional transformations to adopt student-centered pedagogical models, project-based learning that is socially relevant, and a valuing of entrepreneurship and innovation. This reengineering is marked by systemic interaction and multidisciplinarity (CNI, 2021). The revision of the National Guidelines for Undergraduate Engineering Courses in Brazil becomes a crucial element in the development of technical and behavioral competencies, using innovative and active teaching-learning methodologies. Seeking to develop solutions that are coherent in both the tacit and explicit knowledge domains, and that are useful in engineering practice, this process must occur within an institutional space strengthened by the integration between educational institutions and companies. However, the challenge lies in the transition between learning theories, which seek to explain how one learns, and the practical issues of Engineering, which focus on how to obtain specific results in training, qualification, and training (BRASIL, 2019; LUZ et al., 2023).

The changes aim to be broad and sustainable, involving the realignment of the

curriculum and pedagogical project, and the participation of all institutional and teaching leaders. In 2016, MIT launched the NEET program, an interdepartmental effort focused on integrative and project-centered learning, preparing students to solve problems in various technological areas. This initiative, which also stimulates the development of interpersonal skills, exemplifies a new educational approach, flexible and in dialogue with the global challenges of Engineering (CNI, 2021).

1.6.2 The Challenges Faced by Academic Institutions

Dropout rates in higher education are a phenomenon affecting both private and public universities. A study conducted on the Production Engineering course at the Federal Institute of Minas Gerais showed that the average dropout rate throughout the course is nearly 45%. Among the causes identified, areas with the highest dropout rates are those that develop mathematical knowledge. 55.95% of dropouts reached only up to the 3rd semester of the undergraduate program, either due to uncertainty about the course or lack of institutional preparation, while the dropout rate in the 7th semester is lower, a phenomenon explained by the expectation of completing the course (CONCEIÇÃO; LONGHINI; OLIVEIRA, 2020).

Distance learning is another challenge faced by Brazilian Higher Education Institutions. Through an analysis of the volume of distance learning undergraduate courses in Production Engineering in Brazil, considering the period from 2008 to 2019, factors were identified that make the modality sensitive in terms of quality. Distance learning (DL) has helped democratize higher education in the private sector throughout the country, in addition to being present in the public network of the Southeast (SANTOS; ASSUMPÇÃO; CASTRO, 2020).

The first participation of public Production Engineering courses obtained good scores in the ENADE, refuting concerns about the delivery of content. Furthermore, in April 2019, the new National Curricular Guidelines (NCG) for the Engineering course were published, promoting training with practical experiences for the development of skills compatible with a more complex reality. However, the conditions of distance learning for an engineering course require teacher training, as there is a difference in the spatiotemporal and teaching-learning process, as they occur separately for students and teachers, unlike face-to-face classes. Nevertheless, the use of Information and Communication Technologies (ICTs[7]) without reflective learning does not add to the

[7] Information and Communication Technologies (ICTs) are integrated into a range of technological bases that enable, through equipment, software, and media, the association of various environments and individuals

student's formation, making the teacher's role even more fundamental to make the class active, critical, and creative (SANTOS; ASSUMPÇÃO; CASTRO, 2020).

According to the Future of Jobs Report 2023 by the World Economic Forum, the market estimates that around 23% of jobs will change by 2027, forecasting the creation of 69 million new jobs and the elimination of 83 million. Employers expect this advancement in technology adoption to contribute positively to job creation, as this change encourages turnover in the market, promoting a positive balance in job creation (WORLD ECONOMIC FORUM, 2023).

Companies interviewed reported gaps in their employees' skills. According to the study, 6 in 10 workers will need to reskill. In addition to the gaps, the obsolescence of 44% of workers' skills by 2027 was pointed out. With the digitalization of manual functions, solid cognitive skills present the sought-after differential in the market, such as critical and creative thinking. Furthermore, it is expected that mastery of technologies such as Artificial Intelligence (AI) and big data analysis will become even more relevant, with companies' training strategies focusing on these aspects in the next five years. The market expects AI to be in 75% of the companies interviewed for the report and to cause a turnover in jobs in the area where the tool was implemented (WORLD ECONOMIC FORUM, 2023).

In 2014, Brazil recorded a record of 378,000 new students enrolling in engineering courses. However, this number has declined continuously in subsequent years, stabilizing at 250,000 enrollments since 2019. The decline was entirely in the private sector, while the public sector saw a small increase. In parallel, the Distance Learning (DL) modality has gained popularity, especially in private institutions, where 44% of the 249,000 entrants opted for this modality in 2021. Additionally, the course completion rate is 39%, indicating an estimated dropout rate of 61%. These data highlight the dynamic changes and challenges faced in engineering education in Brazil (PESQUISA FAPESP, 2023).

2 METHODOLOGY

This article addresses recent topics with few updated publications. Therefore, it will adopt a qualitative approach, given the scarcity of updated and consolidated publications on the subject. An exploratory approach was chosen, using semi-structured

in a network, facilitating communication among its members and expanding the actions and possibilities already guaranteed by technological means (SOARES; BUENO; CALEGARI; LACERDA; DIAS, 2015).

interviews and document analysis to collect detailed and contextual data. Case studies were selected based on relevance and representativeness criteria, allowing for an in-depth understanding of the investigated phenomena.

Based on this project, a Systematic Literature Review was developed, a process of identifying, selecting, and critically evaluating literature relevant to the article (GALVAO; PEREIRA, 2014), based on qualitative analysis to conceptualize the agile project management methodology, ISO 56.002, risk management, and explore the New Curricular Guidelines for engineering courses. In addition, a narrative review is conducted, in which quantitative studies on course entrants and distance learning (DL) students are reported, using the most up-to-date and well-regarded sources. Both reviews map the studied scenario, Industry 4.0, and the academic context of Brazilian engineering undergraduate programs.

As a proposed study, Qualitative Case Study Analysis is the methodology used to collect data on FAE Centro Universitário and its Production Engineering course, in order to map and problematize its scenarios. From this study of the analyses on innovation and education in both environments and a case study, it will be possible to construct. Through semi-structured qualitative interviews with authorities from the senior management of Onesubsea and with the coordinator of engineering courses at FAE, Dr. Aleksandra Gouveia Santos Gomes da Silva, it is possible to elucidate the two case studies addressed in this article, allowing for an in-depth investigation of the phenomenon within its real context.

This article resumes, through the Iterative Review Study, the guidelines and actions previously raised by the Academic Scientific Initiation Project already carried out in partnership with Aker Solutions, “Education for Innovation in the Context of Industry 4.0” (LUZ et al., 2023) and the Montana Report (HEART, 2022). The approach used in the first article was based on social research techniques, in order to gain experience, contribute to the discussion, and develop knowledge in an integrated manner. The analysis of the present project seeks to integrate the data raised in other research to structure knowledge within the requirements of the ISO 56.002 standard, the Agile Project Methodology, and to explore academic delivery within the parameters of market demand.

3 ANALYSIS OF RESULTS

3.1 CASE STUDY

3.1.1 Montana Report

At Montana State University, a study was conducted on the implementation of ISO 56.002 at Aker Solutions Brazil, specifically in the subdivision focused on the development of new technologies and Subsea operations. This project identified gaps related to innovation culture and management, as the company had already adhered to metrics similar to those required by ISO 56.002, therefore already had a basis for implementing improvements. Among the weaknesses found, the study presented the following points: the company showed a solid basic knowledge of innovation tools and methodologies; lack of documentation formalizing the leadership's commitment to implementing the ISO; based on the study, the biggest obstacle to completing the implementation of this new culture is this lack of communication between hierarchies and with the company's subsidiaries; a clearly established policy regarding willingness to take risks and tolerance for them was not identified; there is a gap in the terminology, quantitative and qualitative metrics used to measure innovation in the organization (HEART et al., 2022).

Recently, Aker Solutions, together with SLB and Subsea7, announced the closing of a *joint venture*[8] called OneSubsea on October 2, 2023. Aker Solutions' strategic decision to join SLB and Subsea7 to form OneSubsea was a significant move to drive innovation and efficiency in subsea production. The new company, OneSubsea, aims to help customers unlock reserves and reduce cycle time, holding for this an extensive complementary portfolio of subsea production and processing technology, access to industry-leading knowledge in reservoirs and digital domain, unique pore-to-process integration capabilities and reinforced R&D capabilities. This strategic shift allows Aker Solutions to benefit from the combined expertise and innovation capabilities of SLB and Subsea7, while maintaining a significant role in the new company (AKER SOLUTIONS, 2023).

[8] An English term referring to a strategic partnership between two or more companies, where two entities join forces to capitalize on an activity for a limited time, without either losing their own identity or brand. In the case of Aker Solutions, they formed a joint venture with Subsea7, called OneSubsea. SLB holds 70% of the shares, Aker Solutions 20%, and Subsea7 10% (WOLFFENBÜTTEL, 2006).

In a conversation in 2024 with a senior management position at OneSubsea, the company's scenario regarding the challenges faced with the change was elucidated, mirroring the diagnosis of the Montana report. With the change of the Joint Venture, OneSubsea faces differences in organizational cultures, among the sensitive points of the OneSubsea transition there is a topic that converges with the old gap of Aker, within project management there is a lack of preparation for Risk Management. The flow of changes caused by the migration of the organizational culture exposes the company to opportunities and threats, in addition to the adaptation of procedures that implies divergences in approach due to the difference in organizational culture. Thus, with each change or action taken, a risk is assumed, but it is still unknown how to manage it.

3.1.2 FAE - University Center

In 2024, FAE Centro Universitário reformulated the curriculum of its Production Engineering course, seeking to update the professional profile of its graduates. FAE implemented new training axes including: technical base, operations, impact projects, people, technology, management, finance, strategies, belt certifications, quality, and sustainability. This change aims to deliver professionals capable of working with materials, procedures, tools, people, and productive systems, thus exploring the increase in production quality and productivity. Not only the use of new tools but the faculty also foresees laboratory classes that expose students to real challenges (FAE, 2024).

Among the knowledge inserted in the course update, there are classes on administrative and digital skills, focusing on the training of students for strategic decisions and holistic analysis of the environment. This shift in focus allows the trained engineer to change their productivity, moving from the factory floor to the macro impact of their activities within the company. The subjects now seek an entrepreneurial vision of management, analysis, automation, and planning, entering the intellectual realm of service, no longer manual.

The coordination of the FAE engineering course sought to reformulate the curriculum, aiming to comply with the NCGs and deliver competent professionals to the market. In addition to the mandatory curricular grid, the course promotes belt certifications that are developed throughout the course as a competitive differential for entrants (FAE, 2024). The Black Belt certification represents the development of leadership capacity in problem-solving projects, as well as the ability to train and mentor project teams. While the Green Belt certification demonstrates aptitude in activities to assist in data collection and analysis for projects led by Black Belts (ESCOBAR et al., 2021).

3.2 ANALYSIS

Brazil's ranking in the Global Innovation Index, as reported by CNI, places it as the most innovative economy in the Latin America and Caribbean region. However, according to the National Confederation of Industry, the index does not yet reflect the performance of the Brazilian economy, and there is extensive potential to be explored. In particular, CNI points out the lack of training in STEM areas, which are the professionals who promote innovation within companies through the development of technologies and tools that provide the company's competitiveness. The adaptation of working professionals becomes essential in the context of Industry 4.0, to guarantee the competitiveness of Brazilian industry (CNI, 2021).

The scarcity of qualified professionals in this context demands an urgent response from the educational sector. In this scenario, the National Confederation of Industries (2023) also points out that engineering students need a more developed academic curriculum aligned with new emerging technologies, ensuring that they are prepared for the constant adaptations of the market. To assess the level of this engineering training in private universities, a questionnaire was applied in 2022 within FAE Centro Universitário, so that teachers and students of Mechanical Engineering and Production Engineering could evaluate the university's preparation in the face of market experiences, contact with digital tools, and the impact of technologies on professional performance.

In higher education institutions, there are still courses guided by traditional teaching methodologies focused on the development of technical competencies, however, the study conducted with the students exposed the lack they felt for more current methods that introduce multidisciplinary tools and skills, in addition to digital tools. The research also investigated, within the scope of the academy's monitoring of innovation, the weight given to digital technologies in learning, and found that both students and faculty understand the use of digital technologies as a tool for integration between theory and practice, which contribute to the development of multidisciplinary competencies and that the use of these tools improves the efficiency of classes. The work also argues that the lack of interaction between the institution and innovation directly impacts the performance of its graduates in the field, in the development of companies, and in the dissemination of technological knowledge in use (CRUZ et al., 2022).

The change in the course at FAE Centro Universitário adds significantly by incorporating more current methodologies and digital tools, promoting a multidisciplinary training that integrates theory and practice. This improves students' preparation for the demands of the market, as pointed out by previous research, which identified the need for more modern teaching methods and the importance of digital

technologies in the development of competencies. With these changes, FAE not only meets the expectations of students and teachers but also contributes to the training of more qualified and adaptable professionals to the innovations of Industry 4.0, enhancing the competitiveness of Brazilian industry.

In addition to the general analysis, in the CNI report on the evolution of engineering education, a virtual meeting with Concremat interns is described in February 2021. In this meeting, a quick survey was conducted to understand their experiences and impressions of the corporate environment. Two questions were formulated: the first asked what surprised them most when they started the internship, of the 76% of responses, 50% emphasized the interdisciplinary nature of the work environment, while 26% highlighted the absence of obtaining technical-behavioral knowledge in the academic environment. In the second question, the interviewers asked what was learned at work that had not been learned at the university, 75% chose the alternative that pointed out the impact of relationships with clients, other professionals, and companies (CNI, 2021).

The challenge foreseen by CNI for educational institutions, and in particular for corporations, will be, based on holistic curricula focused on professional experience, as PMBOK® (2021) had already suggested, to promote the interaction of these graduates of the digital era with the conventional training of the older generation, transforming the learning of the former and the experience of the latter into a productive exchange of perspectives.

With the aim of preparing engineers to face current challenges and contribute to the future, SENAI-Cimatec University Center has been implementing, since 2017, the Academic Innovation Project in seven Engineering courses. The project, which has already involved more than 70 people, involves an extensive review of the curricula of the courses, the introduction of new educational methods and technologies, the focus on the development of skills, teacher training, changes in infrastructure, and, in particular, the development of skills that involve complex cognitive domains. Following the requirements established in the NCGs, competency-based curricula seek a balance in the development of technical-scientific and transversal competencies. Technical competencies are used in specific situations of a particular professional function, while transversal competencies are more related to the subjective quality of performance and involve aspects such as teamwork, communication, adaptability, and autonomy. The combination of these two categories of competencies is what guarantees a training that prepares the professional to deal effectively with adverse situations in their work environment (CNI, 2021).

The market forecast is that engineering professionals will be more exposed to technologies that facilitate work involving calculations and technical knowledge of the area, the future explores tools that support most of the workload, leaving professionals with other skills in the spotlight. In particular, soft skills are the characteristics that qualify the engineer as prepared to work on projects, for example: the ability to lead teams, logical reasoning, critical thinking, and effective communication (CRUZ et al., 2022).

Once the professional has the competence to work in a team, it will be their problem-solving methods that will find solutions in the company's projects, and the use of agile methodologies, such as Scrum and Design Thinking, presented by PMBOK®, has proven to be essential to increase the efficiency and flexibility of teams. These methodologies promote short development cycles, incremental deliveries, and continuous feedback, allowing for rapid adjustments and constant improvements. In addition, transparency and collaboration are strengthened, facilitating communication between team members and stakeholders. When it comes to project risk management, the application of agile methodologies is equally crucial. The iterative and incremental approach of agile methodologies allows for early identification of risks and the implementation of mitigation strategies more effectively. Under the vision of the demand of Onesubsea, to need to enter risk management, its size already supports the activities indicated by (NETO, 2020; SPÓSITO et al. 2018; VIEIRA; BARRETO, 2019) for training in risk management: planning management; identification; qualitative analysis; quantitative analysis; tracking; control; monitoring; responses and implementation of responses.

To make the company more competitive, the identification, analysis, response, and monitoring of risks are essential, which can be done through agile project management methodologies. As an alternative solution, Spósito (2018) presented the use of the Fine process management model, a method that, in addition to identifying the highest priority risks, can also calculate the values of each operation. The objective of this analysis is to create a prioritization that guides the team's focus as effectively as possible. This analysis makes the company's risk management more concrete, facilitating informed decision-making.

Many of the risks and threats to be assessed and managed vary according to the economic moment, the market of operation, the sector of the organization and the level of maturity of the company in governance and compliance practices. For a comprehensive view of enterprise risks, it is necessary to consider five pillars, financial, cyber, regulatory, operational, and strategic risks, which according to Deloitte (2017) will allow the construction of a risk matrix with a more complete analysis.

Among the data collected in its research, Deloitte identified that almost 60% of the organizations interviewed already monitor their risks, so that they can identify new opportunities and threats, and also update the risk matrix assembled for the

company. Among the care that contributes to risk control, 69% of companies maintain communication and awareness channels as essential aspects of the project, engaging the clear and timely understanding of the culture of risk management intelligence of the company throughout all hierarchical levels of the organization. In addition to this care, companies recognized the capacity for advanced data analysis coming from the interest in identifying key risks in a preventive way, more than half of the companies interviewed identify it as a beneficial skill (DELOITTE, 2017).

A relevant risk identified in the Deloitte study was the assessment of the capacity of its professionals for risk management, where 59% of respondents stated that their employees in the risk management area have an adequate level of training for the area. Meanwhile, 51% of respondents reported that the level of knowledge of these employees is not adequate for the risk analysis function. This demonstrates that there is a gap in study in the market, a result that reinforces the need to develop the pedagogical nature of the risk management function, encouraging the creation of this culture of constant study and innovation of competencies (DELOITTE, 2017).

FINAL CONSIDERATIONS

Since innovation involves embracing change, whether it's something entirely new or a renewal, when a company innovates, it exposes itself to uncertainty factors that can bring both benefits and drawbacks, thus assuming a risk. Based on this premise, risk management is mandatory for the development of innovation within corporations. As explored, the company Onesubsea, within its Project Management sphere, presents a specific deficiency in Risk Management. This article was able to identify the pillars of risk identification and the stages of its management.

Still in the context of innovation and Project Management, the data from Deloitte (2017) analyzed that the market presents gaps in the training and preparation of its professionals. As suggested by the Industry Recovery Plan presented by CNI in 2023, the main factors to boost the competitiveness of Brazilian industry include investment in technology, innovation, and education. The constant development of competencies and skills has become a professional requirement arising from Industry 4.0. The new technologies that have emerged and the changes in socio-professional relationships are causing intense changes in working conditions, employment levels, and the requirements made in the curriculum. Similarly, there are positions being created that demand professionals with a more complete profile of competencies compatible with the position, filling more complex positions within the new industrial systems (NETO, 2020).

After reading two of the main Brazilian industrial organizations, CNI and SENAI, it is noticeable that engineering is the area of knowledge that propels innovation in the country's industry. Moreover, there are many equipment and technologies being used abroad that could be adopted within the Brazilian industry, but the lack of modernization of academia prevents the connection between professionals and innovation from happening in the academic field. This lack of link has already been pointed out by the CNI Strategic Map (2023-2032) and is a factor that the Confederation has already placed on the radar of gaps to be filled by 2032.

Brazilian engineering is internationally recognized for its achievements in infrastructure, a success attributed to the quality of engineering education in Brazil during the 1970s and 1980s. However, the market has evolved in a way that Brazilian engineering academia has not yet followed. In addition, the COVID-19 pandemic highlighted the need for a pedagogical language suitable for the implemented educational technologies. From the study of the market in which the Engineering Academy is inserted, it was possible to verify the need for the reformulation of traditional Engineering courses. Faced with the speed of updating technologies, it is essential, as Cruz et al. (2022) point out, that the professional be able to develop and adapt to the environment. In this way, the restructuring of engineering courses would allow the development of new competencies in the professionals to be trained. They would consequently be able to implement projects in their companies, including Risk Management, so that the company can seek assertiveness in its investments. This would bring security and enable the entry of innovation into the organization, directly impacting the competitiveness of the Brazilian industry.

To do so, the country needs to invest in reskilling and upskilling strategies, which keep the skills and competencies of workers aligned with new technological trends. Engineers face unprecedented challenges that require continuous improvement, innovation, leadership, and effective communication. In addition to a robust technical background, they need to manage technical and commercial decisions, communicating complex ideas clearly. Understanding the systemic and integrated vision is essential to make decisions that benefit complex and integrated systems.

Considering the dropout rate pointed out in the study by Conceição, Longhini, and Oliveira (2020), as the environment in which FAE seeks to train a professional with an analytical and strategic profile. In this way, FAE Centro Universitário has had a coherent response to the demand of its audience by reformulating the production engineering course, the changes accompany the need for a holistic view of production, provide opportunities for the development of soft skills and bring new competitive skills to engineering students, this set of preparations allows the creation of the critical thinking that PMBOK® (2021) indicated as the basic requirement for professionals.

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